湖泊流域动态

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- 全球湖泊的甲烷排放：最新时空数据和甲烷动态模拟揭示排放并没有那么多

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Greenland ice sheet climate disequilibrium and committed sea-level rise

Jason E. Box；Alun Hubbard；David B. Bahr;等

Ice loss from the Greenland ice sheet is one of the largest sources of contemporary sea-level rise (SLR). While process-based models place timescales on Greenland's deglaciation, their confidence is obscured by model shortcomings including imprecise atmospheric and oceanic couplings. Here, we present a complementary approach resolving ice sheet disequilibrium with climate constrained by satellite-derived bare-ice extent, tidewater sector ice flow discharge and surface mass balance data. We find that Greenland ice imbalance with the recent (2000–2019) climate commits at least 274 ± 68 mm SLR from 59 ± 15 × 103 km2 ice retreat, equivalent to 3.3 ± 0.9% volume loss, regardless of twenty-first-century climate pathways. This is a result of increasing mass turnover from precipitation, ice flow discharge and meltwater run-off. The high-melt year of 2012 applied in perpetuity yields an ice loss commitment of 782 ± 135 mm SLR, serving as an ominous prognosis for Greenland's trajectory through a twenty-first century of warming.

（来源：Nature Climate Change 出版年: 2022,**DOI:** 10.1038/s41558-022-01441-2）

Global goals overlook freshwater conservation

DUARTE V. GONÇALVES AND VIRGILIO HERMOSO

As global conservation and restoration policies focus on a land and sea framework, freshwater biodiversity and services continue to decline at alarming rates . If freshwater ecosystems are overlooked, their sustainability could be compromised when decision-makers evaluate trade-offs with land and sea conservation and development goals. To protect freshwater biodiversity and vital services, international agreements must explicitly acknowledge freshwater ecosystems as a unique realm and set specific goals to address their problems .

At the 2021 UN Climate Change Conference in Glasgow (COP26), countries reaffirmed their commitments to the three Rio Conventions on Biological Diversity, Climate Change, and Desertification . The three respective panels are preparing reports that will shape the 2030 sustainable development goals (SDGs) and the 2021–2030 UN Decade on Ecosystem Restoration. Setting explicit objectives for freshwater ecosystems in these goals must be a priority.

Unfortunately, the recently released "Global land outlook" , the flagship publication of the UN Convention to Combat Desertification, a convention that defines pathways to sustainable land and water management, still mostly treats fresh water as a simple resource for services such as irrigation and consumption rather than a unique ecosystem that sustains biodiversity and a range of other services and that has particular management needs. The undervaluing of freshwater ecosystems is demonstrated by how rarely the word is used: Fresh water is mentioned twice in the summary for decision-makers, but both times as "freshwater use," with no mention of the associated ecosystems or their management. Land restoration commitments of "1 billion hectares of farms, forests, and pastures" make no explicit allusion to rivers or other freshwater ecosystems. This shortsightedness is consistent with SDG 15 ("life on land"), which discounts the uniqueness of the freshwater realm, and with SDG 6 ("water and

sanitation"), which prioritizes only the most immediate services that freshwater ecosystems provide. Underestimating the value of fresh water undermines the potential for long-term sustainability.

Some recent reports provide hope that we can prioritize freshwater conservation and recognize the unique problems and challenges that such ecosystems face. In the Intergovernmental Panel on Climate Change's sixth assessment report (AR6), the working group on "impacts, adaptation and vulnerability" breaks ecosystem impacts into terrestrial, ocean, and fresh water . In addition, the latest draft of the post-2020 Global Biodiversity Framework indicates the possibility of including fresh water in several goals and targets.

（来源：Science 卷:377 出版年: 2022,**DOI:** 10.1126/science.add6295）

700,000 years of tropical Andean glaciation

Rodbell, D. T.; Hatfield, R. G.; Abbott, M. B.; 等

Our understanding of the climatic teleconnections that drove ice-age cycles has been limited by a paucity of well-dated tropical records of glaciation that span several glacial-interglacial intervals. Glacial deposits offer discrete snapshots of glacier extent but cannot provide the continuous records required for detailed interhemispheric comparisons. By contrast, lakes located within glaciated catchments can provide continuous archives of upstream glacial activity, but few such records extend beyond the last glacial cycle. Here a piston core from Lake Junin in the uppermost Amazon basin provides the first, to our knowledge, continuous, independently dated archive of tropical glaciation spanning 700,000 years. We find that tropical glaciers tracked changes in global ice volume and followed a clear approximately 100,000-year periodicity. An enhancement in the extent of tropical Andean glaciers relative to global ice volume occurred between 200,000 and 400,000 years ago, during sustained intervals of regionally elevated hydrologic balance that modified the regular approximately 23,000-year pacing of monsoon-driven precipitation. Millennial-scale variations in the extent of tropical Andean glaciers during the last glacial cycle were driven by variations in regional monsoon strength that were linked to temperature perturbations in Greenland ice cores(1); these interhemispheric connections may have existed during previous glacial cycles.

（来源：Nature 卷: 607 期: 7981 出版年: 2022,**DOI:** 10.1038/s41586-022-04873-0）

Poyang and Dongting Lakes, Yangtze River: tributary lakes blocked by main-stem aggradation

Chenge Ana; Hongwei Fanga; Li Zhanga;等

During its 6,300-km course from the Tibetan Plateau to the ocean, the Yangtze River is joined by two large lakes: Dongting Lake and Poyang Lake. We explain why these lakes exist. Deglaciation forced the ocean adjacent to the Yangtze mouth to rise 120 m. This forced a wave of rising water surface elevation and concomitant bed aggradation upstream. While aggradation attenuated upstream, the low bed slope of the Middle-Lower Yangtze River (2 * 10-5 near Wuhan) made it susceptible to sea level rise. The main stem, sourced at 5,054 m above sea level, had a substantial sediment load to "fight" against water surface level rise by means of bed aggradation. The tributaries of the Middle-Lower Yangtze have reliefs of approximately hundreds of meters, and did not have enough sediment supply to fill the tributary accommodation space created by main-stem aggradation. We show that the resulting tributary blockage likely gave rise to the lakes. We justify this using field data and numerical modeling, and derive a

dimensionless number capturing the critical rate of water surface rise for blockage versus nonblockage.

（来源：PNAS 卷:119 期:30 出版年: 2022,**DOI:** 10.1073/pnas.2101384119）

Climate change threatens terrestrial water storage over the Tibetan Plateau

Li, Xueying; Long, Di; Scanlon, Bridget R.; 等

The Tibetan Plateau is an important source region of freshwater for large parts of Asia's population. Here the authors quantify past and future terrestrial water-storage changes and find a large net loss in this region, with the Amu Darya and Indus basins as the most vulnerable hotspots. Terrestrial water storage (TWS) over the Tibetan Plateau, a major global water tower, is crucial in determining water transport and availability to a large downstream Asian population. Climate change impacts on historical and future TWS changes, however, are not well quantified. Here we used bottom-up and top-down approaches to quantify a significant TWS decrease (10.2 Gt yr^{-1}) over the Tibetan Plateau in recent decades (2002-2017), reflecting competing effects of glacier retreat, lake expansion and subsurface water loss. Despite the weakened trends in projected TWS, it shows large declines under a mid-range carbon emissions scenario by the mid-twenty-first century. Excess water-loss projections for the Amu Darya and Indus basins present a critical water resource threat, indicating declines of 119% and 79% in water-supply capacity, respectively. Our study highlights these two hotspots as being at risk from climate change, informing adaptation strategies for these highly vulnerable regions.

（来源：Nature Climate Change 出版年: 2022,**DOI:** 10.1038/s41558-022-01443-0）

Rewetting global wetlands effectively reduces major greenhouse gas emissions

Junyu Zou; Alan D. Ziegler; Deliang Chen;等

Carbon and nitrogen losses from degraded wetlands and methane emissions from flooded wetlands are both important sources of greenhouse gas emissions. However, the net-exchange dependence on hydrothermal conditions and wetland integrity remains unclear. Using a global-scale in situ database on net greenhouse gas exchanges, we show diverse hydrology-influenced emission patterns in CO2, CH4 and N2O. We find that total CO2-equivalent emissions from wetlands are kept to a minimum when the water table is near the surface. By contrast, greenhouse gas exchange rates peak in flooded and drained conditions. By extrapolating the current trajectory of degradation, we estimate that between 2021 and 2100, wetlands could result in greenhouse gas emissions equivalent to around 408 gigatons of CO2. However, rewetting wetlands could reduce these emissions such that the radiative forcing caused by CH4 and N2O is fully compensated by CO2 uptake. As wetland greenhouse gas budgets are highly sensitive to changes in wetland area, the resulting impact on climate from wetlands will depend on the balance between future degradation and restoration.

（来源：Nature Geoscience 出版年: 2022,**DOI:** 10.1038/s41561-022-00989-0）

Mapping peat thickness and carbon stocks of the central Congo Basin using field data

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The world's largest tropical peatland complex is found in the central Congo Basin. However, there is a lack of in situ measurements to understand the peatland's distribution and the amount of carbon stored in it. So far, peat in this region has been sampled only in largely rain-fed interfluvial basins in the north of the Republic of the Congo. Here we present the first extensive field surveys of peat in the Democratic Republic of the Congo, which covers two-thirds of the estimated peatland area, including from previously undocumented river-influenced settings. We use field data from both countries to compute the first spatial models of peat thickness (mean 1.7 +/- 0.9 m; maximum 5.6 m) and peat carbon density (mean 1,712 +/- 634 MgC ha^{-1}; maximum 3,970 MgC ha^{-1}) for the central Congo Basin. We show that the peatland complex covers 167,600 km^2, 36% of the world's tropical peatland area, and that 29.0 PgC is stored below ground in peat across the region (95% confidence interval, 26.3-32.2 PgC). Our measurement-based constraints give high confidence of globally significant peat carbon stocks in the central Congo Basin, totalling approximately 28% of the world's tropical peat carbon. Only 8% of this peat carbon lies within nationally protected areas, suggesting its vulnerability to future land-use change. Field surveys suggest peatlands in the central Congo Basin are globally significant carbon stocks, storing approximately 28% of the world's tropical peat carbon.

（来源：Nature Geoscience 卷：15 期：8 出版年：2022,**DOI:** 10.1038/s41561-022-00966-7）

Plastic pollution fosters more microbial growth in lakes than natural organic matter

Sheridan, Eleanor A.; Fonvielle, Jeremy A.; Cottingham, Samuel; 等

Plastic debris widely pollutes freshwaters. Abiotic and biotic degradation of plastics releases carbon-based substrates that are available for heterotrophic growth, but little is known about how these novel organic compounds influence microbial metabolism. Here we found leachate from plastic shopping bags was chemically distinct and more bioavailable than natural organic matter from 29 Scandinavian lakes. Consequently, plastic leachate increased bacterial biomass acquisition by 2.29-times when added at an environmentally-relevant concentration to lake surface waters. These results were not solely attributable to the amount of dissolved organic carbon provided by the leachate. Bacterial growth was 1.72-times more efficient with plastic leachate because the added carbon was more accessible than natural organic matter. These effects varied with both the availability of alternate, especially labile, carbon sources and bacterial diversity. Together, our results suggest that plastic pollution may stimulate aquatic food webs and highlight where pollution mitigation strategies could be most effective. Ultra-high resolution mass spectrometry revealed that plastic bags leach labile compounds. Bioassays performed in Scandinavian lakes indicated that these compounds are incorporated into biomass faster and more efficiently than natural organic matter.

（来源：Nature Communications 卷：13 期：1 出版年：2022,**DOI:** 10.1038/s41467-022-31691-9）

Tropical forests as drivers of lake carbon burial

Amora-Nogueira, Leonardo; Sanders, Christian J.; Enrich-Prast, Alex; 等

A significant proportion of carbon (C) captured by terrestrial primary production is buried in lacustrine ecosystems, which have been substantially affected by anthropogenic activities globally. However, there is a scarcity of sedimentary organic carbon (OC) accumulation information for lakes surrounded by highly productive rainforests at warm tropical latitudes, or in response to land cover and climate change. Here, we combine new data from intensive campaigns spanning 13 lakes across remote Amazonian regions

with a broad literature compilation, to produce the first spatially-weighted global analysis of recent OC burial in lakes (over similar to 50-100-years) that integrates both biome type and forest cover. We find that humid tropical forest lake sediments are a disproportionately important global OC sink of similar to 80 Tg C yr(-1) with implications for climate change. Further, we demonstrate that temperature and forest conservation are key factors in maintaining massive organic carbon pools in tropical lacustrine sediments.

（来源：Nature Communications 卷：13 期：1 出版年：2022,**DOI:** 10.1038/s41467-022-31258-8）

Sustained and intensified lacustrine methane cycling during Early Permian climate warming

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Lakes are a major emitter of the atmospheric greenhouse gas methane (CH_4); however, their roles in past climate warming episodes remain poorly understood owing to a scarcity of geological records. Here we report the occurrence of sustained and intensified microbial CH_4 cycling in paleo-Lake Junggar in northwestern China, one of the largest known Phanerozoic lakes, during Early Permian climate warming. High-precision U-Pb geochronology refines the age of the upper Lucaogou Formation to the Artinskian, which marks a major glacial-to-postglacial climate transition. The C-13-enriched authigenic dolomites indicate active methanogenesis in the anoxic lake sediments, and C-13-depleted hopanes suggest vigorous methanotrophy in the water column. The intensification of CH_4 cycling coincided with increasing global temperature, as evidenced from elevated continental chemical weathering. Our results suggest that the lacustrine CH_4 emissions acted as a positive feedback to global warming and contributed to the demise of the Late Paleozoic Ice Age. This study reports the occurrence of sustained and intensified microbial CH_4 cycling in a giant lake in northwestern China during Early Permian climate warming. Lacustrine CH_4 emissions may have contributed to the end of the Late Paleozoic Ice Age.

（来源：Nature Communications 卷：13 期：1 出版年：2022,**DOI:** 10.1038/s41467-022-32438-2）

Separating natural from human enhanced methane emissions in headwater streams

Zhu, Yizhu; Jones, J. Iwan; Collins, Adrian L.; 等

Headwater streams are natural sources of methane but are suffering severe anthropogenic disturbance, particularly land use change and climate warming. The widespread intensification of agriculture since the 1940s has increased the export of fine sediments from land to streams, but systematic assessment of their effects on stream methane is lacking. Here we show that excess fine sediment delivery is widespread in UK streams (n = 236) and, set against a pre-1940s baseline, has markedly increased streambed organic matter (23 to 100 g m^{-2}), amplified streambed methane production and ultimately tripled methane emissions (0.2 to 0.7 mmol CH_4 m^{-2} d^{-1}, n = 29). While streambed methane production responds strongly to organic matter, we estimate the effect of the approximate 0.7 degrees C of warming since the 1940s to be comparatively modest. By separating natural from human enhanced methane emissions we highlight how catchment management targeting the delivery of excess fine sediment could mitigate stream methane emissions by some 70%. The effects of fertiliser from intensive agriculture are well recognised, but not so well for fine-sediment. Here we show how widespread ingress of agriculturally derived fine-sediment since the 1940s markedly amplifies methane emissions from streams.

（来源：Nature Communications 卷：13 期：1 出版年：2022,**DOI:** 10.1038/s41467-022-31559-y）

Climate and land management accelerate the Brazilian water cycle

Chagas, Vinicius B. P.; Chaffe, Pedro L. B.; Bloeschl, Gunter

Increasing floods and droughts are raising concerns of an accelerating water cycle. A new study shows that the terrestrial water cycle in Brazil has been mostly drying or accelerating, aligned with changes in rainfall, water use, and forest cover. Increasing floods and droughts are raising concerns of an accelerating water cycle, however, the relative contributions to streamflow changes from climate and land management have not been assessed at the continental scale. We analyze streamflow data in major South American tropical river basins and show that water use and deforestation have amplified climate change effects on streamflow extremes over the past four decades. Drying (fewer floods and more droughts) is aligned with decreasing rainfall and increasing water use in agricultural zones and occurs in 42% of the study area. Acceleration (both more severe floods and droughts) is related to more extreme rainfall and deforestation and occurs in 29% of the study area, including southern Amazonia. The regionally accelerating water cycle may have adverse global impacts on carbon sequestration and food security.

（来源：Nature Communications 卷：13 期：1 出版年：2022,**DOI:** 10.1038/s41467-022-32580-x）

Longest sediment flows yet measured show how major rivers connect efficiently to deep sea

Talling, Peter J.; Baker, Megan L.; Pope, Ed L.; 等

There is significant debate about why less than half of European rivers and streams are in good ecological status, despite decades of intense regulatory efforts. Of the multiple stressors that are recognized as potential contributors to stream degradation, we focus on discharge from 26,500 European wastewater treatment plants (WWTPs). We tested the hypothesis that stream ecological status degradation across Europe is related to the local intensity of wastewater discharge, with an expected stream-order (omega) dependence based on the scaling laws that govern receiving stream networks. We found that ecological status in streams (omega & LE;3) declined consistently with increasing urban wastewater discharge fraction of stream flow (UDF) across river types and basins. In contrast, ecological status in larger rivers (omega & GE;4) was not related to UDF. From a continental-scale logistic regression model (accuracy 86%) we identified an ecologically critical threshold UDF = 6.5% +/- 0.5. This is exceeded by more than one third of WWTPs in Europe, mostly discharging into smaller streams. Our results suggest that new receiving water-specific strategies for wastewater management are needed to achieve good ecological status in smaller streams.

（来源：Nature Communications 卷：13 期：1 出版年：2022,**DOI:**10.1038/s41467-022-31689-3）

The emerging role of drought as a regulator of dissolved organic carbon in boreal landscapes

Tiwari, Tejshree; Sponseller, Ryan; Laudon, Hjalmar

Global tree restoration could cause substantial and regionally variable changes in water availability, according to an ensemble of Budyko models and moisture recycling data. Tree restoration is an effective way to store atmospheric carbon and mitigate climate change. However, large-scale tree-cover

expansion has long been known to increase evaporation, leading to reduced local water availability and streamflow. More recent studies suggest that increased precipitation, through enhanced atmospheric moisture recycling, can offset this effect. Here we calculate how 900 million hectares of global tree restoration would impact evaporation and precipitation using an ensemble of data-driven Budyko models and the UTrack moisture recycling dataset. We show that the combined effects of directly enhanced evaporation and indirectly enhanced precipitation create complex patterns of shifting water availability. Large-scale tree-cover expansion can increase water availability by up to 6% in some regions, while decreasing it by up to 38% in others. There is a divergent impact on large river basins: some rivers could lose 6% of their streamflow due to enhanced evaporation, while for other rivers, the greater evaporation is counterbalanced by more moisture recycling. Several so-called hot spots for forest restoration could lose water, including regions that are already facing water scarcity today. Tree restoration significantly shifts terrestrial water fluxes, and we emphasize that future tree-restoration strategies should consider these hydrological effects.

（来源：Nature Communications 卷: 13 期: 1 出版年: 2022,**DOI**：10.1038/s41467-022-32839-3）

Beyond just foodwater

Jim Best, Peter Ashmore and Stephen E. Darby

Flooding, already the largest hazard facing humankind, is becoming more frequent and afecting more people. Adapting to fooding must consider more than just water to encapsulate the efects of sediment movement, re-imagine fooding through a sociogeomorphic lens and expand approaches to knowing about foods.

（来源：Nature Suntainability 卷:5 出版年: 2022, **DOI:** 10.1038/s41893-022-00929-1）

Humans pressure wetland multifunctionality

Rajeev Pillay.

A large dataset of aquatic biodiversity across multiple trophic levels from several wetlands in Brazil reveals that biodiversity-multifunctionality relationships break down with human pressures.

（来源：Nature Ecology & Evolution 出版年: 2022, **DOI:** 10.1038/s41559-022-01842-8）

摘要精选

High Inter- and Intra-Lake Variation in Sediment Phosphorus Pools in Shallow Lakes

Ellen A. Albright; Fleck King Rachel; Quin K. Shingai;等

Phosphorus (P) release from lakebed sediments may fuel phytoplankton blooms, especially in shallow waterbodies. A primary mechanism that controls internal P loading is the size and chemical composition of the sediment P pool. However, variation in sediment P within and among shallow lakes remains poorly quantified. We measured the degree of spatial heterogeneity in the size and composition of sediment P pools, both within and among seven shallow lakes. There was a 1.6× difference in total sediment P among the study lakes, and P composition varied across lakes based on differences in watershed soils and land cover and lake basin morphology. Differences in sediment P composition among lakes imply that the dominant mechanisms of internal loading will also vary among lakes. We also found that higher mobile P (as a fraction of total P) in the profundal sediments was positively correlated with long-term mean chlorophyll-a concentrations ($p = 0.04$), indicating the reciprocal relationship between sediment P composition and phytoplankton biomass in shallow lakes. Additionally, we measured substantial within-lake heterogeneity in total and loosely-bound sediment P within each lake. Concentrations were positively correlated with water depth such that extrapolating measurements from the deep site alone could overestimate whole-lake mean P concentrations, reinforcing that single station methods produce unreliable estimates of mean sediment P stocks. Our results provide insight into the magnitude and pattern of inter- and intra-lake variation in sediment P pools that should be accounted for when sampling, scaling measurements, and modeling sediment P dynamics.

（来源：Journal of Geophysical Research:Biogeosciences 出版年: 2022, **DOI:** 10.1029/2022JG006817）

Methane Emission From Global Lakes: New Spatiotemporal Data and Observation-Driven Modeling of Methane Dynamics Indicates Lower Emissions

Matthew S. Johnson; Elaine Matthews; Jinyang Du;等

Lakes have been highlighted as one of the largest natural sources of the greenhouse gas methane (CH_4) to the atmosphere. However, global estimates of lake CH_4 fluxes over the last 20 years exhibit widely different results ranging from 6 to 185 Tg CH_4 yr^{-1}), which is to a large extent driven by differences in lake areas and thaw season lengths used. This has generated uncertainty regarding both lake fluxes and the global CH_4 budget. This study constrains global lake water CH_4 emissions by using new information on lake area and distribution and CH_4 fluxes distinguished by major emission pathways; ecoclimatic lake type; satellite-derived ice-free emission period length; and diel- and temperature-related seasonal flux corrections. We produced gridded data sets at 0.25 degrees latitude x 0.25 degrees longitude spatial resolution, representing daily emission estimates over a full annual climatological cycle, appropriate for use in global CH_4 budget estimates, climate and Earth System Models, bottom-up biogeochemical models, and top-down inverse model simulations. Global lake CH_4 fluxes are 41.6 +/- 18.3 Tg CH_4 yr^{-1}) with approximately 50% of the flux contributed by tropical/subtropical lakes. Strong temperature-dependent flux seasonality and satellite-derived freeze/thaw dynamics limit emissions at high latitudes. The primary emission pathway for global annual lake fluxes is ebullition (23.4 Tg) followed

by diffusion (14.1 Tg), ice-out and spring water-column turnover (3.1 Tg), and fall water-column turnover (1.0 Tg). These results represent a major contribution to reconciling differences between bottom-up and top-town estimates of inland aquatic system emissions in the global CH_4 budget.

（来源：Journal of Geophysical Research:Biogeosciences 出版年：2022, **DOI:** 10.1029/2022JG006793）

Characterizing temporal and spatial scales of radiatively driven convection in a deep, ice-free lake

Austin, Jay; Hill, Craig; Fredrickson, Jacob; 等

From May to July 2019, an array of moored equipment was deployed in Lake Superior to characterize the spatial and temporal scales of radiatively driven convection (RDC). Previous work suggested that convective plumes have horizontal scales on the order of tens of meters, posing a significant observational challenge. The centerpiece of the deployment was a large, two-dimensional (2D) array of thermistors that provided resolution on the order of 10 meters in both the vertical and a single horizontal dimension. This was augmented by an acoustic Doppler current meter mooring and a meteorology buoy capable of estimating surface heat and momentum fluxes. Instantaneous temperature variability at a given location is dominated by a lateral background flow advecting strong horizontal temperature gradients. By combining velocity data with temperature data, this fact can be used to examine horizontal structure at centimeter scales, and can produce 2D images of instantaneous temperature distribution on a horizontal surface, revealing multiple patterns of temperature anomaly distribution. The walls of convective structures are very sharp, with horizontal gradients on the order of 1 degrees C $m(^{-1})$; horizontal scales of convective structures themselves are on the order of many tens of meters. Finally, convection is shown to strongly control the vertical distribution of water quality parameters.

（来源：Limnology and Oceanography 出版年: 2022, **DOI:** 10.1002/lno.12203）

Dissolved organic matter mediates the effects of warming and inorganic nutrients on a lake planktonic food web

Hebert, Marie-Pier; Soued, Cynthia; Fussmann, Gregor F.;等

Lakes are undergoing striking physicochemical changes globally, including co-occurring increases in dissolved organic carbon and nutrient concentrations, water color, and surface temperature. Although several experimental studies of lake browning and warming have been conducted over the last decade, knowledge remains limited as to the structural and functional responses of multitrophic plankton communities, especially under environmentally relevant physicochemical conditions. Using reverse osmosis to manipulate naturally occurring dissolved organic matter (DOM), we performed an enclosure experiment to evaluate the response of a planktonic food web (zooplankton–phytoplankton–bacterioplankton) to individual and combined increases in DOM and temperature, while accounting for changes in inorganic nutrients associated with DOM enrichment. We found that concomitant increases in DOM and temperature or inorganic nutrients elicited substantially greater biotic effects, but infrequently led to interactive effects. Overall, major plankton groups responded differently to manipulated factors, with most effects observed in standing stocks, community composition, and trophic structure, while metabolic (primary production and respiration) rates appeared to be generally less responsive. DOM enrichment had a clear stimulatory effect on phytoplankton, but weakly affected zooplankton. More specifically, DOM enrichment, alone or combined with inorganic nutrient amendments, decreased zooplankton : chlorophyll a ratios, implying a reduced trophic transfer efficiency and altered

trophic structure. Warming generally increased bacterial abundance and cyanobacterial dominance, especially under DOM-enriched conditions. Collectively, these results demonstrate that increasing local DOM, even by only ~ 2 mgC L 1 , can enhance plankton responses to rising temperature or inorganic nutrients in the near-surface layer of a clearwater lake, with potential implications for ecosystems facing co-occurring environmental changes.

（来源：Limnology and Oceanography 出版年: 2022, **DOI:** 10.1002/lno.12177）

In situ flux estimates reveal large variations in methane flux across the bottom boundary layer of a eutrophic lake

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Methane (CH_4) produced in anoxic sediments plays a significant role in the carbon economy of many lakes and reservoirs. CH_4 released from sediments first crosses the bottom boundary layer (BBL), the layer of water overlying the lakebed where currents are slowed by friction with the sediments below. Physical and biogeochemical conditions in the BBL, which can fluctuate hourly to daily with basin-wide internal waves (seiches), likely influence CH_4 transport from sediments into the hypolimnion. In this study, we estimated CH_4 fluxes across the BBL of a eutrophic lake using a novel in situ flux gradient approach adapted from marine applications. For 2-6 h periods throughout the spring and summer, we estimated CH_4 fluxes across the BBL using simultaneous measurements of CH_4 concentrations, turbulent mixing, and thermal stratification. Sub-daily variation in CH_4 fluxes was high, and CH_4 fluxes sometimes changed several-fold within hours. These rapid shifts in BBL fluxes were likely influenced by fluctuations in seiche-driven variations in the intensity of BBL turbulent mixing. Fluxes increased from spring to summer, concurrent with the development of lake stratification, and fueled an accumulation of CH_4 below the thermocline. Throughout the summer, CH_4 flux across the BBL exceeded CH_4 accumulation below the thermocline, suggesting significant methanotrophy in the hypolimnion, consistent with incubation-based oxidation rates. Our results are the first to demonstrate sub-daily and seasonal variability in the timing and magnitude of CH_4 fluxes within a lake BBL, and highlight a need to quantify such variability in other lentic systems.

（来源：Limnology and Oceanography 出版年: 2022, **DOI:** 10.1002/lno.12193）

Long-term change in metabolism phenology in north temperate lakes

Robert Ladwig；Alison P. Appling；Austin Delany；等

The phenology of dissolved oxygen (DO) dynamics and metabolism in north temperate lakes offers a basis for comparing metabolic cycles over multi-year time scales. Although proximal control over lake DO can be attributed to metabolism and physical processes, how those processes evolve over decades largely remains unexplored. Metabolism phenology may reveal the importance of coherence among lakes and facilitate general conclusions about the controls on lake metabolism at regional scales. We developed a Bayesian modeling framework to estimate DO concentrations and metabolism in eight lakes in contrasting landscapes in Wisconsin, USA. We identify the DO and metabolism phenologies for each lake, and use those to compare how decadal patterns relate to trophic state and landscape setting. We show that lakes can be categorized by their hypolimnetic oxygen consumption dynamics, with oligotrophic lakes having a diverse set of patterns and eutrophic lakes having uniform trends of increased oxygen consumption over the last decade. Metabolism phenology is likewise diverse for oligotrophic lakes, whereas eutrophic lakes in southern Wisconsin share consistent long-term patterns of metabolic

trends and seasonal DO consumption highlighting the importance of trophic state driving metabolism. Eutrophic lakes had higher magnitudes and more seasonal variation in net ecosystem production in contrast to oligotrophic lakes. Generally, long-term metabolic trends of north temperate lakes suggest a limited influence of climate on lake metabolism and that temporal coherence of long-term metabolism change is driven primarily by the landscape setting.

（来源：Limnology and Oceanography 出版年: 2022, **DOI:** 10.1002/lno.12098）

Multiscale effects of wind-induced hydrodynamics on lake plankton distribution

William Gary Sprules；Hélène Cyr；Charles W. Menza;等

In this study, we used a combination of high-intensity sampling technologies, and a 3D hydrodynamic model of a medium-sized lake in southern Ontario, Canada to investigate physical–biological relationships at spatial scales from 100 m to 6 km and temporal scales from hours to months. At the scale of the whole study basin, we predicted that stronger winds would lead to higher zooplankton biomass downwind relative to upwind. The hydrodynamic model suggests rapid downwind displacement of progressively deeper surface mixed layers with increasing winds, and we found a statistically higher downwind biomass of small-bodied zooplankton on windy days, but not large zooplankton. At a fine spatial scale (hundreds of meters), we predicted that zooplankton patchiness would decrease with increasing wind mixing of the upper water column and confirmed this for small-bodied but not large-bodied zooplankton. At this fine-scale crosscorrelations of zooplankton biomass with water temperature and chlorophyll fluorescence suggested that zooplankton are not simply moved passively by water masses. We also found a clear change in the crosscorrelation between large- and small-bodied zooplankton biomass, with out-of-phase spatial distributions during calm periods becoming in-phase with increasing winds. Overall these results indicate that the response of zooplankton to wind-driven physical forces is strongly dependent on an interaction between their body size, which determines their swimming speed and capacity to position themselves vertically in the water column, and the spatial scale and intensity of the wind-generated physical forces. We discuss the implications for food web interactions.

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Natural and anthropogenic controls on lake water-level decline and evaporation-to-inflow ratio in the conterminous United States

C. Emi Fergus ；J. Renée Brooks；Philip R. Kaufmann；等

Lake water levels are integral to lake function, but hydrologic changes from land and water management may alter lake fluctuations beyond natural ranges. We constructed a conceptual model of multifaceted drivers of lake water levels and evaporation-to-inflow ratio (Evap : Inflow). Using a structural equation modeling framework, we tested our model on (1) a national subset of lakes in the conterminous United States with minimal water management to describe natural drivers of lake hydrology and (2) five ecoregional subsets of lakes to explore regional variation in water management effects. Our model fits the national and ecoregional datasets and explained up to 47% of variation in Evap : Inflow, 38% of vertical water level decline, and 79% of horizontal water level decline (littoral exposure). For lakes with minimal water management, Evap : Inflow was related to lake depth (β =-0.31) and surface inflow (β =-0.44); vertical decline was related to annual climate (e.g., precipitation β =-0.18) and water management (β =-0.21); and horizontal decline was largely related to vertical decline (β = 0.73) and lake

morphometry (e.g., depth β =-0.18). Anthropogenic effects varied by ecoregion and likely reflect differences in regional water management and climate. In the West, water management indicators were related to greater vertical decline (β = 0.38), whereas in the Midwest, these indicators were related to more stable and full lake levels (β =-0.22) even during drought conditions. National analyses show how human water use interacts with regional climate resulting in contrasting impacts to lake hydrologic variation in the United States.

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Summer ecosystem structure in mountain lakes linked to interannual variability of lake ice, snowpack, and landscape attributes

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Mountain lakes experience interannual variability in spring snowpack and ice cover that can lead to differences in physical, chemical, and biological properties in the succeeding summer. Lake studies that capture extreme years of snow and ice would be useful to understand and anticipate effects of climate change, but such data are rare for remote mountain lakes. Monitoring of lakes in Olympic, North Cascades, and Mount Rainier National Parks from 2007 to 2018 allowed us to examine limnological differences along interannual and elevation-driven climate gradients that included unusually high (2011-2012) and 100-yr record low (2015) snowpack years. Years with lower spring snowpack had earlier ice-out. Across lakes, our analysis suggested an average of 0.075 degrees C lake warming per day of lost ice duration (0.525 degrees C per week), giving rise to other ecosystem changes linked to temperature such as lower dissolved oxygen, higher total dissolved N, higher chlorophyll, and higher abundance of cladoceran zooplankton. Conversely, in years with higher snowpack and a shorter ice-free season, lakes were colder and clearer (1 m deeper Secchi depth for every 1 m May snow water equivalent), with more dilute ions as well as lower algal biomass and zooplankton abundance. These results add to evidence that changes in snowpack or ice-out dates alter mountain lake ecology through multiple processes associated with hydrology, terrestrial-aquatic connection, water temperature, productivity, ion composition, and plankton communities.

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The role of internal nitrogen loading in supporting non-N-fixing harmful cyanobacterial blooms in the water column of a large eutrophic lake

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Western Lake Erie cyanobacterial harmful algal blooms (cyanoHABs) occur every summer as a result of anthropogenic nutrient loading. Although the physiological importance of nitrogen (N) in supporting bloom biomass and toxin production is established, the role of internal N recycling in the water column to support bloom maintenance is not as well understood. Over three field seasons (2015-2017), we collected water from western Lake Erie and employed bottle incubations with 15 N-ammonium ($NH4^+$) enrichments to determine $NH4^+$ regeneration and potential uptake rates in the water column. Potential $NH4^+$ uptake rates followed spatial and seasonal patterns, with greatest rates measured nearest the Maumee River inflow and during peak bloom months (August and September). Regeneration followed a similar spatial pattern but was greatest in early summer (June and July) and supported similar to 20-60% of potential $NH4^+$ demand during the height of the bloom. Basinwide internal $NH4^+$ regeneration during

the April-October period could supply $NH4^+$ at 60-200% of annual external N loading to the western basin. These results help explain how non-N-fixing cyanoHABs in Lake Erie and other large, eutrophic lakes continue producing biomass and N-rich toxins long after spring nutrient loads are exhausted or transported to other areas. Internal N loads are ultimately driven by external N loads; in low precipitation years, external nutrient loads result in smaller blooms, producing less substrate for subsequent internal N loads. Overall, these findings, along with others, confirm that both internal and external N loading must be considered when evaluating cyanoHAB management strategies.

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Water depth and transparency drive the quantity and quality of organic matter in sediments of Alpine Lakes on the Tibetan Plateau

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Identifying primary environmental drivers mediating the quantity and quality of sedimentary organic matter (OM) in climate-sensitive alpine lakes is crucial to understanding the role of alpine lakes in greenhouse gas emissions and Earth's climate system. Here, we characterized various pools of OM of 20 alpine lakes across the Tibetan Plateau, including bulk OM, water-soluble OM and alkaline-extracted OM from surface sediments, and dissolved OM (DOM) from surface water. The total organic carbon (TOC) content in sediments was low (< 3%), and delta C-13 of TOC and C : N ratios indicated limited allochthonous carbon inputs. Sedimentary water-soluble OM and alkaline-extracted OM were both dominated by low-molecular-weight, low-aromaticity compounds with low contributions of terrestrial humic substances, suggesting that sedimentary leachable OM was primarily regulated by in-lake sources and processes. Redundancy analysis showed that water depth, water transparency, and total phosphorus concentration in water column explained similar to 50% variance of sedimentary bulk and leachable OM, substantiating the importance of autochthonous sources and primary productivity in regulating the quantity and quality of sedimentary OM. Compared with lake surface water DOM, water-soluble OM and alkaline-extracted OM from sediments had higher proportions of terrestrial humic-like substances, suggesting preferential preservation of allochthonous materials in sediments. Our results are the first to demonstrate a clear link between physical attributes and sedimentary OM in Tibetan lakes. The associated relations predict that the amount of total OM and autochthonous carbon preserved in sediments would increase due to the lake enlargement under the scenarios of climate warming and precipitation enhancement, which may amplify greenhouse gas emissions from Tibetan lakes.

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A theory for the relationship between lake surface area and maximum depth

Brendan B. Cael , David Seekell

Maximum depth is crucial for many lake processes and biota, but attempts to explain its variation have achieved little predictive power. In this paper, we describe the probability distribution of maximum depths based on recent developments in the theory of fractal Brownian motions. The theoretical distribution is right-tailed and adequately captures variations in maximum depth in a dataset of 8164 lakes (maximum depths 0.1–135 m) from the northeastern United States. Maximum depth increases with surface area, but with substantial random variation—the 95% prediction interval spans more than an order of magnitude

for lakes with any specific surface area. Our results explain the observed variability in lake maximum depths, capture the link between topographic characteristics and lake bathymetry, and provide a means to upscale maximum depth-dependent processes, which we illustrate by upscaling the diffusive flux of methane from northern lakes to the atmosphere.

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Lake reclamation alters molecular-level characteristics of lacustrine dissolved organic matter – A study of nine lakes in the Yangtze Plain, China

Quan-Hui Ye; Guo-Dong Sun; Ying-Hui Wang;等

In recent decades, the reclamation of lakes has captured 42% of the total lake area of the Yangtze Plain in China and introduced additional pressure on lacustrine water quality. While lacustrine dissolved organic matter (DOM) is critical in regulating biogeochemical processing and aquatic biodiversity, the impact of reclamation on the molecular-level characteristics of lacustrine DOM remains unexplored. Here, the DOM characteristics altered by reclamation practices in the Yangtze Plain lakes were investigated using fluorescence spectroscopy, nuclear magnetic resonance spectroscopy, and Fourier transform ion cyclotron resonance mass spectrometry. Results demonstrated that reclamation not only elevated the quantity (on average +32%) but also altered the characteristics and composition of lacustrine DOM. Compared to the natural water sites close by, reclamation sites did not significantly alter the DOM aromaticity but significantly lowered the average molecular weight and increased the biolability of DOM. The chromophoric DOM and humic-like fluorescent components were remarkably elevated, but not the protein-like fluorescent components. More lipid-like and condensed aromatic-like components were detected in the lacustrine DOM as compared to the lignin-like, carbohydrate-like, and protein-like components, which may be driven by the increased microbial processing. Overall, the significant alteration in characteristics and composition of lacustrine DOM highlights the potential impact of reclamation on the DOM biogeochemical cycle and the environmental quality in aquatic ecosystems.

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Anthropogenic eutrophication of shallow lakes: Is it occasional?

Zhou, Jian; Leavitt, Peter R.; Zhang, Yibo;等

Understanding and managing the susceptibility of lakes to anthropogenic eutrophication has been a primary goal of limnological research for decades. To achieve United Nations' Sustainable Development Goals, scientists have attempted to understand why shallow lakes appear to be prone to eutrophication and resistant to restoration. A rich data base of 1151 lakes (each >= 0.5 km2) located within the Europe and the United States of America offers a rare opportunity to explore potential answers. Analysis of sites showed that lake depth integrated socioecological systems and reflected potential susceptibility to anthropogenic stressors, as well as lake productivity. In this study, lakes distributed in agricultural plain and densely populated lowland areas were generally shallow and subjected to intense human activities with high external nutrient inputs. In contrast, deep lakes frequently occurred in upland regions, dominated by natural landscapes with little anthropogenic nutrient input. Lake depth appeared to not only reflect external nutrient load to the lake, but also acted as an amplifier that increased shallow lake susceptibility to anthropogenic disturbance. Our findings suggest that shallow lakes are more susceptible to human forcing and their eutrophication may be not an occasional occurrence, and that societal

expectations, policy goals, and management plans should reflect this observation.

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Cognizing and characterizing the organic phosphorus in lake sediments: Advances and challenges

Ni, Zhaokui; Li, Yu; Wang, Shengrui

Organic phosphorus (OP) is one of the main forms of phosphorus in lake ecosystems. Mounting evidence has shown that sediment OP has become a major but underestimated issue in addressing lake eutrophication and algal bloom. However, a holistic view of sediment OP remains missing. This review aims to provide an overview of progress on the studies of OP in lake sediments, focusing on the contribution of OP to internal P loading, its potential role in algal bloom, and the migration and transformation. In addition, this work systematically summarized current methods for characterizing OP content, chemical fraction, composition, bioavailability, and assessment of OP release in sediment, with the pros and cons of each method being discussed. In the end, this work pointed out following efforts needed to deepen the understanding of sediment OP, namely: (1) In-depth literature review from a global perspective regarding the contribution of sediment OP to internal P loading with further summary about its pattern of distribution, accumulation and historical changes; (2) better mathematical models for describing drivers and the linkages between the biological pump of algal bloom and the replenishment of sediment OP; (3) fully accounting the composition and molecular size of OP for better understanding its transformation process and mechanism; ; (4) developing direct, high-sensitivity and combined techniques to improve the precision for identifying OP in sediments; (5) establishing the response of OP molecular properties and chemical reactivity to OP biodegradability and designing a comprehensive and accurate composite index to deepen the understanding for the bioavailability of OP; and (6) integrating fundamental processes of OP in current models to better describe the release and exchange of P in sediment-water interface (SWI). This work is expected to provide critical information about OP properties and deliver perspectives of novel characterization methods.

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Distribution and model prediction of antibiotic resistance genes in Weishan Lake based on the indication of Chironomidae larvae

Ding, Chengshi; Gong, Zheng; Zhang, Kai;等

The widespread contamination of antibiotic resistance genes (ARGs) in freshwater environment are becoming a serious challenge to human health and ecological safety. Rapid and efficient monitoring of ARGs pollution is of great significance to ARGs control. Water, bottom mud, and fish have all been used to indicate ARG contami-nation in aquatic environments. However, it is unclear whether macrobenthic invertebrates in the food chain of aquatic environments can be indicators of ARG contamination. In this study, we demonstrated that ARGs including tetA gene, sul2 gene, and km gene were distributed in Chironomidae larvae in Weishan Lake. The ARG distribution was related to animal species, body parts, sampling sites, time, urban environment, animal farming, south-to-north water diversion, food chain, antibiotics, and water storage. Mathematical model predictions of ARG contamination in Weishan Lake were constructed based on the structural equation model (SEM) and the distribution of ARG sul2 in Chironomidae larvae. Influencing factors such as water storage, metal elements, antibiotic, and temperature were found to be closely related to the prediction of ARG contamination. This study provided

a new indicator for ARG contamination in freshwater environments and a method to predict ARGs contamination.

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Dominance of evaporation on lacustrine groundwater discharge to regulate lake nutrient state and algal blooms

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As global threats to freshwater lakes, eutrophication and harmful algal blooms (HABs) are governed by various biogeochemical, climatological and anthropogenic processes. Groundwater is key to join these processes in regulating HABs, but the underlying mechanisms remain unclear. Here, we leveraged basin-wide field data of Lake Taihu (China's largest eutrophic lake) and global archives, and demonstrate the dominance of evaporation on lacustrine groundwater discharge (LGD) in shallow lakes. We extrapolated decadal LGD and the derived nutrient loadings and found that HABs promptly consume ubiquitous groundwater borne nutrients, leading lake water N: P ratios 2-3 months time lagged behind LGD N: P ratios. We conclude that evaporation dominated LGD is an unraveled but crucial regulator of nutrient states and HABs in shallow lakes, which advocates synergistical studies from both climatological and hydrogeological perspective when restoring lake ecosystems.

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Drivers of spatial and seasonal variations of CO_2 and CH_4 fluxes at the sediment water interface in a shallow eutrophic lake

Heyang Sun; Ruihong Yu; Xinyu Liu;等

Shallow eutrophic lakes contribute disproportional to the emissions of CO_2 and CH_4 from inland waters. The processes that contribute to these fluxes, their environmental controls, and anthropogenic influences, however, are poorly constrained. Here, we studied the spatial variability and seasonal dynamics of CO_2 and CH_4 fluxes across the sediment-water interface, and their relationships to porewater nutrient concentrations in Lake Ulansuhai, a shallow eutrophic lake located in a semi-arid region in Northern China. The mean concentrations of CO_2 and CH_4 in porewater were 877.8 ± 31.0 μmol L^{-1} and 689.2 ± 45.0 μmol L^{-1} , which were more than 50 and 20 times higher than those in the water column, respectively. The sediment was always a source of both gases for the water column. Porewater CO_2 and CH_4 concentrations and diffusive fluxes across the sedimentwater interface showed significant temporal and spatial variations with mean diffusive fluxes of 887.3 ±124.7 μmol m^{-2} d^{-1} and 607.1 ± 68.0 μmol m^{-2} d^{-1} for CO_2 and CH_4, respectively. The temporal and spatial variations of CO_2 and CH_4 concentrations in porewater were associated with corresponding variations in dissolved organic carbon and dissolved nitrogen species. Temperature and dissolved organic carbon in surface porewater were the most important drivers of temporal variations in diffusive fluxes, whereas dissolved organic carbon and nitrogen were the main drivers of their spatial variations. Diffusive fluxes generally increased with increasing dissolved organic carbon and nitrogen in the porewater from the inflow to the outflow region of the lake. The estimated fluxes of both gases at the sediment-water interface were one order of magnitude lower than the emissions at the water surface, which were measured in a companion study. This indicates that diffusive fluxes across the sediment-water interface were not the main pathway for CO_2 and CH_4 emissions to the atmosphere. To improve the mechanistic understanding and predictability of greenhouse gas emissions from shallow lakes, future studies should aim to close the apparent gap in

the CO_2 and CH_4 budget by combining improved flux measurement techniques with process-based modeling.

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Excluding interference and detecting Microcystin-LR in the natural lakes and cells based a unique fluorescence method

Li, Bingyan; Liu, Yipeng; Liu, Yong; 等

Cyanobacteria blooms that cause the death of aquatic and terrestrial organisms have attracted considerable attention since the 19th century. The most typical toxin in cyanobacteria blooms is cyanobacteria toxin, particularly microcystin-LR (MC-LR). Therefore, a simple and highly efficient method for detecting MC-LR plays a role in studying the ecological toxicology of MC-LR. However, as MC-LR itself is located in a complex envi-ronment, traditional techniques present complex and false-positive defects. To address the above issues, novel technologies should be explored and discovered. Herein, we describe the development of MC-BDKZ as the first paradigm of probes that can concurrently report MC-LR in natural lakes and cells. This novel material shows large Stokes Shift and possesses good photostability and high sensitivity. Considering the properties mentioned above, MC-BDKZ not only achieves the detection of MC-LR in the lake water samples, but also completes the imaging of exogenous MC-LR in cells. Moreover, the interference of many factors in the lake and cells is excluded completely in the process of MC-LR detection. We comprehensively analyzed the response principle and potential application of MC-BDKZ in the process of MC-LR detection. Compared with the conventional MC-LR detection technologies, fluorescence probe technology shows better convenience and greatly reduces distance from the practical application in vitro and in vivo. We envisioned that the development of this visual research tool could provide crucial clues for exploring the pathogenesis of MC-LR in body.

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Long-term monitoring particulate composition change in the Great Lakes using MODIS data

Xu, Jiafeng; Liu, Huaiqing; Lin, Jie;等

Particulate composition provides important information for understanding the changes in underwater light fields and primary productivity. In this study, a semianalytical algorithm, based on Rayleigh-corrected reflectance at 678 nm and 748 nm on Moderate Resolution Imaging Spectroradiometer (MODIS) images was used to estimate the ratio of chlorophyll a to total suspended solids (Chla/TSS), which characterizes the particulate composition of the Great Lakes. The long-term spatial and temporal characteristics of Chla/TSS in the Great Lakes from 2000 to 2020 were obtained. The results demonstrated that Lake Superior had the highest average Chla/TSS values (5.79 & PLUSMN;0.76 mu g/mg), while Lake Erie had the lowest average Chla/TSS values (2.93 & PLUSMN;0.76 mu g/mg). The Mann -Kendall test showed that the Chla/TSS of the Great Lakes all showed an increasing trend, notably in Lake Michigan, with 88.23% pixels showing significant increasing trend. Climatic and hydrological factors dominated the intra-annual variation of Chla/TSS, with contribution rates ranging from 71.47% to 92.54%. Through the annual Chla/TSS change pattern analysis, it was found that the contribution of wind speed to the annual vari-ation in Chla/TSS was slight. Changes in temperature played a major role in the interannual variability of Chla/ TSS in Lake Superior and Ontario; runoff and settlement were the major contributors in Lake Huron and Michigan, while cropland dominated the Chla/TSS interannual variability in Lake Erie.

Furthermore, the significantly low values of Chla/TSS in spring had the potential to predict the occurrence of blooms in western Lake Erie, and the spatial distribution of Chla/TSS could help predict the location of blooms in the next few days.

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Molecular insight into the release of phosphate from dissolved organic phosphorus photo-mineralization in shallow lakes based on FT-ICR MS analysis

Li, Xiaolu; Guo, Minli; Wang, Yi;等

Dissolved organic phosphorus (DOP) is a key factor in the water eutrophication process because of its high potential bioavailability and inorganic phosphate (Pi) compensation ability through bio-and photo -mineralization. However, the research on the characterization and transformation of DOP is insufficient owing to their complex composition. This study investigates the release of dissolved Pi from DOP photo-mineralization in Lake Dong based on Fourier-transform ion cyclotron resonance mass spectrometry (FT-ICR MS) analysis. The results showed that the photo-release of dissolved Pi is spatially heterogeneous in Lake Dong and is consistent with the distribution of DOP concentration. The FT-ICR MS results showed that the simulated irradiation decreased the relative abundance (RA) of the DOP molecular formulae with higher molecular weight (MW) and higher double bond equivalence values (DBE), while the RA of DOP molecular formulae with lower MW and lower DBE value increased or remained. Besides, the total RA of lipid-like formulae increased from 49.09% to 55.90%, while the oxy-aromatic-like formulae decreased from 50.91% to 44.10%, suggesting that simulated irradiation would influence the potential bioavailability of DOP. As the main photolysis medium during DOP photo-mineralization, the hydroxyl radicals (& BULL;OH) are mainly derived from dissolved organic matter (DOM) compared to the nitrate (NO3) and iron ion (Fe3+) in Lake Dong. These results are important in understanding the ability and mechanism of DOP photo-mineralization and provide suggestions for cycling phosphorus in eutrophic shallow lakes.

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Natural versus anthropogenic controls on the dissolved organic matter chemistry in lakes across China: Insights from optical and molecular level analyses

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Dissolved organic matter (DOM) plays an essential role in the global carbon biogeochemical cycle for aquatic ecosystems. The complexity of DOM compounds contributes to the accurate monitoring of its sources and compositions from large-scale patterns to microscopic molecular groups. Here, this study demonstrates the diverse sources and compositions for humic-rich lakes and protein-rich lakes for large-scale regions across China with the linkage to optical components and molecular high-resolution mass spectrometry properties. The total fluorescence intensity of colored DOM (CDOM) for humic-rich lake regions (0.176 Raman unit; R.U.) is significantly ($p<0.05$) higher than that of the protein-rich lake region (0.084 R.U.). The combined percentages of CDOM absorption variance explained by the anthropogenic and climatic variables across the five lake regions of Northeastern lake region (NLR), Yungui Plateau lake region (YGR), Inner Mongolia-Xinjiang lake region (MXR), Eastern lake region (ELR), and Tibetan-Qinghai Plateau lake region (TQR) were 86.25%, 82.57%, 80.23%, 88.55%, and 87.72%

respectively. The averaged relative intensity percentages of CHOS and CHONS formulas from humic-rich lakes (90.831%, 10.561%) were significantly higher than that from the protein-like lakes (47.484%, 5.638%), respectively. The more complex molecular composition with higher aromaticity occurred in the humic-rich lakes than in the protein-rich lakes. The increasing anthropogenic effects would significantly enhance the sources, transformation, and biodegradation of terrestrial DOM and link to the greenhouse gas emission and the carbon cycle in inland waters.

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Nitrite and nitrate reduction drive sediment microbial nitrogen cycling in a eutrophic lake

Zhang, Dandan; Li, Mingyue; Yang, Yuchun;等

The anaerobic microbial nitrogen (N) removal in lake sediments is one of the most important processes driving the nitrogen cycling in lake ecosystems. However, the N removal and its underlying mechanisms regulated by denitrifying and anaerobic ammonia oxidation (anammox) bacteria in lake sediments remain poorly understood. With the field sediments collected from different areas of Lake Donghu (a shallow eutrophic lake), we examined the denitrifying and anammox bacterial communities by sequencing the nirS/K and hzsB genes, respectively. The results indicated that denitrifiers in sediments were affiliated to nine clusters, which are involved in both het-erotrophic and autotrophic denitrification. However, anammox bacteria were only dominated by Candidatus Brocadia. We found that NO(3)(-)and NO2- concentrations, as well as Nar enzyme activity were the key factors affecting denitrifying and anammox communities in this eutrophic lake. The enrichment experiments in bio-reactors confirmed the divergence of denitrification and anammox rates with an additional complement of NO2?, especially under a condition low nitrate reductase activity. The coupled denitrification and anammox may play significant roles in N removal, and the availability of electronic acceptors (i.e., NO(2)(-)and NO3-) strongly influenced the N loss in lake sediments. Further path analysis indicated that NO2-, NO3- and some N-related enzymes were the key factors affecting microbial N removal in lake sediments. This study advances our understanding of the mechanisms driving the of denitrification and anammox in lake sediments, which also provides new insights into coupled denitrification-anammox N removal in eutrophic lake ecosystems.

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Organic carbon quantity and composition jointly modulate the differentiation of nitrate reduction pathways in sediments of the Chinese eutrophic lake, Lake Chaohu

Gao, Junkai; Liu, Guanglong; Li, Xiaowen;等

Twelve sampling sites from two basins of Lake Chaohu were studied seasonally from June 2020 to April 2021 in Hefei City (China) to better understand the effect of organic carbon (C) quantity and composition on nitrate (NO_3--N) reduction pathways. Serious algal bloom in the west basin of Lake Chaohu (WLC) resulted in higher organic C accumulation and NO_3--N deficiency in interstitial water compared to the east basin of Lake Chaohu (ELC), jointly leading to a high C/NO3--N ratio. This triggered dissimilatory nitrate reduction to ammonium (DNRA) over denitrification in terms of higher DNRA rate, nitrogen retaining index (NRI), and nrfA gene abundance mediating DNRA. Furthermore, high oxygen-alkyl C and abundance of functional genes mediating labile organic C decomposition and DNRA suggested that the

alkyl carbon-oxygen bond was responsible for DNRA induction. Different bacterial community composition and diversity involved in C and nitrogen (N) metabolism in two basins indicated that bacteria in sediments of WLC were more active in NO_3--N reduction. Spearman correlation analysis showed that the less represented genera, such as Thiobacillus and Clostridium, were positively correlated with both organic C and NO_3--N reduction rates, respectively. Hence, organic C composition could affect NO_3--N reduction function by shaping the specific bacterial community.

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Production and transformation of organic matter driven by algal blooms in a shallow lake: Role of sediments

Du, YingXun; An, ShiLin; He, Hu;等

The generation of organic matter (OM) occurs synchronously with phytoplankton growth. Characterization of the generated particulate and dissolved OM during algal blooms in eutrophic lakes is crucial for better understanding the carbon cycle but remains limited. We speculate that sediments play a critical role in the biogeochemical transformation of OM derived from algal blooms in shallow lakes. In this study, changes in OM quantity and quality and the concentrations of biogenic elements (nutrients and metals) during algal blooms, were studied in situ in a shallow eutrophic lake (Lake Chaohu, China). Two enclosure treatments in the presence and absence of sediments were compared, and the cause-effect relationships among sediment, nutrients, metals, phytoplankton, particulate OM (POM), and dissolved OM (DOM) were revealed by a partial least square-path model (PLS-PM). The results showed that the changes in nutrients and metals concentrations over time were consistent with that of chlorophyll a (Chl a), and at the end of the treatment, the concentrations of Chl a, nutrients, and metals in Treatment S (with sediments) were approximately 3-5 times of those in Treatment N (without sediments). The high concentration of Chl a in Treatment S resulted in a high quantity of POM, which showed low molecular weight, low humification, and was enriched in protein-like components (~ 70%). For DOM, the quantity increased after the decrease in POM, and DOM quality showed a significantly higher abundance of humic-like components and a higher molecular weight than POM did. The PLS-PM results showed that the significant positive effects of sediment on nutrients, metals, phytoplankton, POM, and DOM were 0.28, 0.37, 0.28, 0.25, and 0.25, respectively, suggesting that sediment had an important role in the biogeochemical cycles of these substances. The significant negative relationship between POM and DOM (-0.62) and the distinct difference in POM and DOM quality implied the efficient transformation of the freshly generated OM to those with a higher molecular weight, higher humification, and potentially refractory. Our results depicted the quick biogeochemical transformation of nutrients, metals, and the potential formation of refractory organic carbon in water column, as driven by the couple of the algae pump with the microbial carbon pump.

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Reservoir water quality deterioration due to deforestation emphasizes the indirect effects of global change

Xiangzhen Kong; Salman Ghaffar; Maria Determann;等

Deforestation is currently a widespread phenomenon and a growing environmental concern in the era of rapid climate change. In temperate regions, it is challenging to quantify the impacts of deforestation on the catchment dynamics and downstream aquatic ecosystems such as reservoirs and disentangle these

from direct climate change impacts, let alone project future changes to inform management. Here, we tackled this issue by investigating a unique catchment-reservoir system with two reservoirs in distinct trophic states (meso and eutrophic), both of which drain into the largest drinking water reservoir in Germany. Due to the prolonged droughts in 2015–2018, the catchment of the mesotrophic reservoir lost an unprecedented area of forest (exponential increase since 2015 and ca. 17.1% loss in 2020 alone). We coupled catchment nutrient exports (HYPE) and reservoir ecosystem dynamics (GOTM-WET) models using a process-based modeling approach. The coupled model was validated with datasets spanning periods of rapid deforestation, which makes our future projections highly robust. Results show that in a short-term time scale (by 2035), increasing nutrient flux from the catchment due to vast deforestation (80% loss) can turn the mesotrophic reservoir into a eutrophic state as its counterpart. Our results emphasize the more prominent impacts of deforestation than the direct impact of climate warming in impairment of water quality and ecological services to downstream aquatic ecosystems. Therefore, we propose to evaluate the impact of climate change on temperate reservoirs by incorporating a time scale-dependent context, highlighting the indirect impact of deforestation in the short-term scale. In the long-term scale (e.g. to 2100), a guiding hypothesis for future research may be that indirect effects (e.g., as mediated by catchment dynamics) are as important as the direct effects of climate warming on aquatic ecosystems.

（来源：WATER RESEARCH 卷:221 出版年: 2022, **DOI:** 10.1016/j.watres.2022.118721）

River phosphorus cycling during high flow may constrain Lake Erie cyanobacteria blooms

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Cyanobacterial harmful blooms have been increasing worldwide, due in part to excessive phosphorus (P) losses from agriculture-dominated watersheds. Unfortunately, cyanobacteria bloom management is often complicated by uncertainty associated with river P cycling. River P cycling mediates P exports during low flow but has been assumed to be unimportant during high flows. Thus, we examined interactions between dissolved reactive phosphorus (DRP) and suspended sediment P during high flows in the Maumee River network, focusing on March-June Maumee River DRP exports, which fuel recurring cyanobacteria blooms in Lake Erie. We estimate that during 2003-2019 March to June high flow events, P sorption reduced DRP exports by an average of 13-27%, depending upon the colloidal-P:DRP ratio, decreasing the bioavailability of P exports, and potentially constraining cyanobacteria blooms by 13-40%. Phosphorus sorption was likely lower during 2003-2019 than 1975-2002 due to reductions in suspended sediment loads, associated with soil-erosion-minimizing agricultural practices. This unintended outcome of erosion management has likely decreased P sorption, increased DRP exports to Lake Erie, and subsequent cyanobacteria blooms. In other watersheds, DRP-sediment P interactions during high flow could have a positive or negative effect on DRP exports; therefore, P management should consider riverine P cycles, particularly during high flow events, to avoid undermining expensive P mitigation efforts.

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The global social-economic dimension of biological invasions by plankton: Grossly underestimated costs but a rising concern for water quality benefits?

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Planktonic invasive species cause adverse effects on aquatic biodiversity and ecosystem services. However, these impacts are often underestimated because of unresolved taxonomic issues and limited biogeographic knowledge. Thus, it is pivotal to start a rigorous quantification of impacts undertaken by planktonic invasive species on global economies. We used the InvaCost database, the most up-to-date database of economic cost estimates of biological invasions worldwide, to produce the first critical assessment of the economic dimension of biological invasions caused by planktonic taxa. We found that in period spanning from 1960 to 2021, the cumulative global cost of plankton invasions was US$ 5.8 billion for permanent plankton (holoplankton) of which viruses encompassed nearly 93%. Apart from viruses, we found more costs related to zooplankton (US$ 297 million) than to the other groups summed, including myco- (US$ 73 million), phyto- (43 million), and bacterioplankton (US$ 0.7 million). Strikingly, harmful and potentially toxic cyanobacteria and dinoflagellates are completely absent from the database. Furthermore, the data base showed a decrease in costs over time, which is probably an artifact as a sharp rise of novel planktonic alien species has gained international attention. Also, assessments of the costs of larval meroplanktonic stages of littoral and benthic invasive invertebrates are lacking whereas cumulative global cost of their adults stages is high up to US$ 98 billion billion and increasing. Considering the challenges and perspectives of increasing but unnoticed or neglected impacts by plankton invasions, the assessment of their ecological and economic impacts should be of high priority.

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Drivers of Spatiotemporal Variability in Drinking Water Quality in the United States

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Approximately 10% of community water systems in the United States experience a health-based violation of drinking water quality; however, recently allocated funds for improving United States water infrastructure ($50 billion) provide an opportunity to address these issues. The objective of this study was to examine environmental, operational, and sociodemographic drivers of spatiotemporal variability in drinking water quality violations using geospatial analysis and data analytics. Random forest modeling was used to evaluate drivers of these violations, including environmental (e.g., landcover, climate, geology), operational (e.g., water source, system size), and sociodemographic (social vulnerability, rurality) drivers. Results of random forest modeling show that drivers of violations vary by violation type. For example, arsenic and radionuclide violations are found mostly in the Southwest and Southcentral United States related to semiarid climate, whereas disinfection byproduct rule violations are found primarily in Southcentral United States related to system operations. Health-based violations are found primarily in small systems in rural and suburban settings. Understanding the drivers of water quality violations can help develop optimal approaches for addressing these issues to increase compliance in community water systems, particularly small systems in rural areas across the United States.

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Magnitude and Drivers of Oxic Methane Production in Small Temperate Lakes

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Methanogenesis is traditionally considered as a strictly anaerobic process. Recent evidence suggests instead that the ubiquitous methane (CH_4) oversaturation found in freshwater lakes is sustained, at least

partially, by methanogenesis in oxic conditions. Although this paradigm shift is rapidly gaining acceptance, the magnitude and regulation of oxic CH_4 production (OMP) have remained ambiguous. Based on the summer CH_4 mass balance in the surface mixed layer (SML) of five small temperate lakes (surface area, SA, of 0.008-0.44 km(^{2})), we show that OMP (range of 0.01 +/- 0.01 to 0.52 +/- 0.04 mu mol L^{-1} day($^{-1}$)) is linked to the concentrations of chlorophyll-a, total phosphorus, and dissolved organic carbon. The stable carbon isotopic mass balance of CH_4 (delta C-13-CH_4) indicates direct photoautotrophic release as the most likely source of oxic CH_4. Furthermore, we show that the oxic CH_4 contribution to the SML CH_4 saturation and emission is an inverse function of the ratio of the sediment area to the SML volume in lakes as small as 0.06 km(^{2}). Given that global lake CH_4 emissions are dominated by small lakes (SA of <1 km(^{2})), the large contribution of oxic CH_4 production (up to 76%) observed in this study suggests that OMP can contribute significantly to global CH_4 emissions.

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Anthropogenic stressors compound climate impacts on inland lake dynamics: The case of Hamun Lakes

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Inland lakes face unprecedented pressures from climatic and anthropogenic stresses, causing their recession and desiccation globally. Climate change is increasingly blamed for such environmental degradation, but in many regions, direct anthropogenic pressures compound, and sometimes supersede, climatic factors. This study examined a human environmental system - the terminal Hamun Lakes on the Iran-Afghanistan border - that embodies amplified challenges of inland waters. Satellite and climatic data from 1984 to 2019 were fused, which documented that the Hamun Lakes lost 89% of their surface area between 1999 and 2001 (3809 km^2 versus 410 km^2), coincident with a basin-wide, multi-year meteorological drought. The lakes continued to shrink afterwards and desiccated in 2012, despite the above-average precipitation in the upstream basin. Rapid growth in irrigated agricultural lands occurred in upstream Afghanistan in the recent decade, consuming water that otherwise would have fed the Hamun Lakes. Compounding upstream anthropogenic stressors, Iran began storing flood water that would have otherwise drained to the lakes, for urban and agricultural consumption in 2009. Results from a deep Learning model of Hamun Lakes' dynamics indicate that the average lakes' surface area from 2010 to 2019 would have been 2.5 times larger without increasing anthropogenic stresses across the basin. The Hamun Lakes' desiccation had major socio-environmental consequences, including loss of livelihood, out-migration, dust-storms, and loss of important species in the region.

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Assessing the inundation dynamics and its impacts on habitat suitability in Poyang Lake based on integrating Landsat and MODIS observations

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Poyang Lake, the largest freshwater lake in China, serves critical ecosystem function for water regulation and biodiversity conservation. However, it experienced dramatic changes in lake inundation due to recent climate change and human activities, causing ecological and economic problems. Here, we applied a multiple-index water detection rule to integrated Landsat and MODIS products to reconstruct surface water series at 30-m and 8-day resolutions and quantified the spatiotemporal inundation dynamics in

Poyang Lake over the past 20 years (2000-2019). Furthermore, their influences on habitat suitability for herbivorous birds were also assessed from the perspectives of hydroperiod and vegetation growth threshold. The significant declining trend (-26.66 km(2) yr(-1), $p < 0.001$) for the annual minimum water areas throughout the 20 years implied that Poyang Lake was undergoing a continuous shrinkage in the low-water season. On the monthly scale, inundation frequency (IF) decreases were more significant in September-January, most of which occurred in the alluvial delta zones near the lake center. The altered water regime after the Three Gorges Dam (TGD) might be the dominant contributor responsible for the continuous lake shrinkage during the recent low-water period. The sub-lakes suffered from spring drought rather than winter drought, triggering vegetation successions regarding the reversed trend of the well-documented xerophilization in Poyang Lake. The recent earlier and prolonged dry seasons caused an increase of suitable habitat for herbivorous birds (13.92 km(2) year(-1), $p < 0.1$), but triggered a potential risk of food quality degradation when the migratory waterbirds peaked in December. These results provide a clear reference for optimizing the hydrologic management and biodiversity conservation of Poyang Lake.

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Comparison of acid volatile sulphide, metal speciation, and diffusive gradients in thin-film measurement for metal toxicity assessment of sediments in Lake Chaohu, China

Diao, Fei; Liu, Yuchen; Xu, Di;等

The toxicity of heavy metals in sediments is inseparable from their forms in the environment. Traditional sediment tox-icity assessment systems, such as total metals, dissolved metals in pore water, metals extracted by the Community Bu-reau of Reference procedure, and acid volatile sulphide (AVS)-simultaneously extracted metal (SEM), have their own limitations. This study revealed the horizontal and vertical distribution characteristics of AVS and SEM in Lake Chaohu and three typical groups of two-dimensional profiles of diffusive gradients in thin-film (DGT)-labile S(-II) were ob-tained at representative sampling sites. There was a positive correlation between DGT-labile S(-II) and AVS due to sulphate-reducing bacteria anda negative correlation due to the high sulphate reduction rate induced by high total or-ganic carbon. Moreover, there was no correlation between DGT-labile S(-II) and AVS when bioturbation was dominant in the sediments. To realise the application of DGT measurement in toxicity assessment of heavy metals in sediment through the sandwich relationship of DGT-labile metals vs. metals speciation vs. sediment toxicity assessment, the key relationship of DGT-labile metals vs. metals speciation was explored. DGT-labile Ni showed potential to reveal this relationship.

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Cyanotoxin-encoding genes as powerful predictors of cyanotoxin production during harmful cyanobacterial blooms in an inland freshwater lake: Evaluating a novel early-warning system

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Freshwater harmful cyanobacterial blooms (HCBs) potentially produce excessive cyanotoxins, mainly microcystins (MCs), significantly threatening aquatic ecosystems and public health. Accurately predicting HCBs is thus essential to developing effective HCB mitigation and prevention strategies. We previously developed a novel early-warning system that uses cyanotoxin-encoding genes to predict cyanotoxin

production in Harsha Lake, Ohio, USA, in 2015. In this study, we evaluated the efficacy of the early-warning system in forecasting the 2016 HCB in the same lake. We also examined potential HCB drivers and cyanobacterial community composition. Our results revealed that the cyanobacterial community was stable at the phylum level but changed dynamically at the genus level over time. Microcystis and Planktothrix were the major MC-producing genera that thrived in June and July and produced high con-centrations of MCs (peak level 10.22 mu g.L-1). The abundances of the MC-encoding gene cluster mcy and its transcript levels significantly correlated with total MC concentrations (before the MC concentrations peaked) and accurately predicted MC production as revealed by logistic equations. When the Microcystis-specific gene mcyG reached approximately 1.5 x 10(3) copies.mL(-1) or when its transcript level reached approximately 2.4 copies.mL(-1), total MC level exceeded 0.3 mu g L-1 (a health advisory limit) approximately one week later (weekly sampling scheme). This study suggested that cyanotoxin-encoding genes are promising predictors of MC production in inland freshwater lakes, such as Harsha Lake. The evaluated early-warning system can be a useful tool to assist lake managers in predicting, mitigating, and/or preventing HCBs.

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Distribution of microplastics in benthic sediments of Qinghai Lake on the Tibetan Plateau, China

Jiang, Ning; Luo, Wei; Zhao, Pin;等

Although several studies of microplastics (MPs) with size <5 mm in lake sediments focused on lakeshore areas, there have been no studies of distributions of MPs from lakeshores to the center of a lake. To test our hypothesis that MPs decrease from lakeshore to the center, a study was conducted on the largest brackish lake on the remote and high-altitude Tibetan Plateau, China. Abundances and characteristics of MPs in 14 samples of surface sediment collected from a river bay, a lake bay, and a lake central area were investigated. Distributions were influenced by river inflow, tourism, and minimal activity of humans, respectively around Qinghai Lake. The mean abundance of MPs in sediments of Qinghai Lake was 393 +/- 457 items/kg, dry mass (dm). Based on the range of MP abundances in surface sediments of lakes worldwide, Qinghai Lake was classified as being moderately polluted with MPs. The dominant color, shape, size, and polymer type of MPs in sediments were transparent, fiber, 0.05-1 mm, and polypropylene, respectively. The river bay had a mean abundance of MPs two-fold greater than either the bay or central area of the lake. This indicates that the river catchment caused more pollution with MPs, while the central area of the lake was not a sink for MPs. Spatial trends of MPs in sediments from the shore to the center of the lake differed among areas, and were significantly related to wind, lake current, sedimentation rate, water- and sediment-properties, water depth, and proximity to land sources of MPs.

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Export and risk from antibiotic remobilization from surrounding water to lake in the extreme 2020 Yangtze River basin flooding

Dong, Jianwei; Shang, Meiqi; Feng, Ranran;等

Global climate change increased the frequency of extreme rainfall events, leading to higher flood risk. In addition to the personal and property losses, another important consequence of a flood disaster was release and exposure risks from emerging contaminants, which was usually overlooked. The remobilization and fate of the antibiotics induced by floods remain unclear. We captured antibiotic

concentrations around the Chaohu Lake after an unprecedented flood with a range of 5.0-317 ng/L. Higher concentrations in polder waters than their receiving rivers were attributed to the antibiotic release from soil particles and the sharp increase of water: soil ratio by flood storage. Source apportionment analysis of antibiotics implied that diffuse pollution by manure application and aquaculture activity was the predominant sources. Commonalities of spatial variations of antibiotics in polders were related to the condition of waterlogging and pollution source. The total antibiotic storage for all submerged polders was estimated at 27.9 kg. The concentrations and risks from pumping floodwater detained by polders into the lake were much higher than that from discharging flood directly into the lake. The retention-reaction-remobilization process would pose unexpectedly high risks for the lake. This study provided a new sight for constructing ecological wetland flood storage areas.

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How reliable is chlorophyll-a as algae proxy in lake environments? New insights from the perspective of n-alkanes

He, Yong; Wang, Xiangyu; Xu, Fuliu

Chlorophyll -a (Chl-a) has been employed as the golden proxy of algae biomass and algae cell densities in lake environments for many years. However, how reliable Chl-a is as algae proxy in lake environments needs further evaluation. Here, we take the eutrophic Lake Chaohu and 46 lakes and reservoirs across China as objects on temporal and spatial scales, respectively, to resolve this issue from the perspective of n-alkanes. Our results showed that Chl-a ranged from 10.5 to 735 mu $g.L^{-1}$ with a geometric mean of 92.4 mu $g.L^{-1}$ in Lake Chaohu. There were no statistically significant correlations between Chl-a and algae cell densities in all seasons (Pearson's correlation, $p > 0.05$), and also for macrophytes and terrestrial plants input ($p > 0.05$). It was related to the complex changes of environmental factors. By contrast, Chl-a ranged from 7.1 to 1608 mu $g.L^{-1}$ with a geometric mean of 125 mu $g.L^{-1}$ in nationwide lakes and reservoirs, and its occurrence was not only related to algae, but also associated with macrophytes and terrestrial plants ($p < 0.05$). In summary, Chl-a can be applied as an algae proxy, but its application is subject to certain restrictions. Besides, the multiple sources of Chl-a in lake environments may result in an overestimation of algae cell densities. Compared to Chl-a, biogenic n-heptadecane (bio C17) could be regarded as a potential alternative. Hence, we compared the advantages and disadvantages of bio C17 and Chl-a in the aspects of specificity, accuracy, sensitivity and applicability. We found that for most scenarios, their limitations could be surmounted by each other, but failed in some scenarios. Accordingly, an ensemble proxy system may be used for more reliable representation of algae in lake environments.

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Hydrologic balance and inundation dynamics of Southeast Asia's largest inland lake altered by hydropower dams in the Mekong River basin

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Inland lakes have been increasingly impacted by climate change and human activities, leading to unprecedented environmental consequences. Among many rapidly changing lakes is the Tonle Sap Lake (TSL) in Cambodia-Southeast Asia's largest inland lake-which is under growing threats from altered flows and inundation dynamics due to compounding effects of climate change and dam construction in the

Mekong River basin (MRB). While previous studies have examined the potential causes of recent changes in open water areas, a mechanistic quantification of the lake's shifting hydrologic balance and inundation dynamics due to natural climate variability and dam operations is lacking. Here, using a hydrological-hydrodynamic modeling system that includes the major dams in the MRB, we show that while climate variability has been a key driver of inter-decadal variabilities in the lake's water balance, the operation of Mekong dams has exerted a growing influence-especially after 2010-on the Mekong flood pulse, Tonle Sap River's flow reversal, and the TSL's inundation dynamics. The dam-induced dampening of the Mekong's peak discharge increased from 1-2% during 1979-2009 to -7% in the 2010s, causing comparable alterations in the peak of inflow from the Mekong into TSL. More crucially, during the 2010s, the dams caused a reduction in annual inflow volume into TSL by 10-25% and shortened the annual inundation duration by up to 15 days in the lake's periphery. Further, seasonally inundated areas decreased (increased) most substantially by -245 km2 or -3% (-270 km2 or -6%) in August (April) during the 2010s. These results demonstrate that Mekong dams have already caused substantial alterations in the hydrologic balance and inundation dynamics of the TSL. Our findings offer critical insights relevant for improved transboundary water management and decision making in light of growing concerns about the adverse impacts of large dams in the MRB.

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Impacts of underwater topography on the distribution of microplastics in lakes: A case from Dianchi Lake, China

Deng, Chunnuan; Li, Dafeng; Li, Ju;等

The spatial distribution of microplastics and the factors influencing their distribution in lakes are important aspects of plastics pollution studies. This study investigated the impacts of lake underwater topography on the spatial distribution of microplastics in Dianchi Lake in China. Data on spatial distribution of microplastics were obtained by pump sampling, microscopic examination, and polymer identification. Parameters of underwater topography were extracted from an isobaths map of Dianchi Lake. The relationships between underwater topography and the abundance of microplastics were analyzed. The results showed that for the northern part of the lake, water depth, slope gradient, relief, roughness and surface curvature have significant relationships with the spatial distribution of microplastics. In the southern part, only roughness showed a significant relationship. The roughness is the only important factor which impacts the microplastics distribution in both parts of the lake and the whole lake. These differences between the northern part and the southern part of the lake are related to the stronger circular currents in the southern part of the lake. These results showed that the impacts of underwater topography manifest themselves well when lake currents are weak, and these impacts are reduced or muted when lake currents are strong. Our research results provide a good reference for understanding distribution and migration principle of microplastics in lakes.

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Large alpine deep lake as a source of greenhouse gases: A case study on Lake Fuxian in Southwestern China

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However, the spatiotemporal patterns of GHG emissions have not been adequately quantifled in large deep lakes, resulting in substantial uncertainties in the estimated GHG budgets in global lakes. In this

study, the spatial and seasonal variability of diffusive GHG (CO_2, CH_4, and N_2O) emissions from Lake Fuxian located on a plateau in Southwestern China were quantifled. The results showed that the surface lake water was oversaturated with dissolved GHG concentrations, and the average concentrations were 24.25 mu M CO_2, 0.044 mu M CH_4, and 14.28 nM N_2O, with diffusive emission rates of 8.82 mmol CO_2 m^{-2} d^{-1}, 31.94 mu mol CH_4 m^{-2} d^{-1}, and 4.94 mu mol N_2O m^{-2} d^{-1}, respectively. Diffusive CH_4 flux exhibited high temporal and spatial variability similar to that in most lakes. In contrast, diffusive CO_2 and N_2O flux showed distinct seasonal variability and similar spatial patterns, emphasizing the necessity for increasing the temporal resolution in GHG flux measurements for integrated assessments. Water temperature and/or oxygen concentrations were crucial in regulating seasonal variability in GHG emissions. However, no limnological parameter was found to govern the spatial GHG patterns. The frequent advection mixing caused by wind-driven currents might be the reason for the low spatial heterogeneity in GHGs, in which the inconspicuous mechanism requires further research. It was recommended that at least 11 locations were needed for representative whole lake flux estimates at each sampling campaign. In addition, the maximum peak of CH_4 in the oxycline from Lake Fuxian indicated that low CH_4 oxidation

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Nutrient levels and prokaryotes affect viral communities in plateau lakes

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Viruses are the most abundant organisms in aquatic environments. Recent advances of viral metagenomic have greatly expanded our understanding of aquatic viral communities. However, little is known about the difference of viral communities and driving factors in freshwater lake. This study seeks to understand the spatio-temporal variation, differences, and driving factors of viral communities in two plateau lakes (Dianchi and Fuxian Lakes) with significant nutritional differences. The viral communities exhibited apparent seasonal variation in Dianchi Lake, while seasonal influences on the viral communities were greater than location-based influences. Two-thirds of all detected viral taxa were shared in two lakes, but there was variation in the composition of viral communities. Correlations between prokaryotic communities, environmental factors and viral communities were analyzed. The nutrients, chlorophyll a were primarily environmental parameters affecting viral communities, and the prokaryotic community was significantly correlated with the viral community. In addition, several viruses infecting humans were identified in two lakes, with the most abundant being Herpesviridae and Poxviridae. Overall, these findings provide information on the dynamics, composition, and differences of viral and prokaryotic communities in plateau lakes with different nutrient levels. These results suggest that nutritional levels and prokaryotic communities could play an important role in shaping viral communities in freshwater lakes.

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Permafrost degradation is accelerating beneath the bottom of Yanhu Lake in the Hoh Xil, Qinghai-Tibet Plateau

Zhang, Yuxin; Xie, Changwei; Wu, Tonghua;等

Lakes on the Qinghai-Tibet Plateau (QTP) have notably expanded over the past 20 years. Due to lake water level rise and lake area expansion, the permafrost surrounding these lakes is increasingly becoming submerged by lake water. However, the change process of submerged permafrost remains

unclear, which is not conducive to further analyzing the environmental effects of permafrost change. Yanhu Lake, a tectonic lake on the QTP, has experienced significant expansion and water level rise. Field measurement results indicate that the water level of Yanhu Lake increased by 2.87 m per year on average from 2016 to 2019. Cold permafrost, developed in the lake basin, was partially submerged by lake water at the end of 2017. Based on the water level change and permafrost thermal regime, a numerical heat conduction permafrost model was employed to predict future changes in permafrost beneath the lake bottom. The simulated results indicate that the submerged permafrost would continuously degrade because of the significant thermal impact of lake water. By 2100, the maximum talik thicknesses could reach approximately 7, 12, 16, and 19 m under lake-bottom temperatures of +2.0, +4.0, +6.0, and +8.0 degrees C, respectively. Approximately 291 years would be required to completely melt 47 m of submerged permafrost under the lake-bottom temperature of +4 degrees C. Note that the permafrost table begins to melt earlier than does the permafrost base, and the decline in the permafrost table occurs relatively fast at first, but then the process is attenuated, after which the permafrost table again rapidly declines. Compared to climate warming, the degradation of the submerged permafrost beneath the lake bottom occurred more rapidly and notably.

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Record of heavy metals in Huguangyan Maar Lake sediments: Response to anthropogenic atmospheric pollution in Southern China

Wu, Hongchen; Wang, Jingfu; Guo, Jianyang;等

The historical atmospheric heavy metal pollution of southern China over the past 200 years was explored by analyzing radiometric dating, heavy metals, and Pb isotopes from a sediment core in Huguangyan Maar Lake. Zn, Cd, Sb, Tl, and Pb in the lake are closely related to anthropogenic activities, while Cr and Ni are mainly derived from the weathering of basalt surrounding the lake. Atmospheric Zn, Cd, Sb, and Tl increased rapidly after 1980, consistent with the local industrial development. The increase of atmospheric Pb in southern China occurred earlier than in other regions of China, with the increase after 1850. War and the use of leaded gasoline were the main causes for the rapid increase in atmospheric Pb during 1910-1950. From 1950 to 2000, the input of Pb from anthropogenic activities decreased gradually due to the stable social environment. After 2000, atmospheric Pb continued to rise due to continued industrial development. The three-end-member model of Pb isotopes indicates that coal combustion is the main source of current atmospheric Pb. The proportion of Pb derived from vehicle exhaust emissions reached a peak in the 1960s, then gradually decreased and further reduced with the ban on leaded gasoline after 2000. These results are important in identifying the sources of atmospheric heavy metal pollution and in formulating pollution control strategies.

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Seasonal variation and ecological risk assessment of microplastics ingested by economic fishes in Lake Chaohu, China

Wu, Jiajun; Yin, Xiaowei; Liu, Yunzhao;等

seasonal field studies of MPs concentrations in aquatic life are scarce. In this study, we analyzed the seasonal variation and ecological risk of MPs concentrations in economic fish species from Lake Chaohu in China between wet and dry seasons. Within both seasons, MPs in fish were systematically analyzed using methods of KOH digestion, NaCl density floatation and raman spectroscopy. MPs abundance in

economic fishes were significantly higher in dry season than that in wet season, which can be ascribed to the MPs' amplification effects in lacustrine ecosystems during dry season. Whereas, our results recorded similar and homogenized characteristic composition of MPs in economic fishes between wet and dry seasons. In both seasons, fiber was the main morphological type, black and blue were the most common MPs color, and MPs ranging from <0.5 mm accounting for the most abundant size. In addition, polypropylene (PP) and polyethylene terephthalate (PET) accounted for the most abundant polymer type detected by economic fishes in both seasons. In terms of feeding groups and habitat preferences, planktivorous and pelagic fish species exhibited sensitive variations of MPs concentrations between wet and dry seasons, thus being highlighted as good bioindicators of MPs contaminants in freshwater ecosystems. Our results revealed higher ecological risks of MPs in wet season than that in dry season when indicating from polymer risk index (H). By providing detailed and direct toxicity information, our study highlights the usage of polymer risk index for ecological risk assessment in aquatic organisms.

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Sedimentary organic carbon storage of thermokarst lakes and ponds across Tibetan permafrost region

Wei, Zhiqiang; Du, Zhiheng; Wang, Lei;等.

Sedimentary soil organic carbon (SOC) stored in thermokarst lakes and ponds (hereafter referred to as thaw lakes) across high-latitude/altitude permafrost areas is of global significance due to increasing thaw lake numbers and their high C vulnerability under climate warming. However, to date, little is known about the SOC storage in these lakes, which limits our better understanding of the fate of these active carbon in a warming future. Here, by combining large-scale field observation data and published deep (e.g., 0-300 cm) permafrost SOC data with a random forest (RF) machine learning technique, we provided the first comprehensive estimation of thaw lake SOC stocks to 3 m depth on the Tibetan Plateau. This study demonstrated that combining multiple environmental factors with the RF model could effectively predict the spatial distributions of the thaw lake SOC density values (SOCDs). The model results revealed that the soil respiration, normalized difference vegetation index (NDVI), and mean annual precipitation (MAP) were the most influential factors for predicting thaw lake SOCDs. In total, the sedimentary SOC stocks in the thaw lakes were approximately 52.62 Tg in the top 3 m, with 53% of the SOC stored in the upper layers (0-100 cm). The SOCDs generally exhibited high values in eastern Tibetan Plateau, and low values in mid-and western Tibetan Plateau, which were similar to the patterns of the land cover types that affected the SOCDs. We further found that the SOCDs of thaw lakes were generally higher than those of their surrounding permafrost soils at different layer depths, which could be ascribed to the erosion of soil particles or leaching solution from the thawing permafrost soils to lakes and/or enhanced vegetation growth at the lake bottom. This research highlights the necessity of explicitly considering the thaw lake SOC stocks in Earth system models for more comprehensive future projections of the carbon dynamics on the plateau.

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Temperature and precipitation dominates millennium changes of eukaryotic algal communities in Lake Yamzhog Yumco, Southern Tibetan Plateau

Huo, Shouliang; Zhang, Hanxiao; Wang, Jingfu;等

Despite significant climate change on the Tibetan Plateau, the historical succession trend and underlying driving mechanism of aquatic ecosystem in alpine lake remain unclear. In this study, palaeolimnological analysis and highthroughput sequencing of sedimentary DNA were used to investigate environmental changes, primary productivity, and eukaryotic algal community succession over the past millennium in Lake Yamzhog Yumco of the southern Tibetan Plateau. Lake primary productivity significantly increased after ~1850 CE and algal community succession occurred in three stages including the Medieval Warm Periods (approximately 1000-1250 CE), the Little Ice Age (1250-1850 CE), and the Current Warm Period (1850-2020 CE). Moreover, succession was synchronous with inferred climate changes. Partial least square path modeling indicated that climate factors affected primary productivity and eukaryotic algal community structure by affecting nutrient loading. The results suggest that glacier melting and permafrost degradation caused by climate warming, combined with increased precipitation, may be the major driving factors of nutrient concentration increases, phytoplankton biomass increases, and shifts in community composition. Considering the expected trends of future climate change and continuous warming, the restoration of vegetation cover and reduction of non-point source nutrient loading in the Tibetan Plateau is urgently needed to mitigate climate change impacts on alpine lake aquatic ecosystems.

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The influence of nutrients on the composition and quantity of buried organic carbon in a eutrophic plateau lake, Southwest China

Jiang, Quanliang; Hou, Xikang; Huang, Changchun;等

The regulation of lacustrine organic carbon (OC) burial by nutrient is an outstanding knowledge gap in the current understanding of lake carbon cycles. In this study, we determined how nutrients quantitatively correspond with OC burial using the parallel factor analysis (PARAFAC) method in Dianchi Lake, southwest China. Factors were classified into three types according to their historical sedimentation characteristics: the background factor (BF), response factor (RF), and contingency factor (CF). The BF represented the original OC input combination in the lake and was insensitive to nutrient changes. The RF represented the OC input combination that was induced or promoted by nutrient changes in the lake. The CF represented short-term discontinuous factors in sedimentary history, which may be related to unique historical events. The results indicate that changes in the total nitrogen (TN) to total phosphorus (TP) ratio correlated with changes in the BF contribution; whereas the quantity of OC was mainly correlated with TN. The >90% of OC buried in sediment was quantitatively simulated by BF and RF; the driving effect of RF on OC burial was approximately 13 times higher than that of BF. It was observed that a 1 mg kg(-1) increase in TN led to approximately 2.2 units increase in RF contribution in Dianchi lake, while the BF was insensitive to changes in TN. Thus, changes in lake nutrients may effectively change the composition and quantity of OC. buried in lake sediment.

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The interaction of physical structure and nutrient loading drives ecosystem change in a large tropical lake over 40 years

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Many lakes across the world arc entering novel states and experiencing altered biogeochemical cycling due to local anthropogcnic stressors. In the tropics, understanding the drivers of these changes can be difficult due to a lack of documented historic conditions or an absence of continuous monitoring that can

distinguish between intim- and inter-annual variation. Over the last forty years (1980-2020), Lake Yojoa (Honduras) has experienced increased watershed development as well as the introduction of a large net-pen Tilapia farm, resulting in a dramatic reduction in seasonal water clarity, increased trophic state and altered nutrient dynamics, shifting lake Yojoa from an oligotrophic (low productivity) to mesotrophic (moderate productivity) ecosystem. To assess the changes that have occurred in lake Yojoa as well as putative drivers for those changes, we compared Secchi depth (water clarity), dissolved inorganic nitrogen (DIN), and total phosphorus (TP) concentrations at continuous semi-monthly intervals for the three years between 1979 and 1983 and again at continuous 16-day intervals for 2018-2020. Between those two periods we observed the loss of a clear water phase that previously occurred in the months when the water column was fully mixed. Seasonal peaks in DIN coincident with mixing suggest that an enhanced accumulation of ammonium in the hypolimnion (the bottom layer of a stratified lake) during stratification, and release to the epilimnion (the top layer of a stratified lake) with mixing maintains high algal abundance and subsequently low Secchi depth during what was previously the clear water phase. This interaction of nutrient loading and Lake Yojoa's monomictic stratification regime illustrates a key phenomenon in how physical water column structure and nutrients interact in tropical monomictic lakes. This work highlights the need to consider nutrient dynamics of warm anoxic hypolimnions, not just surface water nutrient concentrations, to understand environmental change in these societally important but understudied ecosystems.

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The role of humic substances in sediment phosphorus release in northern lakes

Tammeorg, Olga; Nuernberg, Gertrud K.; Noges, Peeter; 等

phosphorus (P) release are largely unexplored. Here we elucidated the factors behind experimentally-derived sediment release rates of P by diffusion (DF) in four Finnish lakes with a range of colour. Next, we extended our analysis to a larger set of northern lakes for further insights regarding possible implications of organic substances on sediment P release. The significant correlation between pore-water soluble reactive P and dissolved iron, and a positive effect of ironbound sedimentary P (Fe-P) on DF supports the classic paradigm of redox-dependent P release in the four Finnish lakes studied. Nevertheless, the P release from Fe-P may be inhibited by humic substances, as we observed lower Fe-P and negative DF in two humic rich lakes (high DOC). The analysis of a larger set of northern lakes supported the negative effect of humic substances on P release rate (RR) determined by in situ P increases. In this dataset, DOC correlated positively with water colour and negatively with RR. Furthermore, multiple stepwise regression analysis selected sediment total P and organic matter content in sediments (LOI) as the best predictors of RR, similar to a previously published model by Nurnberg (1988). While the model predictions (RRpred) were correlated to RR in the present study, they tended to overestimate RR that was determined in closed experimental systems. The inhibiting effects of humic substances on RR may be manifested in both internal P loading and primary production.

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Variation trends and attribution analysis of lakes in the Qiangtang Plateau, the Endorheic Basin of the Tibetan Plateau

Li, Meng; Weng, Baisha; Yan, Denghua;等

The Tibetan Plateau (TP) is the area with most high-altitude lakes in the world, of which most are in the Qiangtang Plateau (QP), the endorheic basin of the TP. Since the 1990s, abundant studies have reported the accelerated expansion of lakes in the QP. However, the dominant factors affecting lakes expansion or shrinkage are still controversial. Here we extract six periods of 300 lakes according to the satellite image. It indicates that 90% of the lakes in the QP were expanding, mainly located in the middle of the plateau; 10% of the lakes tended to shrink, mainly located in the areas surrounding the plateau and near the Tanggula Mountain and Nyainqentanglha Mountain, with an altitude over 4500 m. Meanwhile, we explored the influence factors for lake area changes by analyzing the variations in precipitation and glacier. Seven different driving models leading to the lake changes are proposed. Lake expansion was mainly caused by the increase of precipitation and glacier melting, while the causes of lake shrinkage are quite different, such as the change of precipitation and evaporation, the geological structure of lake outlet, the increase of outflow caused by the more transformation of lake water from solid to liquid, etc. This study can provide some support for plateau grassland protection and ice lake outburst prevention.

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Water depth and land-use intensity indirectly determine phytoplankton functional diversity and further regulate resource use efficiency at a multi-lake scale

Zhou, Qichao; Zhang, Yun; Tao, Juan;等.

Biodiversity & ndash;ecosystem functioning relationships under multiple pressures have recently been the subject of broad studies. For the key primary producer in aquatic ecosystems, phytoplankton, several studies have focused on trait based functional diversity (FD) and the related functioning (e.g., resource use efficiency, RUE), and their linkages. However, investigations of the effects of environmental factors at different levels (e.g., land use, lake morphometry, climate and nutrients) on FD and RUE are sparse. We developed a data-driven-model framework to simultaneously elucidate the effects of multiple drivers on FD (functional diversity based on dendrograms, FDc and functional richness, FRic) and RUE (of nitrogen and phosphorus) of phytoplankton based on data from 68 Yunnan-Guizhou Plateau lakes, Southwest China. We found that the concentration of total phosphorus, which is mainly affected by land-use intensity and influenced by water depth, was the primary (positive) driver of changes in both FDc and FRic, while RUE was mainly explained by phytoplankton FD (i.e., FRic). These results indicate that water depth and land-use intensity influence indirectly phytoplankton FD and further regulate RUE. Moreover, nonlinear correlations of RUE with FRic were found, which may be caused by interspecific competition and niche differentiation of the phytoplankton community related to nutrient levels. Our finding may help managers to set trade-off targets between FD and RUE in lake ecosystems except for extremely polluted ones, in which the thresholds derived from the Bayesian network, of total phosphorus, total nitrogen and land-use intensity were approximately 0.04 mg/L, 0.50 mg/L and 244 (unitless), respectively. The probability of meeting the RUE objectives was lower in shallow lakes than in deep lakes, but for FRic the opposite was observed.

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What caused the spatial heterogeneity of lake ice phenology changes on the Tibetan Plateau?

Cai, Yu; Ke, Chang -Qing; Xiao, Yao; 等

these lakes has undergone remarkable changes in recent years. We obtained the ice phenology records for 71 lakes for the period of 2001 to 2020 and found overall later trends for both freeze-up and break-up dates. As a result, the changes in ice cover duration showed great spatial heterogeneity. Therefore, we analyzed the causes of lake ice phenology changes from two aspects: climate change and lake properties. The results showed that the changes in air temperature dominated the variations in ice phenology, followed by solar radiation. The weakened wind power in the northeastern part of the plateau was favorable for the delay of break-up end dates and the extension of ice cover durations. Furthermore, by changing the lake size and salinity, water balance changes led to aggravated ice phenology changes for some lakes, while for some other lakes, they moderated or even reversed the changes caused by other climatic factors. In general, the spatial inconsistency of changes in multiple climatic factors (especially differences between the northeastern and southwestern parts) during the 20 years was the main reason for the heterogeneity of lake ice phenology changes on the Tibetan Plateau. This study preliminarily summarized some of the effects of climate change and lake properties on lake ice phenology, and the results are important for understanding the physical mechanism of lake ice phenology changes under climate change.

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Assessing the performance of the Tiangong-2 wide-swath imaging altimeter observations for water level monitoring over complex and shallow lakes

Wu, Guiping; Liu, Yuanbo; Liu, Rui 等.

As a significant hydrological parameter, the water level of complex and shallow river-lake wetland has important implications for a number of hydrological, biological, physical and chemical processes. Current in-situ and satellite-based methods both have disadvantages in capturing water levels over smaller surface water bodies with spatial heterogeneity or complexity. Interferometric imaging radar altimeter (InIRA) is a latest generation of Ku-band radar altimeter onboard Tiangong-2 (TG-2), the Chinese space laboratory, launched in 2016. Similar to the design idea of NASA's SWOT, it is expected to improve this situation through wide-swath altimetry. However, the capacity of the TG-2 InIRA to measure water levels within small surface water bodies remains unexamined. To explore these performances, particularly their potential impact on hydrology research, an assessment and comparison between in-situ and TG-2 derived measurements was performed over the largest river-lake wetland in China. The results showed that the TG-2 InIRA, with a broad range of coverage, was able to effectively capture most of the surface water at its elevation. For the focused shallow depressions, a relatively good correlation was observed between the in-situ and InIRA-derived water surface elevations (WSEs), with an R-2 of 0.97, RMSE of 0.29 m, and absolute difference ranging from 3 to 55 cm. The accuracy of InIRA-derived WSEs was highly controlled by the depression sizes, and the absolute biases broadly increased in a power law fashion as the size of the depression decreased. In addition, surface water profiles along the Ganjiang and Xiushui River channels indicated that the TG-2 InIRA could also measure river WSEs, with absolute differences below 0.43 m. Although differences were observed, the results of the river gradient distribution were consistent with the practical situation and showed overall slopes of 18.72 cm/km and 12.43 cm/km for the Xiushui and Ganjiang Rivers, respectively. Such results demonstrated that TG-2 InIRA measurements can satisfactorily capture spatial patterns of the surface water gradient, which is useful for accurately estimating river discharge. This study will not only bridge the gap between in-situ

measurements and forthcoming SWOT products but also contribute to water resource management and hydrologic service assessments over data-sparse regions of river-lake systems within the study area.

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Centenary covariations of water salinity and storage of the largest lake of Northwest China reconstructed by machine learning

Jiang, Xingan; Fan, Chenyu; Liu, Kai;等

In the context of accelerating climate changes and economic boom in the past decades, lakes have undergone drastic changes worldwide. Particularly in arid and semi-arid regions, those lakes were severely impacted and threatened due to their hydrologic sensitivity and ecological vulnerability. As the largest lake in Northwest China with arid climate, Bosten Lake provides precious water resources and ecosystem services to local communities. Although a large quantity of earlier efforts have been paid on Bosten Lake, there is still absence of tracking its changing trajectory at a long timescale (e.g., one century), which restricts the holistic understanding of the decadal periodic lake desiccations and their driving forces. This study employs a machine learning method to reconstruct the centenary covariations of water storage and salinity of Bosten Lake by integrating multi-source data. The results showed that, compared with the high stage of 6.76 x 10(9) m(3) in 1961, the lake water storage substantially dropped twice to 3.96 x 10(9) m(3) in 1987 and 4.67 x 10(9) m(3) in 2013. In recent years, the lake level rose rapidly and recovered back to the comparable stage of the 1960 s by 2020. Four metrics of accuracy evaluation employed in this study indicate the reliability of the XGBoost model, with the mean absolute error of 0.31 m, mean squared error of 0.37 m, r-square of 0.85, and adjusted r-square of 0.84. The centenary recon-struction results reveal that the lake salinity underwent six-phase fluctuations with the water level and storage changes during 1920-2020, with the highest value of 1.87 g/L in 1987 and the lowest value of 1.19 g/L in 2002. During the past century, the water salinity and storage of Bosten Lake were influenced chiefly by vapor pressure and precipitation, followed by wet day frequency, daily mean temperature, and potential evapotranspiration. Moreover, the uncertainty of the machine learning model was also explored and discussed. It could be mainly associated with the data accuracy of input climate variables and the ignorance of environmental impacts from the intense agricultural activities after the 1960 s. This study is expected to advance the scientific understanding of long-term change characteristics of Bosten Lake and to provide a technical reference of reconstructing cen-tenary hydrologic and environmental trajectory for dryland lakes.

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Future rise of the Great Lakes water levels under climate change

Miraj B. Kayastha; Xinyu Ye; Chenfu Huang;等

The Great Lakes of North America are the largest unfrozen surface freshwater system in the world and many ecosystems, industries, and coastal processes are sensitive to the changes in their water levels. The water levels of the Great Lakes are primarily governed by the net basin supplies (NBS) of each lake which are the sum of overlake precipitation and basin runoff minus lake evaporation. Recent studies projected the future NBS of the Great Lakes by dynamically downscaling General Circulation Models (GCMs) using Regional Climate Models (RCMs). However, their RCMs had been coupled to one-dimensional (1D) lake column models which lack the ability to accurately simulate the Great Lakes' hydrodynamics and thermal structure. In this study, an ensemble of three dynamical downscalings based

on the Great Lakes-Atmosphere Regional Model (GLARM) is used to project the future NBS and water level of the Great Lakes. GLARM is a three-dimensional (3D) regional climate modeling system for the Great Lakes region that two-way couples an RCM to a 3D hydrodynamic lake and ice model, making this the first study to use such an advanced model for water level projection of the Great Lakes. For the present-day climate, over-lake precipitation and lake evaporation simulated by GLARM, along with the basin runoff simulated by the GLARM-driven Large Basin Runoff Model (LBRM), track the mean seasonal cycle of the NBS components remarkably well. In particular, compared to previous studies, the most significant improvements are made in estimating the lake evaporation. For future hydroclimate, the ensemble average projects an increase in annual NBS and average annual water level for each lake. The projected NBS increase is mostly due to an increase in over-lake precipitation and basin runoff combined with a relatively smaller increase in lake evaporation. According to the ensemble average, by 2040–2049, the average annual water levels of Lake Superior, Michigan-Huron, and Erie are projected to increase by +0.19, +0.44, and +0.28 m, respectively, relative to 2010–2019. The individual downscaling cases highlight the uncertainty in climate projection, showing both increases and decreases in annual NBS and water level projection. The projected changes in the average annual water levels by 2040–2049 relative to 2010–2019 range from − 0.01 to +0.32 m in Lake Superior, − 0.13 to +0.80 m in Lake Michigan-Huron and − 0.09 to +0.54 m in Lake Erie.

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Improving the accuracy of glacial lake volume estimation: A case study in the Poiqu basin, central Himalayas

Qi, Miaomiao; Liu, Shiyin; Wu, Kunpeng; 等

Lake volume is a critical parameter in the prediction of potential flood volume and peak discharge in the risk assessment of glacial lake outburst flood (GLOF). As existing volume-area scaling relationships often blur the complexity of lake geometry, we presented a new volume-scaling law specific to moraine-dammed lakes, derived from a large lake bathymetry dataset. The relationship was based on the premise that lake geometry parameters (i.e., area, volume, width/length ratio) scale predictably. We then critically evaluated the performance of the new approach and compared it with 19 existing empirical relationships by examining a database of glacial lake bathymetry obtained without repeated measurements. Overall, the new volume-scaling relationship showed a more robust performance than other published formulas. In addition, an intriguing result was that regional differences were not always controlled by the predictability of lake volumes, that is, there were no regional restrictions on the use of the new method, at least not in the Himalayas. Finally, using the new approach and high-resolution Landsat imagery, our results of sequential mapping of all lakes in the Poiqu basin indicated that the total lake volume has increased by 148% from 1974 to 2020. Compared with other formulas, the lake volume estimation approach proposed in this paper provides an approximate mean value, which provides a key input parameter for flood simulation and a new alternative for estimating lake volume.

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Longterm multisource satellite data fusion reveals dynamic expansion of lake water area and storage in a hyperarid basin of China

Zhang, Chuanhui; Lv, Aifeng; Jia, Shaofeng; 等

Lakes play an important role in global hydrologically and provide substantial water resources in hyperarid

regions, and they are becoming even more significant as climate change impacts hydrological processes, especially in these sensitive regions. This study proposes a lake-monitoring framework that uses multisource satellite data to automatically estimate the spatiotemporal variations from 1987 to 2020 of lake area, lake water level, and lake water storage (LWS) in the Qaidam Basin (QB), which is a typical hyperarid basin in northwest China. The global surface water dataset provides long-time-series data for lake areas. Multisource satellite images (Landsat 7, Landsat 8, Sentinel 2) and altimetry data (CryoSat 2, ICESat, ICESat 2, Sentinel 3) are used to build hypsometric curves (the fit to the curve of lake area vs lake water level) to reconstruct lake water level before the 21st century. In contrast with traditional methods, we propose to verify the construction of a hypsometric curve to select a reasonable curve and thereby improve the accuracy of the extrapolation of lake water level. On this basis, we estimated the variation of LWS from 1987 to 2020 and to use products of the gravity recovery and climate experiment and of land surface model simulations to estimate the variation in total LWS in the QB for comparative analysis. The results show that the total LWS in the QB has increased by 82.63% over the past 33 years. Compared with the mean value from 2004 to 2009, the total LWS in 2020 increased by 4.41 km(3), which is equivalent to 12.53%-19.49% of the increase in terrestrial water storage. This ratio cannot be ignored. The analysis of spatiotemporal variations in lakes shows that large shallow lakes are disappearing, leading to ecological deterioration in some areas. Conversely, there is increased water storage in small deep lakes, which may be beneficial for water conservation in hyperarid basins. In conclusion, the proposed automated processing program should facilitate the rapid monitoring of lake dynamics around the world. We emphasize that the variation of lake water storage in hyperarid basins cannot be ignored, which should stimulate more relevant research.

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Numerical modeling for the temporal variations of the water interchange between groundwater and surface water in a regional great lake (Poyang Lake, China)

Zhou, Pengpeng; Wang, Guangcai; Mao, Hairu; 等

For areas possessing both regional-scale floodplain lakes and complex river system, the allocation pattern of water interchange between the groundwater and the lakes and rivers, as well as its temporal variations under year-scale climate changes, are important issues in regard to water resources and ecology environment but are rarely revealed. This study presented a numerical groundwater modeling of the Poyang Lake area to reveal the difference of the temporal variation patterns of the groundwater-lake water interchange and that of the groundwater-river water interchange, and to assess the potential effects of year-scale climate on the temporalspatial variability of water interchange and on the allocation pattern of the net groundwater discharges into rivers and lake. It is found that the monthly groundwater discharge into surface water exhibits significant temporal variability, which reveals an inverse correlation between monthly groundwater discharge and lake water levels and precipitation amounts. Rainy months can lead to groundwater recharge from the Poyang Lake. Our simulated results reveal that, in the dry year of 2018, the variable monthly groundwater discharge into Poyang Lake and the monthly groundwater recharge from Poyang Lake were 0.97-9.67 x 10^8 m^3/month and 0.07-2.54 x 10^8 m^3/month, respectively. Additionally, the annual water interchange amount between groundwater and the Poyang Lake was 9.44 x 10^8 m^3/year, and the annual net groundwater discharge into Poyang Lake was 6.76 x 10^8 m^3/year. However, the hydraulic interaction between groundwater and the five rivers only features

groundwater discharge into rivers with variable monthly groundwater discharge into the five rivers of 0.20-0.72 x 10^8 m^3/month and an annual total groundwater discharge amount of 5.32 x 10^8 m^3/year in 2018. Additionally, our water interchange results of the rainy year of 2010 indicate that the annual water interchange amount between groundwater and the Poyang Lake was 22.74 x 10^8 m^3/year, the annual net groundwater discharge into the Poyang Lake was 1.26 x 10^8 m^3/year, and the annual groundwater discharge into the five rivers was 8.10 x 10^8 m^3/year. These comparisons between the results of the rainy year of 2010 and dry year of 2018 can reveal the effects of the year-scale climate on water exchange between groundwater and surface water and imply that a rainy year can increase the total water interchange amount but decrease the total net groundwater discharge into surface water and that groundwater is more likely to discharge into rivers during a rainy year. Furthermore, it is found that a rainy year can significantly alter the spatial distribution of the water interchange between groundwater and lake water and that the backward particle tracking simulation could be helpful in regard to identifying the spatial distribution of water exchange between groundwater and regionalscale lake. These findings can contribute to a deeper understanding of climate effects on the spatial-temporal variability of water interchange between groundwater and surface water in regional floodplain lake areas and provide useful information for the evaluation of local water resources and the estimation of pollutant transportation.

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Satellite data-driven multi-objective simulation-optimization modeling for water-environment-agriculture nexus in an arid endorheic lake basin

Song, Jian; Yang, Yun; Yin, Ziyue;等

In the arid endorheic lake basin with highly developed agriculture, water scarcity drives the nexus of water -environment-agriculture (WEA) while potential evapotranspiration (ETp) is a critical element linking basin -scale irrigation water demand and agro-economic development. The study proposes a satellite remote sensing data-driven multi-objective simulation-optimization (S-O) framework to implement the basin-scale WEA nexus management. The hydrological model (MODFLOW-NWT) combined with the MODIS (Moderate Resolution Imaging Spectroradiometer) based ET(p)estimation with a 500-m spatial resolution simulates the monthly surface water (SW) and groundwater (GW) irrigation practices. Then, the multi-objective evolutionary algorithm (epsilon-MOMA) is applied to solve management model which includes maximization of agro-economic benefit and environmental flow and minimization of environmental risk of total nitrogen loading subject to irrigation water demand, land availability and food supply. The S-O framework is validated in an arid endorheic lake basin with intensive agricultural irrigation in northwestern China. The four-dimensional Pareto-optimal solutions are achieved to optimize crop planting structure and irrigation water allocation in order to avoid cognitive myopia triggered by low-dimensional or single objective optimization. The results highlight the trade-off among the high value crop planting, SW-GW irrigation and environmental flows, and indicating that lowering nitrogen loading is more sensitive to agro-economic benefit. Historical maximum and minimum ETp scenarios are tailored to quantify the impact of ETp change on WEA nexus management. Results show the increasing ET(p)has a great negative effect on the environmental flow objectives. Therefore, how multi-sectoral interests change depending on the basin-wide development goals may be difficult to regulate due to complex WEA nexus and associated deep uncertainty in the future.

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Stable isotopes reveal the lake shrinkage and groundwater recharge to lakes in the Badain Jaran Desert, NW China

Cao, Le; Nie, Zhenlong; Shen, Jianmei;等

The evolutionary stages of the different lakes in the Badain Jaran Desert (BJD) are unknown, and there is a need to elucidate the hydrological implications of the hydrodynamic environmental differences among these lakes. In this study, a stable isotope mass balance model incorporating the effect of evaporation from the lake basins was developed, and the model was used to calculate the remaining water fraction f of 94 lakes relative to the high lake levels in the Middle Holocene, as well as the groundwater recharge rate chi G to the lakes. The results show that only 10-20 % (average of 15 %) of the original lake water remains. One-third of the lakes have become terminal lakes, and half are still gradually drying. If the climatic conditions remain unchanged, the water levels of these lakes will drop by an average of 11 mm per year. chi G has a certain degree of correlation with elevation, suggesting the likely presence of more water recharge sources for the north lakes, which may include the Beida Mountains and the Zongnai Mountains. The total annual groundwater recharge to all of the lakes in the BJD is 1.63 x 107 m3/yr. The delta 18O evolution model of a typical lake (Cherigele Lake) reveals that humidity h and atmospheric vapor delta a18O play the leading role in the evolution of the lake delta 18O, suggesting that this model may serve as a tool for estimating lake evaporation and for reconstructing the paleoclimate. The findings of this study provide support for analyzing the evolution and future trends of lakes in arid desert areas, as well as deeper insights into the water cycle in the BJD.

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Trace metal spatial patterns and associated ecological toxic effects on phytoplankton in Qinghai-Tibet Plateau lake systems along with environmental gradients

Shen, Di; Wang, Yafeng; Jia, Junjie;等

Trace metal concentrations in lake systems may inhibit or promote phytoplankton growth and associated community structure factors, subsequently affecting their gross primary production (GPP). Accordingly, this study investigates trace metals and their associated effects on community structure in Qinghai-Tibet Plateau (QTP) lake systems along with elevation and salinity gradients. Results show that Trace metal pollution was found to occur in greater than 65% of QTP lake systems. Saline lake systems were the most heavily polluted, saltwater lake systems were the most moderately or slightly polluted, and freshwater lake systems were unpolluted. Trace metal concentrations decreased and phytoplankton biomass increased as altitude increased. Conversely, trace metal concentrations increased as salinity levels increased, but phytoplankton biomass decreased. High trace metal concentrations were significantly and negatively correlated to phytoplankton biomass. This also indicates that high trace metal concentrations are highly toxic and inhibit physiological, biochemical, and photosynthetic phytoplankton growth processes.

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Distribution of SOCD along different offshore distances in China's fresh-water lake-Chaohu under different habitats

Yao, Xiaojie; Wang, Jingjing; Xie, Xinyun;等

Carbon storage in wetland ecosystems is an important part of the carbon cycle of terrestrial ecosystems

and provides important ecosystem services. Chaohu Wetland is a typical freshwater lake wetland in China. In this study, soil and plant samples were collected every 500 m through three sample lines of different vegetation habitats (estuarine banks, woodlands and shrub beaches) and different offshore distances, revealing the spatial distribution characteristics of soil organic carbon density (SOCD) in Chaohu wetland. The overall SOCD of Chaohu wetland was low, with different habitats ranking as Woodland > Estuary and riverside > Shrub and beach. SOCD of different offshore distances had no obvious law, and the SOCD decreased significantly with soil depth. The plant biomass was significantly higher at the woodland habitat than at other habitats. Most of soil nutrient indicators were the highest at the woodland habitat, while the estuary-riverside habitat had the highest N and P contents. Soil and plant nutrients at different offshore distances had no obvious change patterns. The contents of soil K, Ca, Mg, and N were significantly positively correlated with SOCD, but soil bulk density and pH were significantly negatively correlated with SOCD, and vegetation P content was significantly negatively correlated with SOCD. The spatial pattern of SOCD changes in this lake coastal wetland was determined by the combined effects of plant nutrients, biomass, and soil physical and chemical properties. Our results indicate Chaohu wetlands may have been experiencing serious degradation. The SOCD of Chaohu wetland is lower than that of other wetlands in China, which is mainly affected by human activities. Different offshore distances and habitat heterogeneity are the main factors affecting the soil carbon cycle of the wetland.

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Identification of origin and runoff of karst groundwater in the glacial lake area of the Jinsha River fault zone, China

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Karst groundwater plays important roles as a water supply and in sustaining the biodiversity and ecosystems of the eastern Qinghai-Xizang Plateau. Owing to the stratigraphic structure, high tectonic activity, and changeable climate of the region, the recharge source, runoff path, and dynamic characteristics of karst groundwater are highly complex, which poses challenges with regard to the protection of water resources and ecology. This study identified the origin and flow processes of karst groundwater in the glacial lake area of the Jinsha River fault zone using satellite remote sensing, hydrochemical and isotope analyses, and flow measurements. Results showed that active faults control the distribution of glacial lakes and the recharge, runoff, and discharge of karst groundwater. Glacial lake water is an important source of karst groundwater in the Jinsha River fault zone area. Specifically, glacial lake water continuously recharges the karst system via faults, fractures, and karst conduits, thereby maintaining the relative stability of karst spring flows. Through hierarchical cluster analysis, two main runoff conduits of karst water were distinguished: one along the Dingqu Fault and the other along the Eastern Zhairulong Fault, which together account for 59% of the total regional karst groundwater flow. The elevation difference between the recharge and discharge areas of the main karst springs is > 1000 m. Groundwater runoff is fast and residence time in the aquifer is short. The dissolution of calcite and dolomite mainly occurs during transit through the groundwater system, and cation exchange is weak. Therefore, the regional karst springs are predominantly HCO3-Ca center dot Mg type. To protect regional karst water resources and ecology, the monitoring and protection of glacial lakes should be strengthened.

（来源：Scientific Reports 卷:12 出版年：2022, **DOI:** 10.1038/s41598-022-18960-9）

Phase synchronization of chlorophyll and total phosphorus oscillations as an indicator of the transformation of a lake ecosystem

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The ecosystem of the Naroch Lakes (Belarus) includes three water bodies, Lake Batorino, Lake Myastro and Lake Naroch. These lakes have a common catchment area. At the end of the 80 s, the ecosystem of the Naroch Lakes underwent a transformation, during which the nutrient load on the catchment area decreased, and the concentration of phosphorus as a limiting factor in these water bodies decreased significantly. At the same time, the Naroch Lakes were exposed to zebra mussel (Dreissena polymorpha Pallas) invasion. In the mid-90 s, the biological and hydrochemical characteristics of the ecosystem of the Naroch Lakes stabilized. We show here that complex processes associated with the transformation of the lake ecosystem and affecting both trophic interactions in the Naroch Lakes and the influence of environmental factors on them can be represented using a single parameter, the phase-locking index, PLI. In this case, a statistically significant numerical value of PLI characterizes the phase synchronization of two processes, oscillations of the concentration of total phosphorus, TP, and oscillations of the concentration of chlorophyll, Chl. We show that the phase synchronization of these processes occurs only after the stabilization of the ecosystem of the Naroch Lakes. In the period preceding the transformation of the lake ecosystem, there was no synchronization. Numerical evaluation of PLI as a holistic parameter allows us to characterize the transformation of the lake ecosystem as a whole without resorting to study of complex interactions of various factors involved in this transformation.

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Residue level, occurrence characteristics and ecological risk of pesticides in typical farmland-river interlaced area of Baiyang Lake upstream, China

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Baiyang Lake is the largest freshwater lake in North China, playing an important role in aquatic products production and eco-environment improvement. Traditional organochlorine pesticides were not enough to reflect ecological risk. We performed the high-throughput and non-targeted screening to identify the high-residue and wide-distribution pesticides at farmland-river interlaced area. We firstly reported the residue level and spatio-temporal distribution of typical pesticides in soils and waters (SP1-SP13) near Fuhe river in 2020-2021. The mean recoveries of eight pesticides ranged from 79.4 to 129%. The residues were 0.250-3530 ng/L (water) and 2.79 x 10(-3)-647 mu g/kg dw (soil), respectively. Thiamethoxam was dominant with the high-residue proportion (HRP) of 53-95% (water, HRP > 50%) and 63-97% (soil, HRP > 60%), respectively. Most of pesticides almost have no significant season-change. The risk quotient (RQ) model results showed that although most pesticides have no aquatic risk (RQ < 0.01), carbendazim and propionazole deserved attention. The individual thiamethoxam at nearly half of the sites exhibited high terrestrial risk (RQ, 1.070-1.682), while propiconazole was at medium risk (SP1, SP2, SP8, and SP9) and high risk (SP12). The RQ(all) were in the range of 0.4541-3.327 (earthworm), 0.0239-0.4552 (algae), 0.1094-1.103 (aquatic invertabrates), and 0.1657-1.923 (fish), respectively, so co-residue caused joint toxic effect to aquatic invertebrates.

（来源：Scientific Reports 卷:12 出版年: 2022, **DOI:** 10.1038/s41598-022-16088-4）

Transition of a small Himalayan glacier lake outburst flood to a giant transborder flood and debris flow

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Glacial lake outburst floods (GLOFs) are a great concern for the Himalaya, as they can severely damage downstream populations and infrastructures. These floods originate at high altitudes and can flow down with enormous energy and change the terrain's existing morphology. One such devastating event occurred on the night of 5 July 2016, from the inconspicuous Gongbatongsha Lake, located in the Poiqu basin, Eastern Himalaya. The Poiqu basin in the Tibetan Autonomous Region currently contains numerous big glacial lakes; however, this event originated from a small lake. The GLOF was triggered following heavy precipitation that led to a slope failure above the lake and deposition of debris into the lake, which breached the moraine dam and rapidly drained the entire lake. The flood damaged several downstream infrastructures, including the Arniko highway, the Upper Bhotekoshi hydropower plant, and several buildings as it made its way into the Bhotekoshi basin in Nepal. This study adopts a multi-model approach to reconstruct the GLOF trigger and the flood's transformation into a severe debris flow. Proxies including flow discharge, flow velocity, runout distances were used to calibrate the model and validate the results. Results reveal that a debris flow of volume ranging between 3000 and 6000 m(3) from the headwall must have led to lake overfill, eventually leading to the GLOF event. The GLOF showed a significant increase in peak discharge from 618 to 4123 m(3) s(-1) at the Zhangzangbo-Bhotekoshi confluence. The average velocity of the flow is calculated to be 5.5 m s(-1). Reconstruction of the erosion and deposition dynamics show that maximum erosion occurred in the first 6.5 km, with maximum deposition occurring near the Upper Bhotekoshi hydropower station. The modeling indicates that the availability of the entrainable debris along the channel, likely from the previous landslides, amplified the event by three orders of magnitude-additional water ingested from the river. Overall, we demonstrate how the small-scale Gongbatongsha GLOF amplified downstream by incorporating pre-existing sediment in the valley and triggered damaging secondary landslides leading to an economic loss of > 70 million USD.

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Water quality assessment of Lugu Lake based on Nemerow pollution index method

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In this paper, three monitoring sections were set up in Lugu Lake, and water samples were collected in 2019, 2020, and 2021 for the determination of physical and chemical properties such as permanganate index, chemical oxygen demand, biochemical oxygen demand (BOD5) and so on. By using the single factor pollution index method and the Nemerow pollution index method, the water quality of three monitoring sections and the whole Lugu Lake was assessed, and the temporal and spatial changes of water quality were analyzed. The findings demonstrate that Lugu Lake's overall water quality is excellent, and that it has not altered significantly in three years.The results of evaluating the water quality by the single factor pollution index method show that, in the past three years, the water quality of the three monitoring sections and the whole of Lugu Lake is Category I, which belongs to no pollution, and the measured indicators all meet the water quality standard of Category I. It can be seen from the evaluation results of the Nemerow index method that the water quality pollution index of Lugu Lake is between 0.22 and 0.34 in the past three years and the water quality evaluation of Changdao Bay, Lake center, Zhaojia

Bay and the whole are Category I standards in 2019, 2020 and 2021. In terms of time changes, the water quality of Lugu Lake has remained stable between 2019 and 2021, and the water quality has been good. From the perspective of spatial changes, in 2019 and 2020, the water quality in Lake center is better than the monitoring sections of Changdao Bay and Zhaojia Bay.

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Ecological impacts of N-deposition in a remote, high-elevation lake in the Three River Headwaters Region, Qinghai-Tibetan Plateau

Luo, Yuxin; Taylor, Karen J.; Potito, Aaron P.; 等

This study provides a new record of nitrogen (N) deposition and ecological response at a remote, high-elevation lake within the ecologically fragile Three River Headwaters Region, northwest China, from the early 20(th)Century to the past decade. A multi-proxy investigation of a lake sediment core including analyses of chironomids (non-biting midge), lake sediment geochemistry (delta N-15, delta C-13, TN, TOC, OC:TN), pollen, non-pollen palynomorphs and Pb-210-dating. Results were compared with regional pollution forcings, including fertiliser application, atmospheric nitrate and dust deposition, and a localised multiscale air quality modelling system for N-deposition. Our data reflect a mesotrophic lake for the majority of the 20(th) Century with minimal anthropogenic impact. A shift in the lake conditions is evident after 1985 with increased nutrient enrichment. Low delta N-15, OC:TN and increasing TN values, together with an increase in chironomid taxa associated with eutrophic conditions and macrophytes are exhibited in the record, particularly since 2002. These changes are consistent with nutrient loading causing a change in trophic status. Redundancy analysis (RDA) and partial RDAs verified TN as an important driver behind the shift in chironomid community composition in recent decades, explaining 22.2% of the variance on its own and 16.9% with other environmental variables partialled out. While temperature change since 1960 was not a primary control on the chironomid community of Lake Bander, a step-change increase in summer temperatures since the 1990s coincided with the disappearance of cold stenotherms from the record and seems to have exacerbated the shift to more productive conditions. This study highlights the reach of airborne N from modern agricultural and industrial activity to remote locations, and demonstrates the utility of palaeolimnological techniques as part of modern ecosystem assessment for conservation.

（来源：Journal of paleolimnology 出版年: 2022, **DOI:** 10.1007/s10933-022-00266-5）

Environmental changes during the past similar to 400 years in alpine Lake Son-Kul, central Tien Shan, Kyrgyzstan: evidence from sedimentary lipid biomarker records

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Environmental and ecological changes recorded in lake sediments can provide valuable information about natural versus anthropogenic effects on the environment, especially in alpine lakes, which are commonly regarded as sensitive indicators of both local and global environmental changes. To reconstruct the past similar to 400 years of environmental history of alpine Lake Son-Kul, central Tienshan, Kyrgyzstan, we measured lipid biomarkers (n-alkanes [n-ALKs] and n-alkanoic acids [n-FAs]) and other geochemical variables (total organic carbon [TOC] and total nitrogen [TN]) in a Pb-210- and Cs-137-dated sediment core. Stratigraphic shifts in lipid biomarkers, TOC and TN indicate three principal environmental stages in the lake over the past four centuries. Stage I (similar to 1600-1900 AD) was

characterized by relatively lower and stable terrestrial organic matter (OM) and limited aquatic primary productivity. A period of shallow-water conditions was revealed by increased abundances in long-chain n-FAs ca. 1775 AD. Stage II (similar to 1900-1960 AD) was characterized by increased allochthonous OM inputs, indicating marked development of terrestrial vegetation caused by elevated temperatures. In stage III (similar to 1960-2011 AD), allochthonous OM inputs and aquatic primary productivity in the lake increased significantly compared to previous stages. Warm and dry conditions may be responsible for the rapid increase in allochthonous OM inputs and changes in herbaceous plant communities during the interval similar to 1960-1983 AD. A pesticide spill in 1976 caused a reduction in aquatic macrophytes, as recorded by biomarker indexes, e.g. Paq, LPTP. In addition, greater human-mediated nutrient loading was responsible for increasing phytoplankton productivity, especially in recent decades.

（来源：Journal of paleolimnology 出版年：2022, **DOI:** 10.1007/s10933-022-00246-9）

Response of lake water nutrient condition to anthropogenic activities from 1871 to 2013 in the Jiuzhaigou World Natural Heritage Site, China

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Over the past century, lake degradation has increased around the world. Jiuzhaigou World Natural Heritage Site in southwestern China has been experiencing water nutrient enrichment, accelerated swamping, and algal biomass increases. These problems are likely associated with enhanced local anthropogenic activities over the past decades. In this study, radioactivities of Cs-137 and Pb-210, diatoms, and nutrient accumulation rates in a lake sediment core from Tiger Lake in Jiuzhaigou World Natural Heritage Site were used as proxies to reconstruct a > 100-year record of environmental change to understand the extent and temporal variability of anthropogenic effects on lake water nutrients. Diatom communities reveal four distinct phases, relating to documented local human activities including (a) Primitive agriculture from 1871 to the mid-1930s, (b) Opium cultivation-logging from the mid-1930s to the mid-1970s, (c) Large-scale logging-the beginning of tourism from the mid-1970s to the early 1990s, and (d) Tourism development from the early 1990s to 2013. Nutrients in the lake (including total organic carbon, total nitrogen, and total phosphorus) steadily increased from 1871 until the late 1990s, declined from the late 1990s to the mid-2000s, and increased rapidly after the mid-2000s. Our data suggest that (a) Opium cultivation, deforestation, and tourism development led to the increase of lake nutrients and primary productivity, (b) Ecological protection measures taken from 1999 to 2004 effectively controlled water pollution, and (c) Post-2005 intensification of tourism further accelerated water quality deterioration. Additional monitoring and mitigation strategies are needed to further reduce nutrient input. Global studies suggest that while water quality of lakes in protected area is better than that of other lakes, care is still required to ensure that tourism activities do not inadvertently increase lake water nutrients.

（来源：Journal of paleolimnology 出版年：2022, **DOI:** 10.1007/s10933-022-00248-7）

Use of sedimentary algal pigment analyses to infer past lake-water total phosphorus concentrations

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We tested the feasibility of using sedimentary algal pigment analyses by spectral deconvolution to infer past lake-water total phosphorus concentrations. We established equations that link lake-water nutrient concentrations and sediment pigment concentrations, using a combination of calibration in both space and time, with a training set of 31 Swedish lakes. The calibration dataset yielded a significant positive

relationship between total carotenoid concentrations and lake-water total phosphorus concentrations. We also compared sediment-pigment-based nutrient inferences with time series of water column monitoring data to evaluate whether temporal changes in total phosphorus concentrations are well captured by analysis of sedimentary pigments. We found that changes in pigment preservation through time can alter the relationship between concentrations of lake-water nutrients and sedimentary pigments, thus limiting the reliability of historical ecological conditions inferred from pigments in the sediment. Our data suggested that ratios of Chlorophyll derivatives to total carotenoids (CD/TC ratio) and Chlorophyll a to Chlorophyll derivatives (CPI) can be used as proxies for pigment preservation. Using our approach, inferred temporal changes in water-column total phosphorus concentrations in lakes are promising, but require further development, specifically with respect to the influence of pigment degradation in both the water column and sediments, as well as the factors that control such degradation.

（来源：Journal of paleolimnology 出版年：2022, **DOI:** 10.1007/s10933-022-00255-8）

Hydrological disconnection from the Yangtze River triggered rapid environmental degradation in a riverine lake

Li, Yan; Liao, Yuejun; Dong, Xuhui; 等

Interactive River-Flood Ecosystem (RFE) is an important feature characterizing the dynamics of the hydrological connectivity between lake and river worldwide. Any disruption in the RFE can impose significant effects on the functioning of floodplain ecosystems. However, due to the lack of long-term monitoring data, the understanding of the process and mechanism behind limnological responses to the changes in hydrological alterations and nutrient loading in floodplain lakes is restricted. The middle and lower reaches of the Yangtze river floodplain lake system of China is one of the significant food bowls of the nation, and makes important contribution to ecosystem services including drinking water and food to the society for generations. The interactive RFE of the Yangtze floodplain lakes is profoundly disrupted by anthropogenic activities over the recent decades. However, the response of such changes in river-lake connectivity is not comprehensively investigated yet. Here, we studied Cehu Lake in the lower reaches of the Yangtze floodplain system to examine the long-term environmental changes with altered river-lake connectivity and increased nutrient loading using high-resolution paleolimnological multi-proxy analyses including geochemistry, grain size and diatom assemblages of a 210Pb/137Cs dated core. Our results suggest that Cehu Lake have experienced two pronounced shifts: immediately after the damming in Yangtze river (1964) completely ceasing the lake-river connectivity, and in 1994. The disruption in the hydrological connectivity in 1964 led to an abrupt decrease in the abundance of Aulacoseira granulata, and an increase in the organic matter (loss-on-ignition), epiphytic and benthic diatoms, while the disruption in 1994 led to increased total phosphorus (TP), lead (Pb), dry mass accumulation rate, and a decline in Fe/Mn, and consequently enhanced lake eutrophication with emergence of enriched nutrient tolerant diatoms (Cyclotella meneghiniana, Cyclostephanos tholiformis). The redundancy analysis (RDA) showed increased TP loads in lake sediment after damming in the Yangtze river. The condition stimulated macrophyte growth with, but altered diatom flora. Reconnecting Cehu lake with Yangtze river together with reducing nutrient loading to the lake from the incoming river may be an effective management practice to relieve the ecological stress.

（来源：Limnologica 卷:95 出版年：2022, **DOI:** 10.1016/j.limno.2022.125993）

A trophic cascade triggers blooms of Asterionella formosa in subtropical eutrophic Lake Taihu, China

Liu, Xia; Li, Yun; Shen, Ruijie; 等

The importance of trophic interactions for determining the distributions, abundances, and taxonomic compositions of organisms in ecosystems has long been studied and debated. Here we test the effect of a trophic cascade on diatom (Asterionella formosa) blooms in subtropical, eutrophic Lake Taihu, China. A long-term data series (2005-2015) on planktivorous fish, zooplankton and diatoms has been analysed. Structural equation modelling is used to test our hypotheses about the influences of top-down and bottom-up forces on A. formosa. Since 2009, a spring bloom of A. formosa has occurred in the lake, coinciding with a reduction of Daphnia galeata biomass and of total cladoceran biomass following a marked increase in the stock of planktivorous fish (bighead carp and silver carp). Light, phosphorus (total and soluble reactive phosphate) and silica did not act as limiting factors for the growth of A. formosa. Structural equation modelling analysis showed that top-down effects of cladocerans on A. formosa biomass were more important than bottom-up effects (wind speed and soluble reactive phosphate). Although A. formosa was negatively correlated with total nitrogen, total with other inorganic nitrogen (NO_3 and NH_4) did not restrict the proliferation of diatom blooms after 2007. These results suggested that the substantial reduction of the Daphnia population caused a diatom bloom through a trophic cascade by planktivorous fish. Our study provides new insight into the effects of trophic interactions on diatom bloom formation in natural freshwater ecosystems.

（来源：Freshwater Biology 出版年：2022, **DOI:** 10.1111/fwb.13986）

Carbon dioxide limitation of benthic primary production in a boreal lake

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Gross primary production (GPP) by benthic microalgae growing on soft sediments is an important contributor to lake productivity in many lakes world-wide. As benthic microalgae have access to nutrients in the sediment they have been regarded as primarily controlled by light, while the role of CO_2 as a limiting factor for benthic GPP in lake ecosystems is largely unknown. In this study, we experimentally tested for CO_2 limitation of benthic GPP by collecting littoral surface sediments, with associated benthic microalgae, from a typical boreal lake. Intact sediment cores were incubated at different depths (light conditions) after addition of dissolved inorganic (bicarbonate) or organic (DOC; glucose) carbon as direct and indirect sources of CO_2, respectively. Benthic microalgal GPP was stimulated by both dissolved inorganic carbon and DOC additions at high, but not at low, light levels. This study shows that benthic microalgal GPP can be CO_2-limited when light is not limiting and suggests that both direct (e.g., via groundwater inflow) and indirect (via mineralisation of DOC) CO_2 supply can stimulate benthic GPP.

（来源：Freshwater Biology 出版年：2022, **DOI:** 10.1111/fwb.13972）

Linking theory with empirical data: Improving prediction through mechanistic understanding of lake ecosystem complexity under global change

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In this study dedicated to Winfried Lampert, we present a suite of case studies which successfully combined empirical long-term and experimental data with theory to identify mechanisms driving the

non-linear dynamics and critical transitions in a lake ecosystem under environmental change. The theoretical concepts used include Warning Indicators. Only by linking theory with data do we gain a mechanistic understanding of the dynamics and long-term changes observed in the case study sites ??? allowing for realistic projections under different climate change scenarios. If this combined approach correctly identifies the mechanisms governing change in case studies, then upscaling beyond the case study at hand is likely feasible. Indeed, for most of the presented case studies, identified mechanisms were confirmed by explicitly linking them to relevant recent studies based on large-scale global data sets. These include the rise in lake ice intermittency, shifts in thermal regime and the amplification of lake???s trophic state in a warmer world. This link also documents the importance and value of re-using long-term records under the FAIR data principles in international initiatives. Further, in the context of linking theory and data, largescale data has the unique ability to test the general validity of a theory, thus giving valuable feedback to theory.

（来源：Fundamental and applied limnology 出版年：2022, **DOI:** 10.1127/fal/2022/1457）

Multi-annual comparisons of summer and under-ice phytoplankton communities of a mountain lake

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Little is known on the dynamics of under-ice phytoplankton communities. We investigated phytoplankton communities in the upper (0-20 m) and lower (30-35 m) layer of oligotrophic Lake Tovel, Brenta Dolomites (Italy) over 6 years during summer and under ice. Winter conditions were different from one year to another with respect to ice thickness and snow cover. Proxies for light transmission (Secchi disc transparency, light attenuation) were similar between seasons, even though the incident solar radiation was lower in winter. Algal richness and chlorophyll-a were not different between seasons while biomass was higher during summer. In four of the 6 years, Bacillariophyta dominated during summer and Miozoa (class Dinophyceae) under ice while in 2 years Bacillariophyta also dominated under ice. Generally, a shift to larger size classes from summer to under ice was observed for Bacillariophyta, Chlorophyta, and Ochrophyta (class Chrysophyceae) while Dinophyceae showed the opposite pattern. No strong links between phytoplankton community composition and abiotic factors (under-ice convective mixing, snow on ice, under-ice light) were found. We suggest that inter-species relationships and more precise indicators of under-ice light should be considered to better understand under-ice processes.

（来源：Hydrobiologia 出版年：2022, **DOI:** 10.1007/s10750-022-04952-3）

Seasonal variations alter the effect of an invasive plant on the decomposition of a native plant in a subtropical eutrophic lake, China

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To assess how the presence of an invasive plant and different-sized decomposers affect plant litter decomposition under different seasonal conditions, we allocated leaves of native Ficus virens Aiton into four different mesh sizes (0.025, 0.042, 0.5 and 5 mm) with and without invasive Alternanthera philoxeroides (Mart.) Griseb. We incubated them for 65 days in an eutrophic lake in summer and winter respectively. The average decomposition rate was significantly higher in summer than in winter, and was significantly higher in mixtures than in F. virens monocultures in both seasons. The presence of A. philoxeroides in the mixture significantly increased invertebrate density and microbial respiration rates in summer but not in winter. Furthermore, contribution of invertebrates to decomposition was higher in the

early stage of decomposition and lower in the late stage in summer, yet that of microbes was relatively constant in winter. Contribution of microinvertebrates increased in summer but that of meio-, macroinvertebrates increased in winter. Our findings indicate that the presence of an invasive plant altered litter decomposition, which may depend on seasonal variations, invertebrate density and decomposition stages.

（来源：Hydrobiologia 卷:826 出版年: 2022, **DOI:** 10.1007/s10750-022-04956-z）

Shelter availability reduces the effects of the invasive Red Swamp Crayfish (Procambarus clarkii) on eelgrass-dominated clear-water lakes: a mesocosm approach

Gao, Jian; Hu, Shengnan; Yang, Cheng; 等

Shelter availability is one of the key features governing crayfish habitat quality. It can directly influence crayfish's individual survival of by lowering the risk of predation, but the ecosystem-wide impacts of sheltering on water quality are largely unknown. To test the effects of shelter availability for Procambarus clarkii in clear-water macrophyte-dominated lakes, we performed a 24-day mesocosm experiment in 20 tanks (4 with one crayfish with and without shelters, 4 with two crayfish with and without shelters and 4 controls). The bottom of each tank was almost completely covered by the eelgrass Vallisneria denseserrulata. Compared with the treatments with shelters, more broken leaves occurred in the treatments without shelters at both crayfish densities at equivalent crayfish numbers, and total phosphorus was higher in the treatments without shelters. Total suspended solids and total nitrogen concentrations were higher in the treatments with two crayfish without shelters than in those with shelters, whilst these variables did not differ between treatments in the mesocosms with one crayfish only. Our results suggest that shelter availability reduces the activity of crayfish (e.g. movement and burrowing) and agonistic behaviour, thereby decreasing the negative effect of the invasive P. clarkii on water quality in V. denseserrulata-dominated clear-water lakes.

（来源：Hydrobiologia 出版年: 2022, **DOI:** 10.1007/s10750-022-04969-8）

Analysis of Surface Water Trends for the Conterminous United States Using MODIS Satellite Data, 2003–2019

Roy E. Petrakis; Christopher E. Soulard; Eric K. Waller; 等

Satellite imagery is commonly used to map surface water extents over time, but many approaches yield discontinuous records resulting from cloud obstruction or image archive gaps. We applied the Dynamic Surface Water Extent (DSWE) model to downscaled (250-m) daily Moderate Resolution Imaging Spectroradiometer (MODIS) data in Google Earth Engine to generate monthly surface water maps for the conterminous United States (US) from 2003 through 2019. The aggregation of daily observations to monthly maps of maximum water extent produced records with diminished cloud and cloud shadow effects across most of the country. We used the continuous monthly record to analyze spatiotemporal surface water trends stratified within Environmental Protection Agency Ecoregions. Although not all ecoregion trends were significant ($p < 0.05$), results indicate that much of the western and eastern US underwent a decline in surface water over the 17-year period, while many ecoregions in the Great Plains had positive trends. Trends were also generated from monthly streamgage discharge records and compared to surface water trends from the same ecoregion. These approaches agreed on the directionality of trend detected for 54 of 85 ecoregions, particularly across the Great Plains and portions

of the western US, whereas trends were not congruent in select western deserts, the Great Lakes region, and the southeastern US. By describing the geographic distribution of surface water over time and comparing these records to instrumented discharge data across the conterminous US, our findings demonstrate the efficacy of using satellite imagery to monitor surface water dynamics and supplement traditional instrumented monitoring.

（来源：Water Resources Research 出版年：2022, **DOI:** 10.1029/2021WR031399）

Classifying Mixing Regimes in Ponds and Shallow Lakes

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Lakes are classified by thermal mixing regimes, with shallow waterbodies historically categorized as continuously mixing systems. Yet, recent studies demonstrate extended summertime stratification in ponds, underscoring the need to reassess thermal classifications for shallow waterbodies. In this study, we examined the summertime thermal dynamics of 34 ponds and shallow lakes across temperate North America and Europe to categorize and identify the drivers of different mixing regimes. We identified three mixing regimes: rarely (n = 18), intermittently (n = 10), and often (n = 6) mixed, where waterbodies mixed an average of 2%, 26%, and 75% of the study period, respectively. Waterbodies in the often mixed category were larger (>= 4.17 ha) and stratification weakened with increased wind shear stress, characteristic of shallow lakes. In contrast, smaller waterbodies, or ponds, mixed less frequently, and stratification strengthened with increased shortwave radiation. Shallow ponds (<0.74 m) mixed intermittently, with daytime stratification often breaking down overnight due to convective cooling. Ponds >= 0.74 m deep were rarely or never mixed, likely due to limited wind energy relative to the larger density gradients associated with slightly deeper water columns. Precipitation events weakened stratification, even causing short-term mixing (hours to days) in some sites. By examining a broad set of shallow waterbodies, we show that mixing regimes are highly sensitive to very small differences in size and depth, with potential implications for ecological and biogeochemical processes. Ultimately, we propose a new framework to characterize the variable mixing regimes of ponds and shallow lakes.

（来源：Water Resources Research 出版年：2022, **DOI:** 10.1029/2022WR032522）

The Effects of Surface Mixers on Stratification, Dissolved Oxygen, and Cyanobacteria in a Shallow Eutrophic Reservoir

Slavin, E., I ; Wain, D. J. ; Bryant, L. D.; 等

Top-down surface mixers are increasingly used in drinking water reservoirs to prevent the development of stratification, control cyanobacteria, and limit sediment release of soluble manganese. A targeted field investigation enabled the discrimination of artificial mixing by surface mixers from wind and convection in a shallow (6.6 m), eutrophic drinking water reservoir. Top-down surface mixers were effective at reducing vertical temperature and dissolved oxygen gradients over a 20 m radius, within which turbulent kinetic energy (TKE) input from the mixers exceeded the maximum TKE contribution from wind and convection. Meteorological conditions appeared to have a stronger influence beyond a 60 m radius from the mixers. Near-bed velocities measured using an Acoustic Doppler Velocimeter (ADV) similar to 30 m north of the mixers were significantly lower when the mixers were not operating; when operating, ADV signal amplitude showed localized sediment resuspension. Cyanobacteria cell counts were high throughout the reservoir but counts of low-light adapted Planktothrix sp. were highest near the mixers, indicating mixer operation may improve growing conditions for Planktothrix. While the destratification goal of mixers was

accomplished locally, the limited range of influence left >90% of the reservoir subject to diurnal stratification, anoxia, and potential internal loading of inorganic nutrients and soluble metals, restricting mixer effectiveness as an in-reservoir management technique to improve raw water quality in shallow systems.

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Algal volatiles–the overlooked chemical language of aquatic primary producers

Mahasweta Saha and Patrick Fink

Volatiles are important ‘infochemicals’ that play a crucial role in structuring life on our planet, fulfilling diverse functions in natural and artificial systems. Algae contribute significant quantities to the global budget of volatiles, but the ecological roles of aquatic volatiles are not well understood. In this review, we discuss the current knowledge of volatile compounds from freshwater and marine microalgae and marine macroalgae, with a focus on their ecological roles. We highlight the multiple reported functions of biogenic volatiles, ranging from intraspecific communication for reproduction, intrabloom signalling and antioxidant functions, to various interspecific signal exchanges that may allow herbivores to locate them and function in defence against competitors and predators. Beyond reviewing our current understanding, we specifically highlight major knowledge gaps and emerging questions for algal volatile research. These novel perspectives have the potential to improve our understanding of aquatic ecosystems and thus need to be addressed in future research. Filling these gaps and addressing these questions will facilitate humanity’s efforts to exploit aquatic volatiles in various applications.

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Evaluating the effects of aquaculture on the freshwater lake from the perspective of plankton communities: The diversity, co-occurrence patterns and their underlying mechanisms

Huimin Xu; Dayong Zhao; Jin Zeng; 等

Aquaculture has significant impacts on freshwater lakes, but plankton communities, as key components of the microbial food web, are rarely considered when assessing the impacts of aquaculture. Revealing the dynamics of plankton communities, including bacterioplankton, phytoplankton and zooplankton, under anthropological disturbances is critical for predicting the freshwater ecosystem functioning in response to future environmental changes. In the present study, we examined the impacts of aquaculture on water quality, plankton diversity and the co-occurrence patterns within plankton metacommunities in a shallow freshwater lake. The study zones are influenced by the 20-year historical intensive aquaculture, but now they are undergoing either ecological aquaculture or ecological restoration. Our results showed that ecological aquaculture was more efficient in nitrogen removal than ecological restoration. Moreover, lower bacterioplankton diversity but higher phytoplankton and zooplankton diversity were found in the ecological aquaculture and ecological restoration zones compared to the control zone. The lower network connectivity of the plankton metacommunities in the ecological aquaculture and ecological restoration zones indicated the decreasing complexity of potential microbial food web, suggesting a possible lower resistance of the plankton metacommunities to future disturbance. Furthermore, plankton communities of different trophic levels were driven under distinct mechanisms. The bacterioplankton community was primarily affected by abiotic factors, whereas the phytoplankton and zooplankton

communities were explained more by trophic interactions. These results revealed the impacts of aquaculture on the plankton communities and their potential interactions, thereby providing fundamental information for better understanding the impacts of aquaculture on freshwater ecosystem functioning.

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Indices and models of surface water quality assessment: Review and perspectives

Yan, Tao; Shen, Shui-Long; Zhou, Annan; 等

Many technologies have been designed to monitor, evaluate, and improve surface water quality, as high-quality water is essential for human activities including agriculture, livestock, and industry. As such, in this study, we investigated water quality indices (WQIs), trophic status indices (TSIs), and heavy metal indices (HMIs) for assessing surface water quality. Based on these indices, we summarised and compared water assessment models using expert system (ES) and machine learning (ML) methods. We also discussed the current status and future perspectives of water quality management. The results of our analyses showed that assessment indices can be used in three aspects of surface water quality assessment: WQIs are aggregated from multiple parameters and commonly used in surface water quality classification; TSIs are calculated from the concentrations of different nutrients required for algae and bacteria, and employed to evaluate the eutrophication levels of lakes and reservoirs; HMIs are mainly applied for human health risk assessment and the analysis of correlation of heavy metal sources. ES-and ML-based assessment models have been developed to efficiently generate assessment indices and predict water quality status based on big data obtained from new techniques. By implementing dynamic monitoring and analysis of water quality, we designed a next-generation water quality management system based on the above indices and assessment models, which shows promise for improving the accuracy of water quality assessment.

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Microcystin pollution in lakes and reservoirs: A nationwide meta-analysis and assessment in China

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The frequent occurrence of microcystins (MCs) has caused a series of water security issues worldwide. Although MC pollution in natural waters of China has been reported, a systematic analysis of the risk of MCs in Chinese lakes and reservoirs is still lacking. In this study, the distribution, trend, and risk of MCs in Chinese lakes and reservoirs were comprehensively revealed through meta-analysis for the first time. The results showed that MC pollution occurrence in numerous lakes and reservoirs have been reported, with MC pollution being distributed in the waters of 15 provinces in China. For lakes, the maximum mean total MC (TMC) and dissolved MC (DMC) concentrations occurred in Lake Dianchi (23.06 mu g/L) and Lake Taihu (1.00 mu g/L), respectively. For reservoirs, the maximum mean TMC and DMC concentrations were detected in Guanting (4.31 mu g/L) and Yanghe reservoirs (0.98 mu g/L), respectively. The TMC concentrations in lakes were significantly higher than those in the reservoirs ($p < 0.05$), but no difference was observed in the DMC between the two water bodies ($p > 0.05$). Correlation analysis showed that the total phosphorus concentrations, pH, transparency, chlorophyll a, and dissolved oxygen were significantly related to the DMC in lakes and reservoirs. The ecological risks of DMC in Chinese lakes and reservoirs were generally at low levels, but high or moderate ecological risks of TMC

had occurred in several waters, which were not negligible. Direct drinking water and consumption of aquatic products in several MC -polluted lakes and reservoirs may pose human health risks. This study systematically analyzed the pollution and risk of MCs in lakes and reservoirs nationwide in China and pointed out the need for further MC research and management in waters.

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Plastisphere in lake waters: Microbial diversity, biofilm structure, and potential implications for freshwater ecosystems

Francesca Di Pippo; Simona Crognale; Caterina Levantesi; 等

Once dispersed in water, microplastic (MP) particles are rapidly colonised by aquatic microbes, which can adhere and grow onto solid surfaces in the form of biofilms. This study provides new insights on microbial diversity and biofilm structure of plastisphere in lake waters. By combining Fourier Confocal Laser Scanning Microscopy (CLSM), Transform Infrared Spectroscopy (FT-IR) and high-throughput DNA sequencing, we investigated the microbial colonization patterns on floating MPs and, for the first time, the occurrence of eukaryotic core members and their possible relations with biofilm-forming bacterial taxa within the plastisphere of four different lakes. Through PCR-based methods (qPCR, LAMP-PCR), we also evaluated the role of lake plastisphere as long-term dispersal vectors of potentially harmful organisms (including pathogens) and antibiotic resistance genes (ARGs) in freshwater ecosystems. Consistent variation patterns of the microbial community composition occurred between water and among the plastisphere samples of the different lakes. The eukaryotic core microbiome was mainly composed by typical freshwater biofilm colonizers, such as diatoms (Pennales, Bacillariophyceaea) and green algae (Chlorophyceae), which interact with eukaryotic and prokaryotic microbes of different trophic levels. Results also showed that MPs are suitable vectors of biofilm-forming opportunistic pathogens and a hotspot for horizontal gene transfer, likely facilitating antibiotic resistance spread in the environments.

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Eutrophic levels and algae growth increase emissions of methane and volatile sulfur compounds from lakes

Jing Wang; ZhiPeng Wei; YiXuan Chu; 等

Eutrophic lakes are hot spots of CH_4 and volatile sulfur compound (VSC) emissions, especially during algal blooms and decay. However, the response of CH_4 and VSC emissions to lake eutrophication and algae growth as well as the underlying mechanisms remain unclear. In this study, the emissions of CH_4 and VSCs from four regions of Lake Taihu with different eutrophic levels were investigated in four months (i.e., March, May, August and December). The CH_4 emissions ranged from 20.4 to 126.9 mg m^{-2} d^{-1} in the investigated sites and increased with eutrophic levels and temperature. H2S and CS2 were the dominant volatile sulfur compounds (VSCs) emitted from the lake. The CH_4 oxidation potential of water ranged from 2.1 to 14.9 μg h^{-1} L^{-1}, which had positive correlations with trophic level index and the environmental variables except for the NH_4^+-N concentration. Eutrophic levels could increase the abundances of bacteria and methanotrophs in lake water. α-Proteobacteria methanotroph Methylocystis was more abundant than γ-Proteobacteria methanotrophs in March and May, while the latter was more abundant in August and November. The relative abundance of Cyanobacteria, including Microcystis, A. granulata var. angustissima and Cyanobium had significantly positive correlations with temperature, turbidity, SO_4^{2-}-S, and total sulfur. Partial least squares path modelling revealed that the algal growth could promote VSC

emissions, which had a positive correlation with CH_4 oxidation potential, likely due to the positive correlation between the CH_4 and VSC emissions from lakes. These findings indicate that water eutrophication and algae growth could increase the emissions of CH_4 and VSCs from lakes. Controlling algae growth might be an effective way to mitigate the emissions of CH_4 and VSCs from freshwater lakes.

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A comprehensive assessment of upgrading technologies of wastewater treatment plants in Taihu Lake Basin

Zheng Wei; Yan He; Xing Wang; 等

To meet the increasingly stringent discharge standards of wastewater treatment plants (WWTPs) in the Taihu Lake Basin, the Chinese government successively established the National Special Water Project Program to develop new technologies to retrofit and upgrade existing wastewater treatment processes during the 11th, 12th, and 13th Five-Year Plans. However, there is a lack of systematic sorting of the existing research outcomes, and thus hinders the application and promotion of the upgrade technologies. Based on the outcomes of the National Special Water Project and a field survey, this research analyzed the current status of wastewater treatment in the Taihu Lake Basin and systematically integrated the retrofitting measures of WWTPs in terms of achieving the Grade IA of the national standard and local stricter discharge standards (DB 32/1072–2018 and DB 33/ 2169–2018). In particular, the boundary conditions, design parameters, specific recommendations of the technologies, and some typical engineering cases were provided accordingly. Finally, this study discussed the future development directions of WWTPs during the upgrade process from the perspective of carbon neutrality and digitalization. The present work will hopefully assist in retrofitting and constructing WWTPs to achieve the stricter effluent discharge criteria and help optimize the design and construction of WWTPs in the best way.

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Short-term effects of macrophyte removal on emission of CO_2 and CH_4 in shallow lakes

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Mass development of macrophytes in freshwater ecosystems is today considered a worldwide problem and substantial resources are spent on macrophyte removal each year. By removing the dominant primary producer, however, this management practice radically changes the ecosystem overnight. Here, we studied short-term effects of the removal of a mass development of free-floating (Pontederia crassipes), submerged (Elodea nuttallii) and emergent (mix of Ludwigia grandiflora and L. peploides) macrophytes on fluxes of CH_4 and CO_2 in three lakes. In our field experiment, we assigned an impact site where macrophytes were removed, and a control site where vegetation remained. Before and after removal, diffusive fluxes of CO_2 and CH_4 were determined in lakes dominated by P. crassipes and E. nuttallii, whereas total emission of CH_4 was determined in all three case study lakes. Additionally, plant biomass, and physical and chemical parameters were measured before and after removal. While removal of emergent Ludwigia spp. showed no clear effect on total CH_4 emission, removal of submerged E. nuttallii reduced both CO_2 fixation and total CH_4 emission. Removal of free-floating P. crassipes, on the other hand, increased CH_4 fluxes and stimulated phytoplankton blooms. The lack of a universal response

across our case study lakes suggests that both macrophyte life forms and environmental parameters can be important factors determining effects of removal. Additionally, indirect effects of macrophyte removal on temperature and dissolved oxygen can help to explain carbon emissions. Long-term effects should be studied to allow development of sustainable management practices.

（来源：Aquatic Botany 卷：182 出版年：2022, **DOI:** 10.1016/j.aquabot.2022.103555）

Risk assessment of potential toxic metal pollution in water-sediment-submerged macrophyte systems: a case study of urban shallow lakes in Central China

Jiang, Changjin; Zhang, Ting; Yang, Zhaoguang 等

Six potential toxic metals (PTMs) in water-sediment-submerged macrophyte systems were investigated in six shallow lakes in Changsha City, Central China. The mean metal concentrations in the surface and interstitial water were in the order of Cu>As>Zn>Cr>Pb>Cd and As>Cu>Zn>Cr>Pb>Cd, respectively. Both surface and interstitial water were not polluted, except the interstitial water of Yue Lake with slight pollution (P-N=1.93). The mean metal concentration was in the order of Zn>Cr>As>Cu>Pb>Cd in the sediments. The concentration of As in all urban shallow lakes exceeded 25 mg kg(-1), and Cd in Meixi Lake and Xianjia Lake also exceeded 0.3 mg kg(-1). The sediments were slight to severe pollution in the studied urban shallow lakes. Among the submerged macrophytes, the concentrations of PTMs were decreased in the order of Vallisneria natans (Lour.) Hara > Myriophyllum verticillatum L. > Centella asiatica (L.) Urban > Potamogeton crispus L. Zn was the most accumulated in all the submerged macrophytes, and the highest bioaccumulation factor (BAF) of Zn was 43.0 in V. natans. V. natans also exhibited relatively high BAFs of 4.6, 2.4, and 4.7 for Cu, As, and Pb, compared with other submerged macrophytes. The translocation factor (TF) of As was no more than 0.3 in all submerged macrophytes. The TFs of the other metals were dependent on the plant species. For most studied metals (As, Pb, Zn, and Cd), significant positive correlations were identified between submerged macrophytes and their surrounding water/sediments ($P<0.05$). These results indicated that the potential use of native submerged macrophytes, especially for V. natans, for PTM removal from urban shallow lakes is worth further exploration.

（来源：Quatic Ecology 出版年：2022, **DOI:** 10.1007/s10452-022-09972-8）

Air temperature effects on nitrogen and phosphorus concentration in Lake Chaohu and adjacent inflowing rivers

Hu, Yuemin; Peng, Zhaoliang; Zhang, Yihui; 等

The relationship between nitrogen and phosphorus concentrations in rivers and lakes and their influencing factors have been global concerns. However, how air temperature changes affect the nitrogen and phosphorus concentrations in rivers and lakes remains unknown. In this study, we conducted analyses linking the characteristics of air temperature to monthly nitrogen and phosphorus monitoring datasets of the lake and adjacent inflowing rivers in the Lake Chaohu basin from 2014 to 2018. We found that the variations in the mean air temperature of the antecedent 7 days significantly affected the nitrogen and phosphorus concentrations in shallow eutrophic lakes, and the air temperature threshold ranged from 3 to 27 degrees C. As the air temperature increased, the nitrogen concentrations in Lake Chaohu decreased, but the phosphorus concentrations showed an upwards trend. The lake had a buffer function, as indicated by the more pronounced response of nitrogen and phosphorus to

increasing air temperature in western Lake Chaohu (TN = - 0.085 mg L-1 degrees C-1, TP = + 0.004 mg L-1 degrees C-1) than eastern Lake Chaohu (TN = - 0.034 mg L-1 degrees C-1, TP = + 0.003 mg L-1 degrees C-1). The decreasing trend of nitrogen concentrations (average declining rate: 0.090 mg L-1 degrees C-1) in inflowing rivers with increasing air temperature was even more pronounced than that in Lake Chaohu. However, no significant statistical relationship was found between the phosphorus concentrations and air temperature in most inflowing rivers. Therefore, this study emphasizes the need to further unravel the coupling mechanism between internal nutrient loads and climate factors while reducing external nutrient loads.

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Characteristics of N_2O release from polluted creeks in the Taihu Lake Basin: sources and microbial populations

Li, Da; Shi, Linglong; Guo, Shuangzhen; 等

Polluted rural creek systems are a potential primary source of nitrous oxide (N_2O). However, to date, the N_2O emission pathways of rural creek systems have yet to be investigated. In particular, the correlations between N_2O emissions and ammonia-oxidizing archaea (AOA), ammoniating bacteria (AOB), and denitrifying communities remain poorly understood. In this paper, a sediment-water-environment simulation system was established to analyze the N_2O emission pathways, and the correlations between N_2O emissions and nitrogen-related functional genes for two creeks that have been polluted by domestic sewage and industrial wastewater have been studied. The results indicated that the N_2O release rate of the creek polluted by domestic sewage was higher than that of the creek polluted by industrial wastewater, and the heterotrophic denitrification and nitrification were the main N_2O emission pathways for the creek polluted by domestic sewage. On the contrary, nitrification and chemical denitrification were the primary N_2O emission pathways for the creek polluted by industrial wastewater. The quantitative PCR (qPCR) results obtained for nitrogen-cycle functional genes in creek sediments indicated that the abundances of AOA genes (AOA amoA), AOB genes (AOB amoA), and denitrification genes (nosZ) were lower in the creek polluted by industrial wastewater than that in the creek polluted by domestic sewage. For the creek polluted by domestic sewage, the N_2O emission rate exhibited a significant positive correlation with the abundances of AOA amoA and AOB amoA and a correlation with the abundances of the dominant nitrogen-cycling microorganisms ($p < 0.05$). However, no such correlations were found for the creek polluted by industrial wastewater. In the future, the patterns detected here will be useful as markers to distinguish whether water has been polluted by industry.

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Pelagic cyanobacterial nitrogen fixation in lakes and ponds of different latitudinal zones

Li, Yan; Yu, Ye-Xin; Ma, Shuo-Nan;等

Excess nitrogen (N) loading is one of the main factors causing eutrophication. Biological N fixation (BNF), as a main contributor to N loading, plays a critical role in the N cycle. The N-2 fixation rate (N(2)fix) is regulated by many factors and is usually higher under conditions of N deficiency. Most studies have focused on the regulation of factors that influence the N(2)fix in specific aquatic ecosystems or artificial conditions, while fewer have focused on large scale such as the latitudinal distribution of N(2)fix. To understand the regulation of the N(2)fix in latitudinal zones, the key factors, and the underlying

mechanism, we compared the N(2)fix in 27 lakes located in different latitudinal zones and analyzed the main regulators. The results showed that (1) heterocyst density (D-Het) and the N(2)fix were highest in low-temperate lakes and were 2.5-2.7 and 11.6-22.1 times greater than in high-temperate lakes and tropical lakes, respectively, in the 99th quantile; (2) D-Het increased and then decreased with increasing latitude and radiation, and peaked at 30.28 degrees N and 2300 J/cm/d; (3) D-Het was positively correlated with temperature and increased slightly with increasing temperature; (4) N(2)fix increased and then decreased with increasing latitude, temperature and radiation, and peaked at 38.8 degrees N, 24.21 degrees C and 2120 J/cm/d. The results suggest that BNF could be regulated by larger scale factors, e.g., temperature and radiation in latitudinal scale. Compared with high-temperate lakes and tropical lakes, low-temperate lakes may face more difficulties in controlling eutrophication due to the potentially higher N loading from BNF under similar nutrient and morphometric conditions.

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Dynamics of phosphorus fractions and bioavailability in a large shallow tropical lake characterized by monotonal flood pulse in Southeast Asia

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This study aims to investigate how the hydrological phase in a flood pulse dominated system, Tonle Sap Lake (TSL), affects the chemical form and bioavailability of P. For this purpose, we conducted extensive field campaigns under different hydrological phases: low-water (LW), rising-water (RW), high-water (HW), and falling-water (FW) phases from December 2016 to September 2017. The TSL ecosystem dis-tinctly exhibited seasonality of the monotonal flood pulse between the low-water and high-water peri-ods, in terms of not only water depth (range 0.5-8.0 m) but also water quality, suspended sediment, P dynamics (concentration, speciation and bioavailability), and trophic status. On an annual basis, the lake retained 56.2% of the external P loads, representing a major sink of P. Seasonally, P dynamics in TSL are determined by internal loading, whereas the annual inflows from the Mekong River basin and lake's tributaries are important sources of P for TSL. Total particulate phosphorus (TPP) constituted >60% of the total P in LW and decreased to <30% during HW, corresponding to the variation in total suspended solids (TSS). Soluble reactive P predominated the total dissolved P during LW (>70%) and decreased to approx. 30% during HW with decreasing TSS and TPP, suggesting the reduction of bioavailability of P in HW. Our results indicate that the flood pulse plays an important role in the chemical form and bioavailability of P in shallow lakes. (c) 2022 International Association for Great Lakes Research. Published by Elsevier B.V. All rights reserved.

（来源：Journal of great lakes research 出版年：2022, **DOI:** 10.1016/j.jglr.2022.04.005）

Environmental predictors of phytoplankton chlorophyll-a in Great Lakes coastal wetlands

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Coastal wetlands of the Laurentian Great Lakes are diverse and productive ecosystems that provide many ecosystem services, but are threatened by anthropogenic factors, including nutrient input, land-use change, invasive species, and climate change. In this study, we examined one component of wetland ecosystem structure - phytoplankton biomass - using the proxy metric of water column chlorophyll -a measured in 514 coastal wetlands across all five Great Lakes as part of the Great Lakes Coastal Wetland Monitoring Program. Mean chlorophyll -a concentrations increased from north-to-south from Lake

Superior to Lake Erie, but concentrations varied among sites within lakes. To predict chlorophyll -a concentrations, we developed two random forest models for each lake - one using variables that may directly relate to phytoplankton biomass (proximate variables; e.g., dissolved nutrients, tempera-ture, pH) and another using variables with potentially indirect effects on phytoplankton growth (distal variables; e.g., land use, fetch). Proximate and distal variable models explained 16-43% and 19-48% of variation in chlorophyll -a, respectively, with models developed for lakes Erie and Michigan having the highest amount of explanatory power and models developed for lakes Ontario, Superior, and Huron hav-ing the lowest. Land-use variables were important distal predictors of chlorophyll -a concentrations across all lakes. We found multiple proximate predictors of chlorophyll -a, but there was little consistency among lakes, suggesting that, while chlorophyll -a may be broadly influenced by distal factors such as land use, individual lakes and wetlands have unique characteristics that affect chlorophyll -a concentra-tions. Our results highlight the importance of responsible land-use planning and watershed-level man-agement for protecting coastal wetlands. (c) 2022 International Association for Great Lakes Research. Published by Elsevier B.V. All rights reserved.

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Future water levels of the Great Lakes under 1.5 degrees C to 3 degrees C warmer climates

Seglenieks, Frank; Temgoua, Andre

With the many different interests that are connected to the water levels of the Laurentian Great Lakes, the future of these water levels are of great concern to many people, businesses, and institutions. Projected future lake levels were calculated using data from the North American component of the Coordinated Regional Downscaling Experiment. The final lake level results are presented in relation to a 1.5 degrees C, 2.0 degrees C, 2.5 degrees C, and 3.0 degrees C change in global mean temperature. The results show that the range of possible values grows as the climate changes, with more extreme values for the lake levels becoming possible with greater changes in the global mean temperature. This increase in the range on both the high and low end may be a more important consideration than any general increase in the average water level for those living around the lakes Because the most severe impacts on the interests around the lake are usually associated with these extreme high or low levels. A greater understanding that the extremes in water levels observed in the past may be exceeded under a changing climate will help in the planning of future developments and activities within the Great Lakes basin with a forward looking coastal risk assessment and help communites build resilience to future extremes. Crown Copyright (c) 2022 Published by Elsevier B.V. on behalf of International Association for Great Lakes Research. This is an open access article under the CC BY-NC-ND license (http://creativecommons.org/ licenses/by-nc-nd/4.0/).

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Human well-being and natural capital indicators for Great Lakes waterfront revitalization

Angradi, Ted R.; Launspach, Jonathon J.; Wick, Molly J.

Revitalization of natural capital amenities at the Great Lakes waterfront can result from sediment reme-diation, habitat restoration, climate resilience projects, brownfield reuse, economic redevelopment and other efforts. Practical indicators are needed to assess the cultural, health, and socioeconomic

benefits of these investments. We compiled U.S. census-tract scale data for five Great Lakes communities: Duluth/Superior, Green Bay, Milwaukee, Chicago, and Cleveland. We downloaded data from the US Census Bureau, Centers for Disease Control and Prevention, Environmental Protection Agency, National Oceanic and Atmospheric Administration, and non-governmental organizations. We compiled a final set of 19 human well-being (HWB) metrics and 26 metrics representing attributes of natural and semi -natural amenities (natural capital). We rated the reliability of metrics according to their consistency of correlations with metrics of the other type (HWB vs. natural capital) at the census-tract scale, how often they were correlated in the expected direction, strength of correlations, and other attributes. Among the highest rated HWB indicators were measures of mean health, mental health, home ownership, home value, life success, and educational attainment. Highest rated natural capital metrics included tree cover and impervious surface metrics, walkability, density of recreational amenities, and shoreline type. Two sociodemographic covariates, household income and population density, had a strong influence on the strength of associations between HWB and natural capital and must be included in any assessment of change in HWB benefits at the waterfront. Our findings are a starting point for applying already available HWB and natural capital indicators in a waterfront revitalization context. Published by Elsevier B.V. on behalf of International Association for Great Lakes Research.

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Effects of dissolved oxygen on the decomposers and decomposition of plant litter in lake ecosystem

Siwen Liu; Guojian He; Hongwei Fang;等

Plant litter releases an amount of carbon, nitrogen and phosphorus during decomposition, which potentially has significant impacts on carbon, nitrogen, and phosphorus cycles and lake eutrophication. Dissolved oxygen (DO) plays an important role in changing the decomposition rate of litter and the major decomposers of litter. The decomposition rates of Phragmites australis, Triarrhena lutarioriparia and Carex spp under four DO concentration conditions (anaerobic group (0 mg/L DO), low DO group (6 mg/L DO), medium DO group (7 mg/L DO), high DO group (8 mg/L DO)) were measured in the laboratory for 120 days. The microorganisms community structure under the four DO conditions was tested to explore the major litter decomposer. The results showed that affected by litter quality, the decomposition rates of the three litters followed the order: Triarrhena lutarioriparia > Phragmites australis > Carex spp. A large amount of carbon, nitrogen and phosphorus were stored in water over litter decomposition. DO accelerated carbon and nitrogen release and promoted the decomposition of litter. The litter of high DO group decomposed 25.5%–42.0% more than that of anaerobic group. DO significantly affected the microbial community structure, and the proportion of microorganisms with the ability to decompose litter was higher in high DO group.

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The use of freshwater macrophytes as a resource in sustainable agriculture

Jorge Poveda

Freshwater macrophytes include different groups of plants that are capable of growing in or very close to aquatic environments (spermatophytes, pteridophytes and bryophytes). These plants play a fundamental role in their ecosystems, regulating biogeochemical cycles, hydrology and sediment dynamic. Currently,

many exotic freshwater macrophytes are being anthropogenically introduced into new ecosystems, posing a serious problem as a consequence of their massive and uncontrolled growth. Despite this, these plants can have different uses, such as biomarkers, phytoremediators, producers of metabolites of interest, or biomass formers for the production of feed, biofuels, pellets or ceramics. In this sense, the use of freshwater macrophytes in vivo, as fresh tissues, dry matter, compost, vermicompost, anaerobic digestate, liquid extracts or biochar has reported important benefits in different crops, promoting plant growth, increasing yield, reducing use of chemical fertilizers or reducing the diseases incidence. These benefits are the consequence of different mechanisms of action of the use of macrophytes as an agricultural resource, such as the contribution of nutrients, the improvement of the microbiota and soil structure, the elimination of heavy metals and pollutants, or the presence of antimicrobial compounds in their tissues. This review proposes the use of the biomass of these macrophytes, whose uncontrolled growth is an environmental problem, as an agricultural resource with important agricultural, environmental and economic benefits. A total of 118 published papers were analyzed and discussed.

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Climate, hydrology, and human disturbance drive long-term (1988–2018) macrophyte patterns in water diversion lakes

Wentong Xia；Bin Zhu；Shuanghu Zhang；等

Macrophytes are affected by many natural and human stressors globally but their long-term responses to these multiple stressors are not often quantified. We employed remote sensing and statistical tools to analyze datasets from both short-term (2017–2018) field investigations to explore seasonal patterns, and long-term (1988–2018) Landsat remote-sensing images to detect annual patterns of macrophyte distributions and study their responses to changes in climate, hydrology, and anthropogenic activities in a chain of water diversion lakes in eastern China. We found: 1) biomass and species richness of macrophytes peaked in summer with dominant species of submerged macrophytes Ceratophyllum demersum, Potamogeton pectinatus, and Potamogeton maackianus and floating macrophytes Trapa bispinosa, and non-native species Cabomba caroliniana spread in midstream Luoma Lake and Nansi Lake in summer, while Potamogeton crispus was dominant in all the lakes in spring; 2) water physicochemical parameters (chloride and water depth), lake characteristics (area and water storage), climate factors (air temperature and precipitation), and anthropogenic activities (commercial fishery and urban development) were significantly correlated to the seasonal distribution of macrophytes; 3) long-term data showed a significantly negative correlation between coverage of floating macrophytes and precipitation where the wettest year of 2003 had the lowest coverage of floating macrophytes; and 4) climate (air temperature) and hydrology (water level) were positively correlated with total macrophyte coverage, but human disturbance indexed by the gross domestic product was negatively driving long-term coverage of macrophytes. Our study has important implications for understanding the long-term succession of macrophytes under both natural and human stressors, and for future environmental management and ecological restoration of freshwater lakes.

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Association between greenhouse gases and dissolved organic matter composition in the main rivers around Taihu Lake

He, Fei; Ma, Jie; Lai, Qiuying; 等

River ecosystems receive a large amount of organic matter, which will increase the production of greenhouse gases (GHGs), including carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). Despite extensive research on the distribution of greenhouse gases and dissolved organic matter (DOM), little is known about the associations between greenhouse gases and DOM compositions. In this study, the distributions of GHGs (CO_2, CH_4 and N_2O) and DOM in the overlying water of the main rivers around Taihu Lake were investigated. The results showed that the concentration of GHGs was positively correlated with dissolved organic carbon concentrations. Three-dimensional excitation-emission matrix fluorescence spectroscopy techniques were employed to identify the source of the DOM, which was related to protein-like and humic-like components. The DOM was a combination of terrigenous and endogenous origins. The GHGs (except CO_2) were significantly associated with DOM composition. These results emphasize the importance of the relationship between GHGs (CO_2, CH_4 and N_2O) and DOM compositions in river ecosystems.

（来源：Journal of Freshwater Ecology 出版年: 2022, **DOI:** 10.1080/02705060.2022.2108924）

The methods and program implementation for river longitudinal profile analysis-RiverProAnalysis, a set of open-source functions based on the Matlab platform

Wang, Yizhou; Zheng, Dewen; Zhang, Huiping

River is one of the geomorphic units that are the most sensitive to tectonic activity, of which the longitudinal profile serves as a key archieve to record information on active tectonics. The stream-power incision model is an important means to analyze channel long profiles and to extract both temporal and spatial patterns of regional tectonic activity. Analytical solutions to the steady-state and linear transient-state equations of the model provides means to calibrate drainage basin concavity, calculate channel steepness index, determine drainage divide stability, project the paleo-channel profile, and to invert the tectonic uplift rate history. Yet, not all of these functions have been implemented in the published open-source tools. Here, we developed a set of open-source codes, River Pro Analysis, which was based on the Matlab platform and integrated all of these functions. The products of the tool set are in the format of image, text and vector files, which not only can be used for visual analysis, but be read by softwares of geographic information system. Taking examples of two transient drainage catchments in the northern margin of the Taiyuan Basin, we analyzed the long profiles of the trunk streams, identified two generations of knickpoints, and estimated the minimum amount of river incision. We combined all the trunk and tributary channels together to model the catchment-wide uplift history and found moderate increases in the uplift rates since the Middle Pliocene and rapid accelation since the late Quaternary. The inverted results are consistent with the sedimentary records in the adjacent basin. By comparing the chi value, slope, and topographic relief of both sides of the catchment divide, we concluded the stability of the drainage divide. Our tool set integrates the main functions of the modern studies on fluvial landscape, thus providing a powerful tool for analyzing river long profiles and for understanding tectonic geomorphology.

（来源：Science China-Earth Sciences 卷: 65 期: 9 出版年: 2022, **DOI:**10.1007/s11430-021-9938-x）

Evaluation of management practices on agricultural nonpoint source pollution discharges into the rivers under climate change effects

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In recent years, agricultural non-point source pollution (ANPSP) has become the biggest threat to Aras River water quality by completing the Mughan irrigation and drainage network. Nutrient pollutants, including nitrate and phosphate, released into the river through drains have created a range of obstacles for locals living around the river. Agricultural activities are generally considered the largest source of non-point pollution. They have no complex and uniform impact along the river. Thus, the spatial distribution of ANPS and highly polluted areas should be identified to manage watershed management. This study proposes a simple framework for identifying pollutant-sensitive areas along the river and management strategies to improve water quality. To this aim, the main factors affecting ANPSP were identified, and the effectiveness of the scenarios selected to comply with water quality regulations for drinking and environment during 1993-2007 were simulated. Based on the sensitivity analysis, land use and fertilizer are the main factors affecting river ANPSP. Thus, their changes were modeled in different scenarios. Based on the results, the ANPSP load was higher downstream. The agricultural lands in region 3 were considered the main source of pollution. Comparing the management scenarios showed that the amount of nitrate and phosphate leaching into the river decreased to 18.1 and 8.35%, respectively, by reducing the consumption of urea and phosphate fertilizers by 50%. The results help watershed managers implement eco-friendly land use and nutrient management programs at specific locations during specific periods to control ANPSP along the rivers.

（来源：Science of the Total Environment 出版年：2022, **DOI:**10.1016/j.scitotenv.2022.156643）

Spatiotemporal changes and driving forces of ecosystem vulnerability in the Yangtze River Basin, China: Quantification using habitat-structure-function framework

Pan, Zhenzhen; Gao, Guangyao; Fu, Bojie

Ecosystem vulnerability is the degree to which an ecosystem is susceptible to adverse effects of external disturbances. Exploring the pattern of ecosystem vulnerability and its driving mechanism is important for regional ecological protection and management. A little study has conducted the ecosystem vulnerability assessment from the perspective of multiple ecosystems characteristics, and the spatial heterogeneity impacts of climate change and human activities on ecosystem vulnerability variation need to be further explored. In this study, a habitat-structure-function framework was proposed to evaluate ecosystem vulnerability pattern of the Yangtze River Basin (YRB) in China from 1990 to 2018. Then, the spatial heterogeneity impacts of various factors on ecosystem vulnerability changes were examined utilizing the Geographically Weighted Regression model. Results show that the ecosystem vulnerability index (EVI) pattern in the YRB decreased from upstream to downstream. There was 63.85% of the basin area experiencing a decline in EVI from 1990 to 2018, which was primarily found in the source, southwest and north regions, while the southeast and east regions have suffered an increase in EVI. The impact of climate change on EVI changes increased as time scales increase, while, human activities were still the dominant factor leading EVI changes. Overall, areas with great impact of climate change on EVI variation were concentrated in the source region and upper reaches, while the remarkable impact of human activities occurred in the whole basin. The enhancement of climate warming and humid trend and the strengthen of ecological protection were benefit to the decline of EVI. The proposed framework can be extended to assess vulnerability in other areas or specific ecosystem types, and the findings are expected to provide policy recommendations for ecosystem conservation and management in the YRB.

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How climate change and land-use evolution relates to the non-point source pollution in a typical watershed of China

Li, Yuanyuan; Wang, Hua; Deng, Yanqing; 等

The water quality of Le'an River Watershed (LRW) is crucial to the water environmental safety of Poyang Lake, especially the concentration of nitrogen and phosphorus. The effect of climate and land use change on watershed water quality has always been under the attention of local managers. More importantly, the lack of detailed studies on climate and land use impact on river water quality has prevented sustainable water security management in the LRW. Therefore, this study aimed to quantify the weight of climate and land use on nutrient loss in the LRW, respectively. We divided the historical period (1990-2020) into six scenarios and a baseline scenario. TN and TP losses in the watershed were simulated using Soil and Water Assessment Tool (SWAT), and the weight of climate and land use were quantified in overall, by period, and by region. The results showed that the weight of climate was greatly higher than land use with values around 90%. However, the weight of land use had a positive cumulative effect in a certain period, and its influence could not be neglected. The climate in all scenarios led to a reduction in nutrient loss, while land use was found to slightly increase the nutrient loss yield. In addition to, unique regional topographic features, urbanization rates, and climatic conditions could cause spatial heterogeneity in the climatic and land use weights.

（来源：Science of the Total Environment 出版年：2022, **DOI:**10.1016/j.scitotenv.2022.156375）

Estimating hydrological consequences of vegetation greening

Luan, Jinkai; Miao, Ping; Tian, Xiaoqiang; 等

Large-scale afforestation program has alleviated environmental problems to some extent in China. However, the response of hydrological processes to vegetation greening at different catchments remains unclear. This study identified the impact of vegetation changes on runoff (Q), evapotranspiration (ET), and soil water storage (SW), as well as their relationships and sensitivities based on a coupled SWAT-PML model for 23 catchments from 2000 to 2018 in the Yellow River Basin (YRB). Results show that leaf area index (LAI) was significantly ($p < 0.05$) increased in 72.2% of the YRB area. Vegetation greening decreased SW and Q, but increased ET in all catchments. The effects of vegetation greening on Q and ET were contrasting with axisymmetric fluctuation distribution. The changes in SW, ET, and Q were strongly correlated with the changes in LAI. Sensitivity of the changes in ET and Q to LAI changes increased when the climate becomes drier. Our study suggests that the vegetation greening followed by the afforestation policy implementation has caused gradually increasing impacts on Q and ET. However, such effects are spatially heterogeneous due to different degrees of increase in LAI and aridity conditions. Given the water crisis problem in the YRB, afforestation activity should be taken into consideration of the increasing water demand and the negative effects of vegetation greening on water resources in the future.

（来源：Journal of Hydrology 卷：611 出版年：2022, **DOI:**10.1016/j.jhydrol.2022.128018）

Local Monitoring Should Inform Local Solutions: Morphological Assemblages of Microplastics Are Similar within a Pathway, But Relative Total Concentrations Vary Regionally

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Pathways for microplastics to aquatic ecosystems include agricultural runoff, urban runoff, and treated or untreated wastewater. To better understand the importance of each pathway as a vector for microplastics into waterbodies and for mitigation, we sampled agricultural runoff, urban stormwater runoff, treated wastewater effluent, and the waterbodies downstream in four regions across North America: the Sacramento Delta, the Mississippi River, Lake Ontario, and Chesapeake Bay. The highest concentrations of microplastics in each pathway varied by region: agricultural runoff in the Sacramento Delta and Mississippi River, urban stormwater runoff in Lake Ontario, and treated wastewater effluent in Chesapeake Bay. Material types were diverse and not unique across pathways. However, a PERMANOVA found significant differences in morphological assemblages among pathways ($p < 0.005$), suggesting fibers as a signature of agricultural runoff and treated wastewater effluent and rubbery fragments as a signature of stormwater. Moreover, the relationship between watershed characteristics and particle concentrations varied across watersheds (e.g., with agricultural parameters only being important in the Sacramento Delta). Overall, our results suggest that local monitoring is essential to inform effective mitigation strategies and that assessing the assemblages of morphologies should be prioritized in monitoring programs to identify important pathways of contamination.

（来源：Environmental Science & Technology 出版年：2022, **DOI:** 10.1021/acs.est.2c00926）

Driving forces of nitrogen cycling and the climate feedback loops in the Yarlung Tsangpo River Basin, the highest-altitude large river basin in the world

Liu, Wenjing; Jiang, Hao; Zhang, Jiangyi; 等

Under the impacts of climate change and the expansion of anthropogenic activities, changes in global nitrogen cycle may be most dramatic at high altitudes. However, a large basin scale understanding of nitrogen cycling is still lacking for the Tibetan Plateau. Taking advantage of the multiple-isotopic approach, we explored the nitrogen cycling processes, the driving forces, and the impacts on climate in the Yarlung Tsangpo River Basin, the highest river basin in the world. We showed that in-soil nitrification dominated the basin-scale nitrogen cycle and that nitrate (NO_3^-) removal was insignificant. For the first time, the NO_3^- source contributions were estimated by an isotope-mixing model. In the high-flow season, animal manure (AM) and soil organic nitrogen and chemical fertilizer (SON & CF) contributed significant amounts of NO_3^- (34-36% and 30-36%, respectively), followed by domestic sewage (DS; 20-27%). In the low-flow season, the contributions from SON & CF decreased (at 27-34%) while those from DS increased (at 21-37%). The annual NO_3^- flux of the Yarlung Tsangpo River was 27.4 x 103 t.yr-1, of which 32.0%, 32.6%, 26.3%, and 9.1% were from SON & CF, AM, DS, and atmospheric precipitation (AP), respectively. The significant spatiotemporal variations in the nitrate sources were regulated by both anthropogenic activities (e.g., sewage and grazing) and climate (e.g., temperature and precipitation). Based on the findings, a nitrification-driven feedback loop on climate was proposed, in which both positive and negative feedback mechanisms were hypothesized. This study adds important basin-scale understanding of the nitrogen cycling patterns and environmental effect implications on the Tibetan Plateau and other sensitive area in the context of global change.

（来源: Journal of Hydrology 卷：610 出版年：2022 DOI: 10.1016/j.jhydrol.2022.127974）

Exploring spatio-temporal distribution and evolution of dry-wet alternation using a three-dimensional identification method

Li, Wen-yi; Wen, Xin; Tan, Qiao-feng; 等

The dry-wet alternation evolves in both time and space and it has the characteristics of both dry and wet events. Previous studies have focused more on dry-wet abrupt alternation, and little is known about dry-wet alternation in larger time scale and space scales. In addition, previous studies have focused either on time or on space domain without considering spatio-temporal continuity of dry-wet alternation. This study proposes an identification method of dry-wet alternation, which can be used to identify and extract successive dry-wet alternations in a long time series. A series of three-dimensional dry-wet structures is developed to visualize dry-wet alter-nation and simulate the spatial-temporal evolution. The time dimension is added into the two-dimensional (latitude-longitude) space to better describe dry-wet alternation and extract dry-wet alternation more completely. Consecutive slices are obtained at each unit time interval to characterize the occurrence, development, migration and disappearance of dry-wet alternation in the space domain in order to better understand the spatio-temporal evolution of dry-wet alternation. Six indicators (transition period, transition rate, area, volume, intensity and density of the three-dimensional dry-wet structure) are proposed to quantify the attributes of dry -wet alternation such as the transition period and rate, scope of influence and severity, and statistical methods are used to analyze the complex spatio-temporal evolution of dry-wet alternation. It is found that dry-wet alternation occurs most frequently in the 1980s and then in the 1960s and 2010s in the Huai River basin. There exists a transition in the spatial distribution of dry-wet regions in the Huai River basin in the 1960s-2000s, as it is wet in the north and dry in the south in the 1960s-1970s, but dry in the north and wet in the south in the 1990s-2000s. Drought is more likely to have large influence range and high severity than wet. The transition period and rate reach the extremum in June-August, and the severity and influence range exhibit an increasing trend since 1980s. Our study may contribute to better understanding the formation and development of dry-wet alternation under environmental changes.

（来源：Journal of Hydrology 卷：612 出版年：2022 DOI: 10.1016/j.jhydrol.2022.128119）

A new robust discharge estimation method applied in the context of SWOT satellite data processing

Gejadze, I.; Malaterre, P. -O.; Oubanas, H.; 等

Knowing river discharge is vital for monitoring the fresh water cycle at the global scale. The Surface Water and Ocean Topography (SWOT) satellite mission will map river water surface elevations and inundated areas for rivers wider than one hundred meters worldwide. These observations can be used for estimating the river discharge. It is the global coverage which makes these observations particularly valuable, however in many cases there will be no data on the bathymetry and river bed properties available. That is why the problem of discharge estimation using solely the SWOT-type observations has received a noticeable attention recently. The attempts to solve this problem have expectedly confirmed that it is highly ill-posed and, therefore, additional data is useful. In particular, the use of the mean discharge estimates retrieved from the global scale hydrological databases (e.g. the Global Water Balance Model) have been accepted. However, taking into account the accuracy of such estimates and the issue of their relevance to the current time period, the problem is still posing a serious challenge. For example, in the results obtained by different methods reported up to date, the estimated hydrograph may suffer from a significant bias, which often makes a major contribution to the total estimation error. In this

paper a new estimation method is suggested, which is specially designed to reduce the solution bias. The concept of this method is similar to the one of the Variational Expectation-Maximization method, however its perception and implementation are original and problem-oriented. In our method, the mean values of the unknown variables are obtained using the Bayesian estimator, whereas the 'shape' functions are updated using the variational data assimilation or generated directly using the inverted simplified hydraulic model. The two steps constitute an estimation cycle, which can be repeated after information exchange. The method has been validated using two available testing sets including 51 cases in total. It has demonstrated a much better robustness and reliability than the variational data assimilation method, and quite a promising performance in terms of accuracy. Since the proof of the concept was in the focus of this study, the issue of computational feasibility was not a priority. Nevertheless, the method in its current form can be applied at local/ regional or basin scales. For a possible global scale application, a generalized discharge estimator is suggested, where the major computational burden falls on the 'learning' stage, which is separated from the discharge prediction algorithm.

（来源：Journal of Hydrology 卷：610 出版年：2022, **DOI:**10.1016/j.jhydrol.2022.127909）

Tracer-aided identification of hydrological and biogeochemical controls on in-stream water quality in a riparian wetland

Wu, Songjun; Tetzlaff, Doerthe; Goldhammer, Tobias; 等

In-stream water quality reflects the integrated results of hydrological mixing of different water sources and associated biogeochemical transformations. However, quantifying the relative importance of these controls is often challenging, particularly in riparian wetlands due to complex process interactions and marked spatio-temporal heterogeneity in environmental gradients. Here, we established a two-step method to differentiate the dominance of hydrological and biogeochemical controls on water quality in a riparian peatland in northern Germany. First, an isotope-based mixing model was developed for distributed modelling of in-stream water balance over a two-year period. The simulation showed the predominance of groundwater inflows for most of the time period, while lateral inflows and channel leakage became more influential in mid-summer, as stream -groundwater connectivity weakened due to declining groundwater levels. A moderate downstream shift from groundwater to lateral inflow was also observed due to the changing channel network geometries and inflow from field drains. The mixing model was then further applied to predict the in-stream concentrations of nutrients, major ions and trace elements. The predicted concentrations were assumed to be those resulting from hydro-logical mixing only, while influence of biogeochemical controls were reflected by the prediction deviation from observation. Accordingly, 15 water quality parameters were grouped based on their simulation performances into hydrologically-controlled (Cl-, Mg, Na, K, and Si), biogeochemically-controlled (DOC, SO_4^{2-} , Mn, and Zn), or controlled-by-both (SRP, NO_3-N, Ca, Fe, Al, and Cu). The mixing modelling not only reproduced the spatio-temporal in-stream water balance with finer process conceptualisation, but also provided a generic method to quantitatively disentangle the relative strength of hydrological and biogeochemical controls. Such a method can be employed as a robust learning tool before extending a hydrological model for water quality simulation, as when, where and how strong biogeochemical controls are exerted provides a strong indicator on which dominant processes need to be conceptualised.

（来源：Water Research 卷：222 出版年：2022, **DOI:** 10.1016/j.watres.2022.118860）

Large-scale reforestation can increase water yield and reduce drought risk for water-insecure regions in the Asia-Pacific

Teo, Hoong Chen; Raghavan, Srivatsan, V; He, Xiaogang; 等

Large-scale reforestation can potentially bring both benefits and risks to the water cycle, which needs to be better quantified under future climates to inform reforestation decisions. We identified 477 water-insecure basins worldwide accounting for 44.6% (380.2 Mha) of the global reforestation potential. As many of these basins are in the Asia-Pacific, we used regional coupled land-climate modeling for the period 2041-2070 to reveal that reforestation increases evapotranspiration and precipitation for most water-insecure regions over the Asia-Pacific. This resulted in a statistically significant increase in water yield ($p < .05$) for the Loess Plateau-North China Plain, Yangtze Plain, Southeast China, and Irrawaddy regions. Precipitation feedback was influenced by the degree of initial moisture limitation affecting soil moisture response and thus evapotranspiration, as well as precipitation advection from other reforested regions and moisture transport away from the local region. Reforestation also reduces the probability of extremely dry months in most of the water-insecure regions. However, some regions experience nonsignificant declines in net water yield due to heightened evapotranspiration outstripping increases in precipitation, or declines in soil moisture and advected precipitation.

（来源：Global Change Biology 出版年：2022, **DOI:**10.1111/gcb.16404）

Landscape determinants of pelagic and benthic primary production in northern lakes

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Global change affects gross primary production (GPP) in benthic and pelagic habitats of northern lakes by influencing catchment characteristics and lake water biogeochemistry. However, how changes in key environmental drivers manifest and impact total (i.e., benthic + pelagic) GPP and the partitioning of total GPP between habitats represented by the benthic share (autotrophic structuring) is unclear. Using a dataset from 26 shallow lakes located across Arctic, subarctic, and boreal northern Sweden, we investigate how catchment properties (air temperature, land cover, hydrology) affect lake physico-chemistry and patterns of total GPP and autotrophic structuring. We find that total GPP was mostly light limited, due to high dissolved organic carbon (DOC) concentrations originating from catchment soils with coniferous vegetation and wetlands, which is further promoted by high catchment runoff. In contrast, autotrophic structuring related mostly to the relative size of the benthic habitat, and was potentially modified by CO_2 fertilization in the subarctic, resulting in significantly higher total GPP relative to the other biomes. Across Arctic and subarctic sites, DIC and CO_2 were unrelated to DOC, indicating that external inputs of inorganic carbon can influence lake productivity patterns independent of terrestrial DOC supply. By comparison, DOC and CO_2 were correlated across boreal lakes, suggesting that DOC mineralization acts as an important CO_2 source for these sites. Our results underline that GPP as a resource is regulated by landscape properties, and is sensitive to large-scale global changes (warming, hydrological intensification, recovery of acidification) that promote changes in catchment characteristics and aquatic physico-chemistry. Our findings aid in predicting global change impacts on autotrophic structuring, and thus community structure and resource use of aquatic consumers in general. Given the similarities of global changes across the Northern hemisphere, our findings are likely relevant for northern lakes globally.

（来源：Global Change Biology 出版年：2022, **DOI:** 10.1111/gcb.16409）

Global increase in methane production under future warming of lake bottom waters

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Lakes are significant emitters of methane to the atmosphere, and thus are important components of the global methane budget. Methane is typically produced in lake sediments, with the rate of methane production being strongly temperature dependent. Local and regional studies highlight the risk of increasing methane production under future climate change, but a global estimate is not currently available. Here, we project changes in global lake bottom temperatures and sediment methane production rates from 1901 to 2099. By the end of the 21st century, lake bottom temperatures are projected to increase globally, by an average of 0.86-2.60 degrees C under Representative Concentration Pathways (RCPs) 2.6-8.5, with greater warming projected at lower latitudes. This future warming of bottom waters will likely result in an increase in methane production rates of 13%-40% by the end of the century, with many low-latitude lakes experiencing an increase of up to 17 times the historical (1970-1999) global average under RCP 8.5. The projected increase in methane production will likely lead to higher emissions from lakes, although the exact magnitude of the emission increase requires more detailed regional studies.

（来源：Global Change Biology 卷：28 期：18 出版年：2022, **DOI:**10.1111/gcb.16298）

中国小型水体空间分布特征及影响因素

吕明权；吴胜军；马茂华等

内陆水体(池塘、水库、湖泊、河流)可为人类社会提供多种生态服务，其中小型水体(池塘和小型水库)相比大型水体分布更广泛、具有更强的生物地球化学循环过程，因此对陆地生态系统的水文和物质循环过程影响不容忽视。然而，因其面积小，在各种资源调查中常被忽略，导致我们对中国小型水体(水体面积<10ha)的空间分布依然缺乏全面的了解，限制我们水资源利用和陆地生源要素通量评估。基于此，以高清遥感图片为数据源，利用卷积神经网络自动识别和人工判别相结合的方法，提取了 2018 年为基期的全国水体空间信息，并详细分析了小型水体的空间分布特征和影响因素。结果表明，全国面积>1000m^2 的水体数量是 517.8 万个，水体(不包括河流)面积 17.93 万 k m^2，约占全国陆地面积的 1.8%，水体总的岸线长度 215.74 万 km。小型水体(510.8 万)占了所有水体数量的 98.65%，占水体面积的 17.85%，占了所有水体岸线长度的 76.4%。降雨量是影响小型水体空间分布的主要因素，气候、地形和人类活动直接解释了 45%的小型水体空间分布变异。研究结果可为小型水体在碳“源汇”核算、生源要素循环、栖息地保护和水文循环影响等研究中提供数据支持。

（来源：中国科学:地球科学，52(08)，**DOI:** 10.1360/SSTe-2021-0151）

科学视点

全球最大冰盖加速融化

在南极洲，从大陆冰川延伸出的冰架漂浮在海洋中，支撑冰川并形成冰盖。

随着气候变暖，南极洲西部的冰层正以惊人的速度融化。与之不同的是，人们认为东南极冰盖能够免受海洋变暖的影响，因为这里靠近冰架的寒冷而稠密的海水为它提供了保护。

然而，一项近日发表于《自然—气候变化》的研究发现，偏西风将温暖的海水吹向了东南极冰盖，使该地区冰层在近几十年中急速变薄。

科学家认为，该研究有助于了解未来海平面上升中最大的不确定性：世界上最大的东南极冰盖在海洋变暖中的脆弱程度。

过去 10 年间的观测数据显示，南极东部冰盖日益受到温暖海水的严重威胁。这些海水“釜底抽薪”，使冰盖下的冰架逐渐融化。过去的研究一直在努力测量海水变暖的程度，并确定其驱动过程。

澳大利亚国家科学局海洋学家 Laura Herraiz-Borreguero 与英国南安普顿大学的 Alberto Naveira Garabato，整理和分析了过去 90 年间东南极及其附近公海的温度和盐度记录，并将这些海洋学观测结果与用于绘制洋流边界的卫星数据进行了比较。

他们发现，自 20 世纪初以来，东南极海洋温度已经上升了 2℃，且升温仍在加速。自 20 世纪 90 年代以来，该地区的海洋变暖速度增加了 2 倍，其中最强烈的变暖发生在东南极大陆附近的冰川区域，那里冰架变薄，且后退得最快。

Herraiz-Borreguero 和 Naveira Garabato 进一步研究发现，在强烈的西风推动下，南极绕极流的南部边缘进一步向南移动，将温暖海水分流到了南极洲东部。目前，夏季西风也会向极地移动，预计这种变化将在本世纪一直持续下去。

Herraiz-Borreguero 指出，了解推动南极冰层大规模损失的过程，将有助于掌握冰层损失促进海平面上升模型中的不确定因素。

在 Herraiz-Borreguero 看来，温暖海水“拍打”大陆架的后果是严重的。如果温水穿透大陆架并“加热”目前位于海平面以下基岩上的冰川，“那么冰川融化的趋势几乎不可阻挡”。

（来源：中国科学报，https://www.cas.cn/kj/202208/t20220816_4844743.shtml ,根据相关资料编译）

气候变化可能导致东南极冰盖加快融化

澳大利亚国立大学 11 日发布公报说，该校科研人员参与的一个国际团队预测，若《巴黎协定》目标未能达成，东南极冰盖会因气候变化影响而加快融化，到 2500 年可能导致海平面上升约 2 到 5 米。相关论文已发表在英国《自然》杂志上。

公报说，东南极冰盖是世界最大的冰盖，拥有地球上绝大部分的冰川冰。澳大利亚国立大学和英国伦敦国王学院等机构的研究人员就东南极冰盖在气候变化的影响下导致海平面上升的风险展开研究。

新研究预测，若全球温度升幅与工业化前相比远低于 2 摄氏度，到 2500 年东南极冰盖将使海平面上升不到半米。但如果由于温室气体排放量高，本世纪全球温度升幅超过 2 摄氏度，那么东南极冰盖会加快融化，到 2300 年可能导致海平面上升约 1 到 3 米，到 2500 年上升约 2 到 5 米。

《巴黎协定》的目标是在本世纪内将全球温度升幅与工业化前相比控制在 2 摄氏度以内，并为把升温控制在 1.5 摄氏度之内而努力。研究人员警告说，如果各国未能实现《巴黎协定》的气候目标，就有可能唤醒“沉睡的巨人”。

该研究共同作者、澳大利亚国立大学地球科学学院的内丽莱·艾布拉姆说，东南极冰盖比南极西部（的冰盖）大 10 倍，它对相对缓和的气候变暖也“高度敏感”，并不像人们想象的那样稳定。

艾布拉姆说，全球如能实现和强化对《巴黎协定》的承诺，不仅可以保护这一世界最大的冰盖，还可以减缓格陵兰岛和南极西部等更容易受到全球变暖影响的主要冰盖融化。

（来源：新华网，https://news.sciencenet.cn/htmlnews/2022/8/484238.shtm ,根据相关资料编译）

研究发现现代黄河水系于 125 万年前开始形成

兰州大学与中国地震局地质研究所、中国地震局第一监测中心、日本岛根大学、中国地质大学（武汉）等单位联合，在三门峡盆地中心实施了环境钻探并开展合作研究，获取了黄河贯通三门峡历史完整的岩芯档案，通过与盆地边缘露头剖面的对比，明确了岩芯 108 米处河道沉积物的首次出现是黄河在三门峡地区留下的最老印迹。近日，相关研究结果在《科学通报》发表，明确了现代黄河水系的形成时代，为研究世界大江大河的形成演化历史和水系发育模式提供了新视角。

“几”字湾的形成和三门峡贯通东流入海是现代黄河水系形成的重要标志，但由于黄河中游地区缺少河流演化完整的沉积记录、下游地区河流频繁改道不易获得第一手资料，当前对现代黄河水系的形成时代还存在 15 万年前、不晚于 88 万年、不晚于 120 万年、150-160 万年前、500 万年前等观点分歧，对其形成原因也存在不同认识。

三门峡是黄河干流上的最后一段峡谷，是连接黄河中游和下游的咽喉地带，在黄河水系形成演化研究中占据关键地位。过去，中外科学家主要围绕三门峡盆地及周边地区的露头剖面开展研究，但由于晚新生界地层出露不连续，研究剖面往往由多个相距数公里的短剖面拼接而成，加之构造复杂、植被覆盖度高、地层风化严重，在剖面对接、沉积相划分、年代测定等方面均存在较大不确定性，是造成现有认识分歧的重要原因。

在中国科学院院士陈发虎的协调和布署下，兰州大学西部环境教育部重点实验室地貌演化与新生代环境研究团队教授王鑫、胡振波、聂军胜、潘保田等联合合作单位共同开展研究。

团队通过系统的沉积学、古地磁定年、物源分析（Sr-Nd 同位素&重矿物组合）、古环境代用指标记录（粒度&易溶盐）研究表明，自 125 万年前开始，三门峡盆地河流沉积物开始大规模发育、上游鄂尔多斯地体的碎屑物质开始大量涌入、沉积环境经历了从封闭型咸水-微咸水湖环境到开放型河流环境的显著转变。综合新开展的地貌分析证据、潘保田团队发表的系列黄河中游黄河阶地证据、近年来发表的边缘海沉积等证据，研究团队提出了现代黄

河水系在 125 万年前开始形成、中更新世全球气候转型期海平面的加速降低对其形成有重要影响的新认识。

（来源：科学网， https://news.sciencenet.cn/htmlnews/2022/8/484558.shtm ,根据相关资料编译）

南极“末日冰川”融化速度加倍

世界上最大冰川之一正“岌岌可危”。根据近日发表在《自然·地球科学》上的一项研究，科学家们发现，由于温暖的深水密集地将热量输送到今天的冰架洞穴，并从下方融化冰架，南极洲西部阿蒙森海的思韦茨冰川（也被称为“世界末日冰川”）融化的速度比之前认为的要快，恐将导致全球海平面上升 3 米。

研究人员称，思韦茨冰川是南极洲地区变化最快的冰川之一，与同样位于阿蒙森海的松岛冰川一起，这两大重要冰川对南极洲海平面上升的贡献最大。

面积相当于佛罗里达州的思韦茨冰川正在迅速崩溃。研究人员为其绘制了一份消融历史轨迹图，从中可以推测冰川未来的演变趋势。

2020 年发布的松岛冰川和思韦茨冰川的卫星图像显示，这两个冰川毗邻而立，出现了高度破裂的区域和开放的断裂。这两个迹象都表明，在过去十年中，冰架较薄的两个冰川上的剪切带在结构上已经变弱。

根据这项研究，科学家们现在发现，思韦茨冰川从搁浅带的退缩速度接近每年 2.1 公里，是从 2011—2019 年间卫星图像上观测到的最快退缩速度的两倍。

研究人员记录了 160 多个平行的山脊，这些山脊是由于冰川的前沿后退并随着每日的潮汐上下波动而形成的。此外，他们分析了水下约半英里处的肋状构造，确定每一条新肋状构造可能都是在一天内形成的。

2018 年 10 月和 2020 年 2 月，思韦茨冰川发生了大规模的崩解事件，当时发生了史无前例的冰架撤退。这使得松岛冰川和思韦茨冰川上的冰架对海洋、大气和海冰中的极端气候变化更加敏感。研究人员认为，如果思韦茨和松岛发生动荡，邻近的几个地区也会四分五裂，导致大范围的崩塌。仅思韦茨冰川就可能导致海平面上升约 10 英尺（约 3 米）。

去年 12 月，美国科罗拉多大学博尔德分校的研究人员预测，思韦茨冰川再“存活”几年就会坍塌。

该研究论文合著者、英国南极调查局海洋地球物理学家罗伯特·拉特说：“思韦茨冰川今天真的是靠着它的‘指甲’紧紧扣在那里坚挺着，应该可以预料到，一旦冰川退缩到海床上的一个浅脊，我们就会在未来短期内看到巨大的变化，甚至就发生在下一年。”

（来源：中国科学院院网，https://www.cas.cn/kj/202209/t20220913_4847400.shtml l,根据相关资料编译）

过去千年热带火山爆发使青藏高原夏季降水减少

青藏高原是长江、黄河等主要河流的发源地，储存了大量的淡水资源，有“亚洲水塔”之称。高原夏季降水总量约占高原大部分地区年总降水量的 70%以上，是“亚洲水塔”的重要补给来源。高原夏季降水的变化不仅会影响水资源分布，也会影响青藏高原的热力强迫作用，并对北半球气候产生重要影响。火山爆发是自然外强迫中的重要因子，喷发后产生硫酸盐气溶胶，减少到达地面的太阳短波辐射，产生冷却作用，影响水循环，在过去千年气候变化中起主导作用。目前尚不清楚过去千年中热带火山爆发对青藏高原降水的影响及其物理过程。

近日，中国科学院大气物理研究所 LASG 国家重点实验室博士后左萌等，基于多套观测资料、过去千年重建降水数据和气候模式模拟结果，揭示了热带火山爆发后高原夏季降水的响应及其物理机制。

研究发现，观测、重建和模式模拟均揭示出热带火山爆发后青藏高原南部夏季降水会显著减少。进一步基于水汽收支和湿静力能诊断方法对降水异常进行分析，将其分解为与水汽变化相关的热力过程和与环流变化相关的动力过程。发现水汽垂直平流动力项和热力项共同导致高原西南部降水减少，热力项主导高原东南部降水减少。其中，热力项的负异常与火山爆发后气温降低，大气可降水量减少有关，导致进入高原的水汽输送减少；动力项则与火山爆发后总湿稳定度的增加，温度异常的空间分布以及西风急流南移导致的异常纬向干平流过程有关，导致高原西南部出现异常下沉运动。进一步分析表明，热带火山爆发后副热带西风急流的南移是由于局地哈德来环流减弱造成的。研究表明，大型热带火山爆发对青藏高原南部夏季降水影响显著，这将进一步减少青藏高原冰川供应来源和径流输出。

（来源：科学网， https://news.sciencenet.cn/htmlnews/2022/9/486955.shtm,根据相关资料编译）

格陵兰冰盖因气候变暖或致海平面升逾 270 毫米

《自然-气候变化》最新发表的一项气候科学研究指出，无论在哪种气候变暖预测情景下，格陵兰冰盖的整体冰损失加上降水量、冰流排放和融水径流的增加都将使海平面至少上升 274 毫米。

该研究论文称，1980 年代，因冰面融化径流和冰流量，格陵兰冰盖失去的冰开始多过因降水而凝结的冰，致使格陵兰冰盖出现冰预算赤字。然而，由于现有模型对土地、大气和海洋边界的测量数据不够精确，研究人员无法准确预测格陵兰岛会如何响应气候变化，而这种响应对未来海平面上升至关重要。

论文通讯作者、丹麦及格陵兰地质调查局的杰森 •鲍克斯(Jason Box)和同事及同行合作，他们利用 2000 年至 2019 年的气候数据，计算了格陵兰冰不平衡已经导致的冰盖体积和面积变化指出，融水径流引起的冰面消融是格陵兰冰盖质量预算发生同比变化的主要驱动因素。

无论在哪一种未来气候情景下，格陵兰冰盖质量损失将导致 5900 平方千米的海冰减退，这相当于其 3.3%的冰体积损失，使海平面至少上升 274 毫米。

论文作者假设 2012 融冰高值年在未来变得常见，那么随着气温在 21 世纪逐步上升，融冰和随即而来的海平面上升可能会达到 782 毫米。他们认为，这项研究预测结果应作为对格陵兰未来的一个警示。

（来源：中国新闻网，https://news.sciencenet.cn/htmlnews/2022/8/485302.shtm ,根据相关资料编译）

全国湖泊有色溶解性有机物组分影响因素研究

近年来，受自然气候条件和人类活动的双重影响，中国湖泊的水环境问题受到广泛关注。有色溶解性有机物（CDOM）是 DOM 中的重要组成部分，是水色遥感重要参数之一，广泛存在于各种天然水体中，湖泊 CDOM 的来源受到周边的土地利用、气候变化、工农业污染排放等影响，与湖泊水质状况高度相关，同时影响水下光场分布特征。

目前，三维荧光技术被广泛应用到国内外各类水体中解析 DOM 的组分和来源特征，但对于大尺度不同地区和不同类型湖泊 CDOM 组分和来源的影响因素解析仍然鲜少报道。中国科学院东北地理与农业生态研究所水环境遥感学科组研究人员等通过对 2015 年至 2019 年间实测的 256 个湖泊样品进行 CDOM 吸收和荧光组分特征分类，结合 FT-ICR MS 技术对 DOM 的分子组分结构以及相关人类活动和自然因素进行解析，发现类腐殖质含量相对较高的湖泊比类蛋白物质含量较多的湖泊 CDOM 吸收系数和荧光组分强度显著增高。此外，自然因素和人类活动因素对 CDOM 组分的影响程度也具有较大差异。该研究为深入探究湖泊 DOM 的组分结构和水环境碳循环规律提供了理论支撑。

（来源：中国科学院院网，https://mp.weixin.qq.com/s/ZSvlLCjDrLcqA7rNUzT68A,根据相关资料编译）

河流溶解性有机物分子组成与生物活性对城市与农田用地梯度的响应

河流、湖库等水体每年传输转化的陆源碳通量可达 5.1PgC yr^{-1}，其中排放的 CO_2 通量可达 3.9PgC yr^{-1}，是陆地有机碳迁移和转化的枢纽和要冲。溶解性有机物(DOM)是天然有机质最重要的赋存形态和活跃成分。DOM 分子组成的改变直接影响其活性和生物可利用性，进而影响水生态系统能量传输过程。流域城市化与农业开发会增加陆源生源要素向河流输出，可能会给下游河流系统带来大量富含蛋白质和高生物活性的 DOC，而森林区以富含芳香性物质的 DOM 为主。尽管 DOM 分子组成的变化对环境影响很大，但关于城市与农业非点源输入对 DOM 的组成、生物可利用性影响的研究依然鲜见报道。

鉴于此，中国科学院南京地理与湖泊研究所张运林研究员研究小组周永强等人通过研究我国东部地区不同城市和农业用地占比梯度下 76 条河流流域面积(1-4850km^2)，采用 DOM

光谱结合傅里叶变换离子回旋共振质谱技术(FT-ICR MS)分析了不同人类活动强度梯度下河流 DOM 的分子组成变化特征，在此基础上通过进一步室内好氧环境 28 天微生物培养实验完成 DOM 生物可利用性的测定，从而揭示了城市和农业用地比重梯度对河流 DOM 组成和生物可利用性的影响机制。

研究结果表明，随着城市和农业用地占比的升高，溶解性有机碳(DOC)浓度升高，脂肪族和多肽类 DOM 以及含 N 和含 S 有机物组分占比升高，相较之下土壤淋溶腐殖酸类组分输入占比减少。FT-ICR MS 结果显示随着城市用地占比上升，含 CHO 分子式的有机质占比降低而含 CHOS 分子式的有机质占比增加。城市化水平不断提升，河流 DOC 生物可利用性不断升高，加速了下游河流有机碳代谢进程。这意味着城市与农业用地比重的增加显著改变了下游河流 DOM 的化学组成与生物可利用性特征，对下游河流生态系统中的有机碳的迁移转化产生了深刻影响，人类活动加速了有机碳的生物地球化学迁移转化过程。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202209/t20220927_6517299.html，根据相关资料编译）

虚拟星座协同监测湖泊富营养化

气候变暖和人类活动双重胁迫下，湖库富营养化和蓝藻水华呈现全球扩张态势，显著削弱了湖库生态服务功能和价值。卫星遥感在湖库环境监测上展示了巨大的优势和应用潜力。目前，MODIS、VIIRS 和 OLCI 等海洋水色传感器空间分辨率较低（~300m），无法满足面积较小的湖库监测需求。随着 Landsat-8、Sentinel-2A/B、Landsat-9 等中高分辨率卫星的陆续发射，携带的较高质量传感器为高分辨率反演湖泊水质提供数据支撑。然而，这些中高分辨率传感器的时间分辨率较低，单独使用难以满足环境变化大的湖库监测需求，联合多源卫星传感器构建虚拟星座成为有效的解决策略。

针对如何构建虚拟星座以高频监测中小型湖泊富营养化问题，中国科学院南京地理与湖泊研究所马荣华研究员课题组曹志刚博士，以云贵高原湖泊为试验区，交叉检验了 Landsat-8/9 OLI、Sentinel-2A/2B MSI 间的光谱一致性，发展了一套基于虚拟星座协同监测湖泊叶绿素 a 的方法，相关成果发表在遥感领域顶级期刊 IEEE Transactions on Geoscience and Remote sensing 上(https://doi.org/10.1109/TGRS.2022.3207345)。论文主要结果如下：

（1）在卫星图像获取湖泊遥感反射率上，DSF 大气校正方法适合在云贵高原湖泊从 Landsat-8/9 OLI 和 Sentinel-2 MSI 获取遥感反射率。该方法精度（相对误差~30%）不仅高于 POLYMER、C2RCC、SeaDAS，且能从 MSI 和 OLI 数据产生一致的湖泊遥感反射率（相对差异 11.8%），奠定了虚拟星座构建的基础。

（2）在叶绿素 a 反演算法上，机器学习模型（MDN、随机森林、SVR）精度高于传统半经验/半分析模型，MDN 方法精度最高。MDN 方法同时适用于 MSI 和 OLI，联合 DSF

大气校正，可从卫星图像获取较可靠的湖泊叶绿素 a 浓度。基于 2293821 个 MSI 和 OLI 同步样点对比发现他们获取的叶绿素 a 具有较好一致性（相对差异 34.6%），据此，建立 OLI-MSI 叶绿素 a 的校正系数，用于构建虚拟星座。

（3）利用 2013-2022 年的 Landsat-8/9 OLI 和 Sentinel-2A/B MSI 图像产生了云贵高原九大湖泊的叶绿素 a 时间序列。过去 10 年，L8/L9/S2 虚拟星座获取的云贵高原九大湖泊群平均叶绿素 a 浓度范围是 1.8μg/L-92.6μg/L 之间，抚仙湖（2.1μg/L）、泸沽湖（1.8μg/L）叶绿素 a 平均浓度极低，洱海、阳宗海、程海叶绿素 a 浓度在 8-16μg/L 之间，滇池、星云湖、杞麓湖和异龙湖则浓度较高，均超过 60μg/L。自 2021 年 9 月 Landsat-9 发射，该虚拟星座的理论观测频次为 2-3 天，基于 MDN 模型，未来可在提升湖泊环境观测空间细节（10-30m）的同时保证湖泊富营养化状态的高频观测。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202209/t20220919_6514213.html，根据相关资料编译）

全国精细化水库空间数据（CRD）和自然湖泊型流域综合要素数据（CODCLAB）产品

自然和人工（水库）湖泊是地表水资源的重要组成部分。过去近百多年，随着人口的快速增长和社会经济的高速发展，全球各地为满足供水、能源、防洪抗旱等需求修筑了大量大坝和水库。据我国水利部公开报道（2022 年），全国已建设有 9.8 万多座水库。目前已公开发布的水库数据集中，存在水库时空信息不完整（水域范围、修筑时间、库容等）、中小型水库严重缺失、数据时效性不足等问题，严重制约了区域水资源管理和流域生态环境综合治理。相比而言，自然湖泊方面公开的空间数据虽然已较为完善，但围绕湖泊所在流域的基础性数据仍缺乏系统性。湖泊是流域的汇，流域是湖泊的源。从湖泊-流域系统视角，精准表达不同湖泊的流域边界，研制和汇编刻画流域内自然和人为要素的变化规律的基础数据，是湖泊科学和流域地理学研究的重要基础性工作。当前，在大数据技术蓬勃发展的背景下，通过充分挖掘和汇编众源资料，构建全国水库空间信息编目数据和湖泊型流域综合要素数据集，将在填补地理要素本底数据不足，促进水文学、湖沼学、环境科学等基础学科研究，辅助国家宏观决策等方面具有重要意义。

针对上述研究问题和目标，在国家重点研发计划、中科院战略性先导科技专项等项目资助下，中国科学院南京地理与湖泊研究所宋春桥研究员课题组联合美国堪萨斯州立大学、加州大学洛杉矶分校等学者，利用地理空间大数据技术，整理汇编现有众源资料，采用空间分析和数理统计等方法，编目了全国精细化水库数据集（CRD）和湖泊型流域自然-人文综合数据集（CODCLAB）。

全国水库数据集（CRD: China Reservoir Dataset）研制的主要数据源包含遥感解译结果、众源地理空间数据、网络信息挖掘和文献资料等。CRD 数据集共提供了全国近 10 万个

（97,435）水库的空间位置信息，水库水域（代表 1984-2020 年时段各水库最大水淹范围）总面积约 5 万 km^2，总库容约 980km^3（924.96-1,060.59km^3）。除了遥感解译的空间信息，CRD 数据集还提供了水库的基础属性信息，包括空间位置、面积、库容、河流级别（针对河道型水库）、水库的流量和停滞时间（换水周期）等。此外，针对 5,143 个大中型水库（面积和库容占总数据集的比例分别为 59%和 82%），该数据集在充分汇总统计年鉴和文献资源的基础上，还提供了正常蓄水位、水库类别、主要用途、调节类型等辅助信息。在全国范围随机抽样 24 个子流域的人工解译结果进行产品评价，平均精度为 95.13%（92.79%到 97.17%不等）。总体而言，CRD 数据集提供了目前中国区域最为全面的水库编目数据，相对于现有公开的水库数据集，CRD 在数据完整性、时效性和准确性上均有显著优势。该数据集将有助于开展全国及各流域尺度的水文水环境监测及地表水资源综合管理。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202209/t20220908_6510675.html，根据相关资料编译）

利用机器学习方法揭示湖泊–流域关键要素世纪尺度时序变化规律及影响因素

湖泊流域系统充分体现了地球表层系统的自然和人文交互、多要素互馈、多过程耦合等特征，湖泊的资源环境生态要素演变与流域气候和环境等因素息息相关。由于湖泊水循环与物质变化的影响因素具有流域空间大尺度和时间非线性的特点,仅依靠观测手段难以实现全过程及各因素定量解析。过程模型模拟作为研究湖泊-流域间要素影响关系的有效方法，但常受限于过程机理复杂不明或参数数据难以获取。该瓶颈问题对于地处偏远的湖泊流域或由于早期资料缺测等因素而尤为明显。迫切需要多源资料融合和非线性过程解析方法，加强湖泊-流域关键要素长时序变化规律及影响因素的定量解析，支撑湖泊流域系统过程的科学理解与管理。

在此背景下，宋春桥研究员课题组以站点观测、多源遥感反演资料及再分析数据集为基础，发挥人工智能技术挖掘变量间深层隐含信息的优势，利用机器学习方法实现对典型湖泊（北方干旱区的呼伦湖、博斯腾湖，东部季风区的鄱阳湖）的水位、水量、盐度及渔业资源量等关键要素（近）世纪尺度的重建，并解析其演变规律及驱动因素。

呼伦湖作为我国第五大湖泊，是蒙古高原生态环境和区域气候变化的重要指示。以往研究基于观测资料和水文模型探究了呼伦湖近几十年的水文演变及生态环境效应，特别关注了呼伦湖水位在卫星测高时代出现的快速下降。然而，呼伦湖在历史更长时间尺度是否出现比上世纪 90 年代来更显著的萎缩阶段？为了更好地理解呼伦湖水资源量变化特征及其驱动因子，本研究尝试在更长时间尺度（如世纪尺度）对比人类活动加剧影响的前后不同阶段研究呼伦湖的水量变化。中国科学院南京地理与湖泊研究所博士研究生范晨雨首先利用多源遥感技术构建了湖滨消落带-水下的完整湖盆地形信息，实现对全湖总水量及变化估算；对比和

遴选了适宜的机器学习方法，结合卫星测高水位数据和气候再分析资料等，重建了过去世纪尺度呼伦湖水位-水量的变化规律，并探讨了湖泊水文水资源演变与气候因子和大气环流异常的联系。研究结果表明，呼伦湖水量在 20 世纪 60 年代达到了近百年的最高位，最低阶段出现在 20 世纪 30-40 年代大旱阶段，甚至低于湖泊近期的最枯点（2012 年）。整个研究时段，呼伦湖水量的年际波动主要受降水和水汽压的影响，其次是湿日频率、潜在蒸散量和温度等因子；然而在不同波动周期，不同气候因子的主导特征存在差异。大气环流指数 AO、ENSO、PDO 和 NAO 与呼伦湖的水量变化有不同程度相关性，且在不同年代际差异较大，这与以往的华北和蒙古高原相关研究结果较一致。其中，1960 年代的湖泊水量高位与 ENSO 具有较强同相位关系。该研究为利用机器学习方法和再分析气候资料重建历史缺测阶段的湖泊水量长时序演变规律提供了一种可行的技术方案，也促进了对我国北方干旱半干旱区湖泊水量平衡响应气候和大气环流特征的科学认识。

同样位于北方干旱半干旱气候区，我国西北最大湖泊博斯腾湖在过去几十年内由于气候与人类活动干扰，其水位与盐度经历了剧烈的变化，引发各界的广泛关注。由于博斯腾湖缺乏长期连续的水文与环境观测数据和统一的观测标准，现有研究大多的关注上世纪末以来该湖泊变化特征，对博斯腾湖水文环境的长期演变及其驱动因素还有待进一步理解。本研究尝试在更长时间尺度上挖掘博斯腾湖的水盐变化特征，提出了基于机器学习方法重建博斯腾湖过去一个世纪湖泊水盐变化的技术方案，揭示气候因素与人为扰动对博斯腾湖水量平衡与盐量平衡的影响，为干旱区水资源和生态环境保护提供科学参考。

该方案基于有限历史观测、文献萃取资料、卫星遥感等多源数据，结合水位与盐度的多年统计关系以及气候再分析数据，利用机器学习模型预测和重建博斯腾湖百年来的盐度与水量协同变化序列。研究结果表明，博斯腾湖水位在 1935 年前后经历了一次急剧下降，接近 1920-1934 年期间变化速率的 20 倍。自此之后水位逐渐上升，直到上世纪 60 年代早期。湖水盐度相应呈现出大幅度的周期性变化：20 世纪 20 年代缓慢上升并在 30 年代初开始超过 1.40g/L，在 30 至 40 年代期间保持在 1.60g/L 左右的高值；此后，湖泊盐度开始缓慢下降至 60 年代初，然后反弹上升至 1987 年历史最高值 1.87g/L；上世纪末盐度以更快速度持续下降，在 2002 年达到 1.19g/L 的底部；本世纪前 20 年，又重现前一个 20 年左右的周期振荡——2013 年湖泊盐度上升到 1.80g/L 左右，并在近年来迅速下降。在分析自然气候因素驱动湖泊水量平衡与盐度变化基础上，本研究也从不同时空尺度讨论了人类活动与工程干扰对博斯腾水盐变化的影响。20 世纪 60 至 80 年代，博斯腾湖流域农业活动显著增强，灌溉面积及农业用水与排水量明显增加，农业活动引发湖泊水量的降低和盐度的升高。由于农业灌溉节水工程实施和现代化农业技术提高，以及一些生态环境保护和水利工程，农业活动影响湖泊水盐变化的程度在减弱。但由于农业活动影响无法在机器学习模拟进行长时序定量信息表达，可能给重建结果带来一定的不确定性，在某些年份误差可能超过 10-20%。

渔业资源作为湖泊生态服务功能的重要组成部分，可为人类提供直接的可食用蛋白质，因此渔业资源的可持续利用关乎民生及粮农安全。现有研究表明湖泊环境对鱼类栖息地分布、生物多样性及渔业资源的可持续性等有重要影响。但是由于湖泊环境变量的复杂性和多样性，湖泊环境变化影响渔业资源的主控因子难以确定。因此，有必要全面评估不同湖泊环境因子对渔业资源量的影响。传统调查研究湖泊渔业资源量与生境关系的方法侧重单点案例为基础的人工调查为主。例如，采用昂贵的水声学探测技术或鱼类标记技术来进行渔业资源及生境评估，需要付出大量的物资、人力、时间等成本，并且无法反映全湖区的总体状况和时空差异性特征，一定程度上限制了其在大区域尺度的推广。遥感技术在鱼类典型生境及渔业资源领域的发展优势，可以更加快速有效地获取密集时间尺度及广阔空间分布的渔业资源动态特征，并在反映直接影响渔业资源量的生境特征方面（产卵、索饵、洄游、栖息等）展现出了巨大的应用潜力。本研究以我国最大淡水湖鄱阳湖为例，利用多源遥感与机器学习方法，设计了不同输入变量（影响因素）组合的模拟实验来预测湖泊环境因子对湖泊渔业资源量的影响。

中国科学院南京地理与湖泊研究所陈探博士通过对鄱阳湖渔业资源量受环境因素在不同时间尺度影响的模拟，研究发现渔业生境的水文气象条件（水文站资料 HS、气象站资料 MS、CRU 模型气象资料）是影响鄱阳湖渔业资源量长期演变的一个关键因素。此外，近 20 年的多变量叠加影响模拟实验表明，影响渔业资源量由高到低的环境因子依次为水生态环境因子（WECO）、水质环境因子（WQ）和水文气象环境因子（HM）。在不同的模拟实验中，最优模型方案为机器学习训练中同时叠加水文气象条件、水质、水生态环境因子的组合实验，模拟结果验证 R 值高达 0.98。本研究结果发现基于公开获取的遥感数据及少量实测数据，利用机器学习智能算法构建基于多维（水文、水质和水生态）环境因子估算渔业资源量的模型可以有效地揭示湖泊-流域综合环境对渔业资源量的影响。研究也讨论了人类活动（特别是渔业政策）对湖泊渔业资源量在长时间尺度影响的关键节点。该工作提供了一个将机器学习算法与地面和卫星数据相结合的概念模型，可以促进渔业资源的大规模调查和评估，可用于全湖区范围的空间模拟，并可向其他区域湖泊进行推广。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202209/t20220902_6508184.html，根据相关资料编译）

湖泊水体溶解有机质与内分泌干扰物生物降解的构效关系

国家“十四五”规划明确提出，要重视水环境中内分泌干扰物、持久性有机污染物等新污染物的治理。类固醇雌激素（SEs）作为一类典型的内分泌干扰物，低暴露水平（～ng/L）就可造成水生生物和人体的内分泌紊乱、生殖毒性、遗传变异等生物毒性，已成为威胁湖泊生态系统和饮用水安全的突出环境问题。据估算，太湖中 SEs 的总量高达 1842 kg。湖泊系统中污染物会通过多种途径发生转化和降解，特别是微生物作为水体中无处不在的分解者，

生物降解是影响 SEs 消减和风险的重要过程。然而，SEs 极低的环境浓度难以作为功能微生物的稳定碳源，因而其降解过程往往依赖于微生物对其他有机物的利用和分解。

溶解有机质（DOM）作为水体中微生物新陈代谢的能量和碳源，不仅影响着群落组成和多样性，而且与微生物对污染物的降解功能息息相关。具体表现为，DOM 中生物可降解组分（BDOC）作为可利用碳源，可维持功能微生物的生长和代谢活性，以及污染物与可降解组分通过共代谢过程得到降解。然而，DOM 的组成结构极为复杂，受其来源（蓝藻水华、陆源输入等）和原位转化过程（生物降解、光分解等）影响，不同时空下 DOM 的生物可降解性存在显著差异。虽然目前已有一些关于 DOM 对内分泌干扰物生物降解的影响研究，但变化环境下湖泊水体 DOM 结构组成与 SEs 生物降解之间的构效关系认知仍不清楚。

中科院南京地理与湖泊研究所江和龙团队的白雷雷博士以江苏太湖为研究对象，（1）通过原位调查和 End-member 混合实验，明确了蓝藻水华期（夏季）和非蓝藻水华期（冬季）水体中 DOM 结构组成与 SEs 生物降解潜力（EBP）的同步时空变化，建立 DOM 光谱特征与 EBP 之间的构效关系；（2）以藻源 DOM 为例，借助前期研发的 DOM 生物活性快速检测及分离装置，通过生物测定、高分辨率质谱、及微生物群落分析，在分子水平深入揭示了藻源 DOM 结构对微生物群落降解 SEs 的影响机制。

主要研究结果：

（1）DOM 结构组成与 SEs 生物降解呈同步时空变化

在蓝藻水华期间，水体中新鲜度较高、腐殖化和芳香性较低的小分子 DOM 浓度升高，BDOC 和 EBP 均显著高于以原位分解后、腐殖化程度较高 DOM 为主的冬季水体（图 1a 和 1d）。空间上，陆源输入的大量强芳香性、高分子量腐殖质不利于 SEs 生物降解，造成竺山湾内 EBP 低于梅梁湾和贡湖湾。End-member 混合实验也证实，藻源 DOM 对 SEs 生物降解的促进作用显著强于陆源 DOM，但微生物老化后藻源 DOM 的底物激发效应剧烈降低。此外，EBP 与%BDOC 的正相关性强于 DOC 浓度，说明相较于总体 DOM，SEs 生物降解更依赖于可生物降解 DOM 的微生物循环。

（2）DOM 光谱特征是预测水体中 SEs 生物降解潜力的有效因子

通过偏最小二乘回归（PLS-R）模型，共得到三个预测组分。如图 3a 所示，PC1 解释了 64%的 DOM 光谱特征变化度和 66%的 Y 变量（EBP 和%BDOC）变化度，代表从新鲜组分到腐殖组分的梯度。PC2 解释了 15%的 DOM 光谱特征变化度和 13%的 Y 变量变化度，代表从强芳香性指数到低分子量指数的梯度。基于 VIP 值，荧光峰 T 和 C 比值是最有效的预测因子（VIP=3.62），说明类蛋白质与类腐殖质组分之比是控制 EBP 和%BDOC 的主要因子。DOM 芳香度和分子量既与其生物可降解性有关，也影响其与 SEs 的化学络合，因此 SUVA254 和斜率比（SR）也是 EBP 的有效预测因子（VIP 分别为 1.42 和 1.08）。线性拟合分析表明，这些因子可以较准确的预测 EBP 和%BDOC (R2 值分别为 0.78 和 0.90)。

（3）SEs 生物降解速率与藻源 DOM 的生物可降解性呈非线性响应

以藻源 DOM 为底物时，雌二醇（E2）经 24 h 几乎降解完全，而随着 DOM 生物可降解性从 78%下降到 1%，E2 降解速率显著下降，表明可生物降解组分的优先同化加快了 E2 的生物降解。然而，随 DOM 生物可降解性降低，生物量标准化 SEs 降解速率呈现先下降、后上升的非线性响应模式，说明寡碳条件下，滞后期（24 h）后 SEs 的生物降解得到增强（图 4b）。综合高分辨率质谱和 PCA 分析，DOM 中类蛋白质和类碳水化合物分子的丰度与微生物浓度和 SEs 降解速率呈正相关，而生物量标准化降解速率与类脂质分子相关。

（4）藻源 DOM 分子的定向降解调控微生物群落的降解功能

微生物学分析表明上述非线性响应模式与“富碳→寡碳”过程中微生物降解 SEs 的驱动机制转变有关。富碳条件下，蛋白质、碳水化合物及不饱和烃类等分子维持并促进微生物群落的生长和多样性，增强代谢活性并加快 SEs 降解。寡碳条件下，替代底物诱发的微生物群落选择和自适应机制在 24 h 适应期后发挥主导作用，提高生物量标准化 E2 生物降解速率。除了潜在降解菌（如 Sphingobacterium）的丰度增加，网络分析也显示高氢碳比的 DOM 分子（蛋白类和脂类分子）具有很高的联结度，是驱动微生物群落构建的主要因子，诱发了强确定性的群落装配过程，上调了群落聚集度及对污染物的代谢能力。

以上结果阐释了变化环境下，湖泊水体 DOM 结构组成与内分泌干扰物生物降解的耦联关系，提出了蓝藻水华产生的 DOM 将加快水体中内分泌干扰物的生物转化，而陆源 DOM 输入及 DOM 的生物老化过程可能造成内分泌干扰物积累。本研究对变化环境下新污染物的动态变化和行为预测具有重要指导意义，也对湖泊复合污染的生态修复提供了科学参考。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202208/t20220815_6500084.html，根据相关资料编译）

凤眼莲可作为全球变化对水生植物影响研究中的模式生物

凤眼莲（Eichhornia crassipes）又名水葫芦、凤眼蓝，原产巴西亚马孙河流域，现已成为世界广布性外来入侵水生漂浮植物。其原本作为观赏植物引入我国台湾省，逸生后已成功入侵长江流域和南方各省区市。凤眼莲克隆繁殖能力极强，只需约半个月其种群中个体数量便可翻倍。富营养化条件下凤眼莲相较本地植物有较强的耐受性，能覆盖水面形成连绵成片的植毡层，遮蔽日光，导致鱼类、浮游动物、底栖生物和其他植物死亡，严重影响水体景观和水产品养殖，对水生生态系统危害极大。凤眼莲现已被列入第一批《中国外来入侵物种名单（2003）》和 IUCN《100 种世界最严重外来入侵物种名录》。

近期，中国科学院南京地理与湖泊研究所李宽意研究员团队黄晓龙助理研究员发表论文，通过进行太湖流域水生植物优势种和生物多样性调查，测算了样方中的水生植物的相对盖度和相对丰度，并计算了样方中的相对频度，其中总和用于计算相对重要性值 RIV，并计算了样方中的三种 α -多样性指数。与 2010 年和 2014 年调查结果相比较，发现 2018 年太湖流域

水生植物本地种生物多样性指数呈现下降趋势，同时优势种有从本地种转化为外来种的趋势，这可能会导致本地种的减少和狭域分布种的灭绝，从而降低淡水生态系统功能服务。太湖流域外来水生植物入侵严重，凤眼莲和另一种入侵植物水盾草（Cabomba caroliniana）成为这一地区部分水体水生植物优势种。相关成果发表于植物学期刊 Frontiers in Plant Science 和湖沼学期刊《湖泊科学》。

谢永宏等人的研究表明凤眼莲单独一条二级根系所有连接的外部连接总和 μ 和植物整条根系中最大的从基部到外部连接的外部连接的个数 a（根系最大路径长度）相等，即 μ = a，其二级根系表现为典型的鱼骨状构型（herringbone branching）。一般认为，植物根系结构具有自相似性，而目前研究表明凤眼莲局部根系与整体根系在结构上并不一致，即凤眼莲的根系能较好地满足植物拓扑学中的对称性假设，却并不满足自相似性假设。为此，黄晓龙等人基于 L 系统建立了水生植物根系动态生长模型，用于模拟水生植物从初生结构到次生结构，从简单根系到复合根系的动态生长过程。根系动态生长模型主要包含根系伸长规则和根系分支规则，并包含由主根与侧根的夹角 θ 和径向角 γ 确定初始根系生长方向。根系模型分析结果表明凤眼莲的单独一条二级根系结构为典型鱼骨状构型，整体根系为典型叉状分支构型（dichotomous branching），即凤眼莲根系同时兼具鱼骨状构型和叉状分支构型的根系特点。凤眼莲整体根系由多条鱼骨状构型根系构成一种特殊的叉状分支构型，可称作“辐射状聚合构型（Poly-herringbone branching）”。这种特殊根系构型或许可以解释凤眼莲高生长和适应能力，这可能有助于解释其高入侵性。通过模型构建显示凤眼莲可以发展出庞大的根系，在较为适宜的条件下，凤眼莲可以达到较高的成熟根系总根长（2042.78 m），这有利于凤眼莲占据较多的空间和资源，使得凤眼莲在对本地植物的竞争中占有优势。相关成果发表于水生生物学期刊 Hydrobiologia 和湖沼学期刊《湖泊科学》，并已获授权相关根系模拟专利（“一种水生植物根系立体几何构型的构建方法”和根系模拟软件著作权。

政府间气候变化专门委员会（IPCC）的报告表明，气温上升仍是 21 世纪全球气候的大趋势。生物入侵是全球变化的一部分，全球变化的其他方面也会对生物入侵产生影响。入侵物种可能会受益于温度的升高，因为气候可以被视为一种资源，而可用资源的增加有利于入侵物种的入侵性（资源波动假说，“fluctuating resources hypothesis (FRH)”）。温度是影响植物生长、繁殖和分布的基本非生物因素。如果冬季气温升高，入侵植物可能有更大的机会越冬并蔓延到之前无法生存的地区。由于漂浮植物生长在水体-大气界面，对不利环境因素的变化比一般水生植物更为敏感，并且凤眼莲水分含量达到 95%，低温会导致植物细胞中形成冰晶使其破裂，还会导致蛋白质失活或变性。于海澔等人的研究表明作为一种热带植物，冬季低温是凤眼莲生长的强烈限制因子，长江流域为凤眼莲冬季自然分布北界。黄晓龙等人以凤眼莲为模式植物，于 2020-2021 年在太湖湖泊生态系统研究站（太湖站）东山分站进行了中宇宙跨年实验，确定了气候变暖（模拟环境温度升高 1.5° C 和 3.0° C）和水位下降（水

深为 1 cm、10 cm 和 20 cm）对凤眼莲 17 种功能性状（生长、形态、根系拓扑结构、光合和化学计量学性状）的影响。结果表明气候变暖和适当的水位下降促进了凤眼莲的越冬生长，这表明入侵植物可以从全球变暖中受益，与 FRH 的假设一致。环境低温诱导凤眼莲在湖泊沿岸带定植扎根行为可被视为生态位变化的独特生长适应策略，这有助于其入侵冬季结冰后水面上死亡的漂浮植物留下的空生态位，这可能有助于它在春季汛期期间繁殖并产生新植株扩散。随着全球变暖的持续，凤眼莲的分布界限可能会向北扩展，水生生态系统将面临更严重的入侵威胁。研究结果同时也表明在冬季湖泊退水期间在湖泊沿岸带淤泥中清除这种植物可能是比在生长旺盛的夏季采取清除措施更有效的防治策略。

作为模式植物，陆生植物拟南芥（Arabidopsis thaliana）在几乎所有植物分支学科中都被广泛研究，然而在水生植物中尚未确定类似的模式生物。目前已经建立了一些凤眼莲模型，如 Lorber 等人的生长和繁殖模型、Gamage 等人的种群生长模型、Yang 等人的机载高光谱图像识别模型、Wilson 等人的自然资源评估模型、Eid 和 Shaltout 的根茎叶生长和相互关系模型和黄晓龙等人的根系拓扑结构模型和动态生长模型。此外关于该物种在淡水生态系统的作用的也已经有大量研究，如 Pinto-Coelho 和 Barcelos Greco 凤眼莲和元素循环的研究；Malik、Villamagna 和 Coetzee 等人凤眼莲对水生生态系统影响、管理和利用的研究；范书锋等人凤眼莲与植食性昆虫的关系的研究；Mohanty、Alvarado、Malar 等人凤眼莲对化学污染物的生物吸附的研究；游文华、范书峰、王彤、于洪伟等人凤眼莲对环境因素的反应的研究；Feng、Mishr 等人凤眼莲在生态修复中应用的研究等等。由凤眼莲高生长速率、强大的克隆繁殖能力和在原产地丰富的有性繁殖能力推断该植物可被视为 r-策略物种。凤眼莲植株大小适中、易于培养、遗传分化低。其叶片相对一般水生植物较大且数量较多，使其叶性状的估计更容易和更精确。其根系较多且具有代表性，根系指标也相对容易估计和量化。因此，我们提倡使用凤眼莲作为水生植物中的模式生物，用于研究水生植物对全球淡水生态系统变化的响应，这也有助于寻求控制其扩散的措施。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202208/t20220810_6497799.html，根据相关资料编译）

基于卫星遥感观测的藻类水华时空变化和驱动机制

在流域高强度人类活动的影响下，全球绝大多数湖库面临着不同程度的水体富营养化问题。水体富营养化最为严重的后果是湖库生态系统退化，表现为草型生态系统退化、藻型生态系统扩张、藻类水华频发暴发，而全球气候变化又进一步加剧了湖库藻类水华及其灾害。近 30 年全球 68%的湖泊藻类水华的暴发强度、暴发规模和暴发频次均呈显著上升趋势。太湖、巢湖、滇池等标志性湖泊遭受蓝藻水华的长期困扰，而近年来洱海、丹江口、白洋淀、三峡水库等水体的藻类水华问题也日益凸显，我国已经成为全球水体富营养化程度最严重，藻类水华暴发频率最高、分布最广的国家之一，对水源地饮用水安全、区域生态环境和人民

的生命健康构成了巨大威胁。尽管经过数年的环境治理，但我国藻类水华并未有明显好转，其根本原因在于目前对藻类水华暴发成因和机制的认识依旧不足。

卫星遥感具有快速、大范围、周期性的特点，已经成为湖泊蓝藻水华监测和预测预警不可或缺的技术手段。本研究工作充分利用遥感观测时空大尺度的优势，结合地面定位监测等技术方法，在卫星时间分辨率对藻类水华遥感提取的影响、风速对藻类水华时空分布的影响以及藻总量对气候变化的响应三个方面取得了一系列重要进展。

藻类在水体中垂向分布异质且变化迅速，卫星时间分辨率差异对于准确捕捉湖泊浮游植物水华时空变化特征至关重要。研究基于 2001-2020 年太湖藻类水华 MODIS 监测数据，生成时间分辨率为 2 天至 30 天的藻类水华模拟数据集。利用多种统计学方法，揭示了不同时间分辨率的藻类水华时空变化趋势的差异及其对气候因素的响应；并从日、月和年的尺度上分别量化了上述差异与时间分辨率之间的关系。研究表明，从基于不同时间分辨率的模拟数据集得出的藻类水华时空变化趋势存在显著的不一致性；随着时间分辨率降低，基于模拟数据集的水华面积与 MODIS 藻类水华面积之间的关系逐渐减弱；藻类水华对气候因子的响应也随时间分辨率在日、月和年尺度上的变化而变化。上述基于模拟数据的结论也得到了太湖、巢湖和滇池的 MODIS、Landsat 系列以及 Sentinel 卫星藻华监测数据的验证。研究结果不推荐基于低时间分辨率的卫星数据来揭示长期的藻类水华动态，建议选用静止轨道卫星数据以及时间分辨率小于 3 天的卫星数据开展湖泊藻华日常遥感监测。

风速是气候变化对东亚大气环流的显著影响因素。尽管风并不是富营养化湖泊藻类生长的主要环境因子，但直接影响着藻华的发生强度和规模。本研究以中国三大典型富营养化湖泊（太湖、巢湖和滇池）为研究区，基于 2000-2018 年 MODIS 卫星遥感影像，定量评估了风对三大湖泊蓝藻水华发生规模的影响，明确了富营养化内陆湖泊发生藻华（藻华面积/水域面积＞4%）的风速阈值，解析了风速季节性变化与藻华发生周期的关系，深化了风通过水动力场藻类的空间分布格局影响的认识。研究表明：（1）三个湖泊风速及蓝藻水华发生规模变化规律差异显著，这与三个湖泊的地理位置以及常年季风类型差异密切相关；（2）风速和藻华面积的月均值呈现显著负相关；当风速<3m/s，藻华面积与风速的关系为显著的线性负相关($r = 0.928\sim0.962$, $p < 0.01$)；（3）风速 3m/s 被认为是发生藻华（藻华面积/水域面积＞4%）的阈值；（4）三个湖泊不同月份风速与藻华规模的相关性比较类似，尤其是在每年的 5-9 月份，三个湖泊的风速均与藻华规模呈现显著的负相关，且温度较高的月份，负相关越强；（5）风速和风向是形成不同水动力场的主导因素之一，基于水动力场的散度场直接影响着藻华的空间分布格局。

富营养化湖泊藻类垂向分布非均匀性，造成采用水体表层叶绿素 a 浓度无法准确、科学地表征湖泊藻总量时空分布。水柱内的藻总量因为可以真实反映水柱内的藻类含量信息，成为代表水体中藻量信息的新指标。该研究以巢湖为研究区，基于 2000-2018 年 MODIS 卫星

遥感影像，重构了 2000-2018 年巢湖藻总量长时序数据，解析了巢湖藻总量时空变化规律，定量评估了气候变化因子对巢湖藻总量时空变化的影响，深化了风通过水动力场对藻总量的空间分布格局影响的认识。研究表明：（1）巢湖全湖藻总量 2000-2018 年每年以 0.569t Chla 速率呈现逐渐增长的趋势；（2）巢湖全湖藻总量呈现双峰年际变化模式；（3）巢湖单元水柱藻总量呈现西部湖区最高，尤其西部湖区的北部沿岸带，东部和中部湖区的中部区域相对较低；（4）单元水柱藻总量对月际、年际尺度上温度变化响应比较敏感，而风速则直接影响着每日的单元水柱藻总量的空间分布格局，较高的温度和偏低的风速促进了湖泊中浮游藻类的生长，风则通过湖泊的水动力过程对藻总量空间分布细节产生直接影响；（5）随着气候变化的加剧，巢湖富营养化状况将面临着更多的挑战。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202208/t20220805_6496824.html，根据相关资料编译）

全球和区域土壤水分产品真实性检验

土壤水分是控制地-气界面水文循环和能量守恒的重要变量。微波遥感和陆面模式是获取全球和区域尺度土壤水分产品的主要手段。根据成像波段划分，微波遥感产品以 X 波段（8–12GHz）、C 波段（4–8GHz）和 L 波段（1–2GHz）为主，分别代表地表以下约 1cm、2cm 和 5cm 深度的土壤体积含水量信息。微波遥感反演土壤水分的基本原理是液态水和固态土壤颗粒的介电常数差异，依次校正地表温度、植被含水量和地表粗糙度后计算土壤介电常数，反演土壤水分含量。2015 年以来，SMAP 是迄今为止总体精度最高的土壤水分产品，无偏均方根误差可达到 0.04cm^3 cm^{-3}；1978 年以来，ESA CCI 是迄今为止时间序列最长的土壤水分产品。鉴于土壤水分反演过程复杂，涉及的假设条件众多，土壤水分产品的真实性检验及在此基础上的算法改进具有重要意义。针对这一问题，中国科学院南京地理与湖泊研究所刘元波研究员团队范兴旺副研究员，联合安徽省气象科学研究所、中国科学院大气物理研究所和河海大学等相关科研人员，取得如下研究成果：

（1）微波遥感土壤水分产品精度（随机误差）受土壤盐分影响，在干旱半干旱农耕区尤为严重，由此导致的不确定性可达 0.005–0.01cm^3 cm^{-3}，与土壤盐分含量成正比。土壤盐分影响在春夏季节较为显著，频繁发生的降水事件将表层盐分淋洗至深层土壤，作物生长季蒸散发增强又可导致深层土壤盐分发生表聚，表层土壤盐分的动态变化直接影响土壤水分反演精度。由于微波穿透深度的差异，土壤盐分对 L 波段 SMAP 产品的影响程度较大，但 X 波段和 C 波段 AMSR2 产品对土壤盐分的响应更为迅速。该研究首次在全球尺度上证实和量化了土壤盐分对微波土壤水分遥感反演精度的影响。

（2）遥感土壤水分产品的系统误差受多种要素共同影响。基于全球加密观测站点数据研究发现，SMAP 产品在晴天无云条件下具有更高的精度，且下午轨道（6p.m.）产品的精度优于上午轨道（6a.m.）产品，这一发现挑战了已有研究结论，认为“日出前的地表更易于

形成土壤-植被冠层等温条件，有利于土壤水分遥感反演”。在云天条件下，SMAP 土壤水分产品普遍存在高估现象，与可能存在的降水事件有关。研究结果证实了基于 SMAP 土壤水分产品计算土壤蒸发的可靠性。与此同时，土壤水分产品的系统误差受土壤湿度（与微波穿透深度成反比）、植被和土壤温度参数的共同影响，但单一要素的解释程度低于 54%。

（3）以安徽省气象站点观测土壤水分数据为参考，系统分析了 16 种主要遥感产品和 5 种陆面模式产品的精度。研究发现，遥感产品在水系发达和地形起伏地区的精度较差，且可用数据量较少，陆面模式产品在数据时空连续性上具有显著的优势。遥感产品精度可能受到水体校正精度和地形效应影响，较为严格的质量控制方案大大减少了可用数据量。陆面模式产品普遍使用高精度降水驱动数据，对降水事件的响应能力较强，但遥感产品能够捕捉灌溉事件，用于研究人类活动对水循环过程的影响。尽管可用数据量较少，SMAP 仍是捕捉灌溉信号的最佳产品。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202207/t20220725_6493095.html，根据相关资料编译）

基于陆基高光谱遥感系统的藻类水华监测

在气候变暖和人类活动双重作用的影响下，藻类水华频发且呈现全球加剧态势，严重威胁经济社会可持续发展和人类健康。由于藻类水华生消过程快，实时精准的监测是藻类水华预测、预警和有效管控的关键。目前藻类水华监测主要包括现场观测、水下自动监测和卫星遥感反演等三种方式。现场观测费时费力，且无法在时间和空间上连续监测；水下自动监测探头易受到水中物质侵蚀，且维护费用高昂；卫星遥感的时间分辨率低且受大气影响较大。

对此，中国科学院南京地理与湖泊研究所张运林研究员团队联合南京中科深瞳科技研究院有限公司、杭州海康威视数字技术股份有限公司，基于水色遥感原理，研发了一款陆基高光谱遥感监测仪及原位高频在线监测系统，实现了藻类水华连续、精准、实时监测，有效弥补了现有方法的不足。

该系统主要由高光谱测量仪器、数据处理平台和远程访问控制、显示和存储平台等三部分组成。高光谱测量仪测定的水体光谱反射率信号，通过嵌入 AI 芯片处理器（数据处理平台）的反演算法，转化为叶绿素 a 信息。光谱反射率和叶绿素 a 数据通过无线传输设备进行远程访问控制、显示和存储。通过系统评估近几十年来应用最广泛的三种叶绿素 a 遥感反演的经验算法、半分析算法以及机器学习算法等，遴选了建模和验证精度最高的反演模型作为陆基遥感系统叶绿素 a 提取的主要模型。

架设在太湖的陆基高光谱遥感监测系统清晰捕捉到 2021 年 8 月发生的两次藻类水华形成过程。除了藻类水华以外，陆基遥感系统亦可同步监测水体透明度、悬浮物、总氮、总磷、高锰酸盐指数、营养状态指数、藻密度等多个水生态环境参数，可为藻类水华发生机理研究提供精细化观测和科学证据。该观测系统主要有以下优势：（1）低成本、环保的方式实时、

连续地提供藻类水华的高频数据；（2）水体信号不受大气影响，不需要进行复杂的大气校正；（3）适用于中小型河流、湖泊的藻类水华动态监测；（4）嵌入的 AI 芯片支持算法快速替换和升级以及远程控制和数据访问。目前该系统已广泛应用于广东、四川、江苏、浙江、北京等数十个重要水体的水质监测。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202207/t20220721_6487855.html，根据相关资料编译）

我国东部平原湖库的水华精准防控

经典的湖沼学研究发现，营养盐（磷和氮）富集会造成浮游植物生物量的显著提升，且两者的对数转换值存在稳健的线性正相关。然而，随着研究尺度的增大，藻类的生长也会受到其他环境条件（如水文形态背景、气候背景）的显著影响，使得相同营养盐水平对应了不同的水华风险。因此，识别藻类的限制因子对湖泊水华精准防控具有十分关键的意义。在中国科学院战略性先导科技专项（A 类）等项目的资助下，中国科学院南京地理与湖泊研究所邹伟博士等人以东部平原 54 个湖库为例，利用约束线回归方法量化了各研究湖泊藻类生长的限制因子，并提出了相应的水华精准防控建议。

首先，利用高阶分位数回归模型量化调查湖库夏季的藻类叶绿素 a 和总氮(或总磷)的上边界方程，其对应了研究区域藻类生物量对氮磷的最大响应潜力，可作为调查湖库藻类受到氮限制和磷限制的“标准”模型。然后，如果藻的氮敏感性(总氮对应的实际叶绿素 a 和“标准”模型的预测叶绿素 a 比值)大于 0.95，则认为是氮限制；同理，藻的磷敏感性(特定总磷对应的实际和预测叶绿素 a 比值)大于 0.95 则认为是磷限制；如果藻的氮磷敏感性均低于 0.95 且和特定的环境条件有关（如高非藻类浊度），则认为藻类生长受到光限制。结果表明，5%、7%、4%、36%、16%、2%和 30%调查点的浮游植物受到氮、磷、氮+磷、光、快速换水、丰富的大型植物以未测量因素限制。基于识别的藻类实际限制，提出了短期尺度上的水华防控建议。

通过分析藻的氮磷敏感性对水深的最大响应(反映了没有显著混杂因素条件下，水深对藻的氮磷敏感性影响)发现，当水深<1.8 m、1.8-2.1 m、2.1-5.2 m 或>5.2 m 条件下，调查湖库藻类的潜在限制因子分别是光、氮、氮+磷、磷。考虑到光是不可控因子，建议 0-2.1m、2.1-5.2m 和>5.2m 的东部平原湖库，宜分别采取控氮、氮+磷和控磷作为水华防控的长期营养盐管理策略。研究结果可为东部平原湖库水华的精准防控提供科学依据，也为其他区域湖库制定因地制宜的水华防控措施提供了参考。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202207/t20220718_6482402.html，根据相关资料编译）

业界动态

水利部：我国水旱灾害防御能力实现整体性跃升

中宣部 13 日举行“中国这十年”系列主题新闻发布会，介绍党的十八大以来水利发展成就。水利部部长李国英在会上介绍，我国水资源短缺、时空分布极不均匀、水旱灾害多发频发，是世界上水情最为复杂、江河治理难度最大、治水任务最为繁重的国家之一。党的十八大以来，社会各界关注治水、聚力治水、科学治水，解决了许多长期想解决而没有解决的水利难题，办成了许多事关战略全局、事关长远发展、事关民生福祉的水利大事要事，我国水利事业取得历史性成就、发生历史性变革。

十年来，水旱灾害防御能力实现整体性跃升。深入贯彻落实“两个坚持、三个转变”防灾减灾救灾理念，坚持人民至上、生命至上，不断完善流域防洪工程体系，强化预报预警预演预案措施，科学精细调度水利工程，成功战胜黄河、长江、淮河、海河、珠江、松花江、辽河、太湖等大江大河大湖严重洪涝灾害，近十年我国洪涝灾害年均损失占 GDP 的比例由上一个十年的 0.57%降至 0.31%。去年以来，黑龙江上游发生特大洪水、黄河中下游发生历史性罕见秋汛、珠江流域北江发生历史罕见洪水，全国有 8135 座(次)大中型水库投入拦洪运用、拦洪量 2252 亿立方米，12 个国家蓄滞洪区投入分洪运用，减淹城镇 3055 个(次)，减

淹耕地 3948 万亩，避免人员转移 2164 万人，同时有力抗击珠江流域等多区域严重干旱，保障了大旱之年基本供水无虞。今年面对长江流域 1961 年以来最严重干旱，坚持精准范围、精准对象、精准措施，实施“长江流域水库群抗旱保供水联合调度专项行动”，保障了 1385 万群众饮水安全和 2856 万亩秋粮作物灌溉用水需求。

十年来，农村饮水安全问题实现历史性解决。锚定全面解决农村饮水安全问题这一打赢脱贫攻坚战的重要指标，全面解决了 1710 万建档立卡贫困人口饮水安全问题，十年来共解决 2.8 亿农村群众饮水安全问题，农村自来水普及率达到 84%，困扰亿万农民祖祖辈辈的吃水难问题历史性地得到解决。加强农田灌溉工程建设，建成 7330 处大中型灌区，农田有效灌溉面积达到 10.37 亿亩，在占全国耕地面积 54%的灌溉面积上，生产了全国 75%的粮食和 90%以上的经济作物，为“把中国人的饭碗牢牢端在自己手中”奠定了坚实基础。

十年来，水资源利用方式实现深层次变革。坚持“节水优先”方针，实施国家节水行动，强化水资源刚性约束，推动用水方式由粗放低效向集约节约转变。2021 年我国万元 GDP 用水量、万元工业增加值用水量较 2012 年分别下降 45%和 55%，农田灌溉水有效利用系数从 2012 年的 0.516 提高到 2021 年的 0.568。近十年我国用水总量基本保持平稳，以占全球 6%的淡水资源养育了世界近 20%的人口，创造了世界 18%以上的经济总量。

十年来，水资源配置格局实现全局性优化。立足流域整体和水资源空间均衡配置，加快实施一批重大引调水工程和重点水源工程。南水北调东、中线一期工程建成通水，累计供水量达到 565 亿立方米，惠及 1.5 亿人。开工建设南水北调中线后续工程引江补汉工程和滇中引水、引江济淮、珠三角水资源配置等重大引调水工程，以及贵州夹岩、西藏拉洛等大型水库，“系统完备、安全可靠，集约高效、绿色智能，循环通畅、调控有序”的国家水网正在加快构建。全国水利工程供水能力从 2012 年的 7000 亿立方米提高到 2021 年的 8900 亿立方米。

十年来，江河湖泊面貌实现根本性改善。坚持绿水青山就是金山银山理念，深入推进流域水生态保护治理。全面建立河长制湖长制体系，省市县乡村五级 120 万名河湖长上岗履职。实施母亲河复苏行动，华北地区地下水水位总体回升，2021 年治理区浅层地下水、深层承压水较 2018 年平均回升 1.89 米、4.65 米，白洋淀水生态得到恢复，永定河等一大批断流多年河流恢复全线通水，京杭大运河实现百年来首次全线贯通。十年来共治理水土流失面积 58 万平方公里，全国水土流失面积和强度“双下降”，实现荒山披绿、“火焰山”变“花果山”。越来越多的河流恢复生命，越来越多的流域重现生机，越来越多的河湖成为造福人民的幸福河湖。

十年来，水利治理能力实现系统性提升。强化水利体制机制法治管理，深化流域统一规划、统一治理、统一调度、统一管理，推进水治理体系和治理能力现代化。长江保护法、地下水管理条例等重要法律法规颁布实施，水行政执法与刑事司法衔接、与检察公益诉讼协作

等机制不断健全。用水权市场化交易等重点领域改革加快推进，水利投融资改革取得重大突破，今年以来银行贷款、社会资本投入水利金额达到 2388 亿元，创历史纪录。数字孪生流域、数字孪生水网、数字孪生水利工程加快建设，水利科技“领跑”领域不断扩大。

（来源：中国新闻网，http://shzhfy.mwr.gov.cn/mtgz/202209/t20220916_1595884.html,根据相关资料编译）

过去十年我国水环境质量发生转折性变化

生态环境部部长黄润秋表示，党的十八大以来，水生态环境保护治理体系不断完善，碧水保卫战成效显著，河湖生态保护修复取得积极进展。经过努力，过去十年我国水环境质量发生了转折性的变化。

中宣部举行“中国这十年”系列主题新闻发布会，介绍“贯彻新发展理念，建设人与自然和谐共生的美丽中国”有关情况。会上，有记者提问称，水生态环境保护工作对提高人民群众生活质量、促进经济高质量发展具有重要的意义。近十年来我国水生态环境状况发生哪些变化？下一步还有哪些打算？

黄润秋表示，水是环境的最基本的要素之一，“水清岸绿、鱼翔浅底”，这是人民群众对美好生态环境的殷殷期盼，也是生态环境保护工作者努力奋斗的目标。他指出，转折性变化可以从三个方面来概括。

第一，水生态环境保护治理体系不断完善。“我们修订了《水污染防治法》，制修订了《长江保护法》等一系列法律法规，还制定了 20 多部相关的污染物排放标准，夯实了水生态环境保护的法治基础。抓住机构改革的机遇，在七大流域设立了水生态环境监督管理机构，强化了水生态环境保护统一监管。”

黄润秋称，“十四五”国控断面总数从 1940 个增加到了 3641 个，实现了十大流域、地级及以上城市、重要水体省市界、重要水功能区“四个全覆盖”。推动建立了跨省流域的横向生态补偿机制，这些年，安徽、浙江等 18 个省份在新安江、赤水河等 13 个流域探索开展了跨省流域上下游的横向生态保护补偿，上下游、左右岸协同共治的良好局面正在形成。

第二，碧水保卫战成效显著。在长江保护修复攻坚方面，各地累计排查发现长江入河排污口 6 万多个，围绕“三磷”治理、劣 V 类国控断面整治等立行立改了 1.6 万多个违法问题，长江干流连续两年全线达到 II 类水质标准。在黄河生态保护治理攻坚方面，已经完成黄河上游及部分中游河段 1.7 万余个排污口的排查，实现了黄河干流全线达到或优于 III 类水体的标准。

在提升城市水环境方面，这些年生态环境部和相关部门一起做了大量的工作，开展了城市黑臭水体整治环境保护专项行动，基本消除了 295 个地级及以上城市建成区的黑臭水体。过去，黑臭水体在城市里是老百姓反映的突出问题，现在成了一道道亮丽的风景线。“十三五”期间，地级及以上城市新建污水管网达到 9.9 万公里，相当于绕地球赤道 2 圈多。1200

多家省级及以上工业园区实现污水集中处理。在保障饮用水安全方面，“我们开展了全国集中式饮用水水源地环境保护专项行动，累计完成了 2804 个水源地 1 万多个问题的排查整治，让群众的‘水缸子’更加安全。”黄润秋说。

第三，河湖生态保护修复取得积极进展。加强了河湖岸线的保护修复，在长江保护修复攻坚战中，腾退的长江岸线就达到了 162 公里，滩岸复绿达到 1213 万平方米，长江岸线的面貌得到了显著改善。针对太湖、巢湖、滇池、洱海等富营养湖泊，加快了湖泊周边的产业结构调整，推进退圩还湖、严格实施氮磷管控和农业面源污染治理，有效遏制了填湖造地、侵占湖泊水域岸线及违法采砂采矿等违法行为。

黄润秋表示，经过努力，过去十年我国水环境质量发生了转折性的变化。各地也涌现出了一大批水污染治理的典型。比如，华北平原最大的淡水湖泊白洋淀，水质过去长期是劣 V 类，雄安新区设立以后，河北省坚持补水、治污、防洪“三位一体”统筹规划、协调推进。2021 年，白洋淀淀区以及入淀河流水质全部达到 III 标准，实现了从劣 V 类到 III 类的跨越性突破。

“不管是水质也好，湖岸的生态景观也好，白洋淀成为一道人水和谐的亮丽风景线。白洋淀里多年没有见到的鳑鲏鱼等一些土著鱼类也在逐渐得到恢复，野生鸟类增加到 237 种，鱼虾成群、水鸟翔集的生态美景再次显现，华北平原的明珠重放异彩。2021 年，全国有 18 个案例入选到第一批美丽河湖的优秀案例，取得了很好的示范效应。”他指出。

黄润秋表示，进入新发展阶段，将着力推动水生态环境保护由水污染防治为主，向水资源、水生态、水环境“三水统筹”转变，尤其是加大水生态系统的保护和修复力度，补齐短板、提高质效，不断把水生态环境保护工作推向深入，为美丽中国建设奠定坚实的基础。

（来源：中国新闻网，http://www.chinanews.com.cn/gn/2022/09-15/9852798.shtml ,根据相关资料编译）

聚焦新时代江河治理理念

为贯彻国家“江河战略”和山水林田湖草沙系统治理理念，推进水利高质量发展，由中国水科院和威立（Wiley）出版集团联合主办的“江河国际论坛”于 24 日在北京以线上线下结合方式举办。国内外院士和专家学者围绕江河治理的理念变革与新技术应用等议题进行学术交流，并发布《River》(江河)首刊，本刊是由中国水科院和 Wiley 出版集团合作出版的开放获取期刊。

中国水科院院长匡尚富在开幕式致辞中强调，江河是地球的自然单元，通过亿万年的水循环过程，塑造了地球的山川地貌，孕育了人类的灿烂文明，支撑着社会经济的持续发展，保障了自然环境与生态系统的生生不息。近年来，中国更加重视江河生态保护和系统治理。长江经济带发展、黄河流域生态保护和高质量发展都已列入国家重大战略，通过流域的系统治理、河湖长制等理念变革和体制机制创新，促进了经济社会发展的绿色转型，推动了生态

文明建设的新进步。《River》期刊涉及江河相关的自然与社会全系统，覆盖从源头到海洋的全过程，为有关江河的最新理念、前沿理论、创新科技提供优秀的论辩平台，为全球各地具有启发意义的治水实践和成功案例提供良好的展示窗口。

斯德哥尔摩水奖获得者、格拉斯哥大学客座教授阿西特·比斯瓦斯表示，江河不仅在各个自然和生态相关议题中不可或缺，在振兴经济、促进就业等方面同样举足轻重。进入21 世纪 20 年代，人类更需要在跨学科、跨部门和跨议题的基础上探讨江河相关议题。《River》期刊提供了就全球和各国可持续发展水目标进展进行交流的平台，其内容涵盖与河流相关的所有生态系统及其直接和间接的经济、社会、政治、环境和文化影响，探讨与江河相关的人口变化、城市化、旅游业、技术等，将促进江河可持续管理水平提高。

论坛期间，国内外院士专家分别作报告，聚焦“人河之缘：一方水土养一方人”“变化背景下江河挑战与应对”“全球大趋势对水领域的影响”“智慧江河管理：下一步是什么？”等主题，从科学平衡江河开发与保护的关系、提升气候变化背景下江河开发利用的适应能力、提升江河治理的智慧化水平、形成更加公平和可持续的江河利用模式、构建天人合一的新时期治水思路等方面提出了未来的江河研究方向。

关于 River 期刊，《江河》（River）是一本跨学科、跨部门、跨议题的综合性国际期刊，内容涉及江河相关的自然与社会全系统，覆盖从源头到海洋的全过程，包含江河科学、技术、工程、管理与战略等。《江河》（River）致力于探讨学术前沿、热点话题、难点及挑战，展示全球之江河自然和社会协同发展的新科技、新认识和新实践，推动江河系统与社会经济的和谐发展与共同繁荣。

（来源：科学网，https://news.sciencenet.cn/htmlnews/2022/8/485237.shtm，根据相关资料编译）

生态环境部:《深入打好长江保护修复攻坚战行动方案》

为深入贯彻习近平总书记关于推动长江经济带发展系列重要讲话和指示批示精神，贯彻落实《中共中央 国务院关于深入打好污染防治攻坚战的意见》和长江保护法有关要求，近日，生态环境部、国家发展和改革委员会、最高人民法院、最高人民检察院、科学技术部、工业和信息化部、公安部、财政部、人力资源和社会保障部、自然资源部、住房和城乡建设部、交通运输部、水利部、农业农村部、应急管理部、国家林业和草原局、国家矿山安全监察局等 17 个部门和单位联合印发《深入打好长江保护修复攻坚战行动方案》（以下简称《行动方案》）。

制定实施《行动方案》是贯彻落实党中央、国务院关于推动长江经济带发展重大国家战略的重要举措，是加强生态环境系统保护修复、推动长江经济带高质量发展的具体行动。《行动方案》以习近平新时代中国特色社会主义思想为指导，深入贯彻习近平生态文明思想，贯彻实施长江保护法，从生态系统整体性和流域系统性出发，坚持生态优先、绿色发展，坚

持综合治理、系统治理、源头治理，坚持精准、科学、依法治污，以高水平保护推动高质量发展，进一步夯实共抓大保护工作基础，努力建设人与自然和谐共生的绿色发展示范带。

《行动方案》明确，到 2025 年年底，长江流域总体水质保持优良，干流水质保持Ⅱ类；长江经济带县城生活垃圾无害化处理率达到 97%以上，县级城市建成区黑臭水体基本消除，化肥农药利用率提高到 43%以上，畜禽粪污综合利用率提高到 80%以上，农膜回收率达到 85%以上。

《行动方案》聚焦持续深化水环境综合治理、深入推进水生态系统修复、着力提升水资源保障程度、加快形成绿色发展管控格局四大攻坚任务，提出了 28 项具体工作，主要包括巩固提升饮用水安全保障水平、深入推进城镇污水垃圾处理、深入实施工业污染治理、深入推进农业绿色发展和农村污染治理、强化船舶与港口污染防治、深入推进长江入河排污口整治、加强磷污染综合治理、推进锰污染综合治理、深入推进尾矿库污染治理、加强塑料污染治理、建立健全长江流域水生态考核机制、全面实施十年禁渔、巩固小水电清理整改成果，切实保障基本生态流量（水位）、严格国土空间用途管控、完善污染源管理体系、防范化解沿江环境风险、引导绿色低碳转型发展等。

为确保各项攻坚任务措施落地见效，《行动方案》要求加强组织领导、强化法治与标准保障、健全资金与补偿机制、加大科技支撑、严格监督执法，构建全民行动格局，让全社会参与到保护长江母亲河行动中来。生态环境部将会同各地区各有关部门抓好《行动方案》实施，突出重点、协同联动，扎实推进长江保护修复攻坚战各项工作，加大重点任务调度和指导帮扶力度，督促地方按期完成攻坚战目标任务。

（来源，中国水网，https://www.h2o-china.com/news/338518.html，根据相关资料编译）

《地球大数据支撑可持续发展目标报告（2022）》在联合国发布

依托中国科学院建设运行、全球首个以大数据服务联合国 2030 年可持续发展议程的可持续发展大数据国际研究中心（SDG 中心）21 日晚发布消息说，该中心和中国科学院“地球大数据科学工程”先导专项撰写的《地球大数据支撑可持续发展目标报告（2022）》，纽约当地时间 20 日在联合国“全球发展倡议之友小组”部长级会议上由中方正式发布。

来自中国 40 多家科研院所、高校等共 170 余名科研人员参与的《地球大数据支撑可持续发展目标报告（2022）》，反映了可持续发展大数据领域的最新研究成果，是大数据支撑可持续发展目标（SDGs）落实的创新性实践。

该报告聚焦零饥饿、清洁饮水和卫生设施、经济适用的清洁能源、可持续城市和社区、气候行动、水下生物、陆地生物等 7 个可持续发展目标的 25 个具体目标及可持续发展（SDG）多指标交叉与综合开展了一系列指标监测评估示范研究工作，形成 42 个典型案例，贡献 31

套数据产品、21 种方法模型和 33 项决策支持，展示了全球、区域、国家和典型地区四个尺度的 SDG 指标监测和评估成果。

“零饥饿”方面，研究发现 2020 年全球约 85.2%的耕地为单季种植模式，复种指数仍有提升潜力；2015-2020 年，中国农田耕层土壤有机碳增加了 3.4%。

“清洁饮水和卫生设施”方面，研究发现中国地下水环境改善显著，农业用水效率显著提高，总体用水紧张程度呈下降趋势，水资源管理工具优化提升明显。

“经济适用的清洁能源”方面，研究发现 2020 年全球通电建筑面积较 2014 年增加显著；2021 年，中国可再生能源装机和发电量分别是 2015 年的 2.12 倍和 1.79 倍。

“可持续城市和社区”方面，研究发现 2000-2020 年全球城镇化协调发展；中国以全球 19%的城市建成区面积贡献了全球 28%的城市显著变绿区域，中国城市增绿受益人口占全球受益总人口约 47%。

“气候行动”方面，研究发现中国及其省级政府已建立起较为完善的减灾体系，中国气候变化教育体系相对完善；全球陆地不断升温，高温热浪频率和强度增加，海洋热含量不断增加。

“水下生物”方面，研究发现近十余年中国近海营养盐浓度显著降低；中国近海湿地在抵御台风减少灾害损失方面发挥了显著作用；近十年来中国围填海管控和治理取得了显著成效。

“陆地生物”方面，研究发现中国土地退化治理成效显著；中国山地生态系统受保护比例较高，空间布局正在进一步优化；主要外来入侵物种防控效果显著，并形成具有推广价值的防控技术体系。

在 SDG 多指标交叉与综合方面的研究发现，过去 20 年，中国省级行政区 SDG 多指标协同与权衡关系具有显著的时空差异；通过在海南省、云南省临沧市、广西壮族自治区桂林市、广东省深圳市等四个典型区域开展 SDGs 综合评估，可为中国不同特色区域科学确立优先发展目标、缓解发展中存在的 SDG 指标权衡问题、优化可持续发展路径提供决策参考。

同时，《地球大数据支撑可持续发展目标报告(2022)》对 2010-2021 年中国 56 个环境类可持续发展指标进展情况进行评估的结果显示，中国环境类指标相比于 2015 年(议程起始年)整体大幅改善，在 2030 年议程实施接近中期之际，在评估的中国 56 个指标中，已有近一半的环境类指标提前实现目标，为 2030 年整体实现可持续发展目标奠定良好基础。

据了解，自 2019 年以来，中国已连续 4 年发布《地球大数据支撑可持续发展目标报告》系列，其定量、系统解读不同尺度和区域 SDGs 的实现进程和变化趋势，研究成果为直接填补 SDG 指标监测数据缺失提供了高质量数据产品，也为提升指标的全球协同与可比性、应对

跨国界可持续发展问题提供科学实证，为服务联合国 2030 年可持续发展议程提供科技支撑，并为全球发展倡议的深入实施做出积极贡献。

（来源：中国新闻网，https://news.sciencenet.cn/htmlnews/2022/9/486659.shtm ,根据相关资料编译）

财政部：推动黄河流域生态保护和高质量发展

为贯彻落实黄河流域生态保护和高质量发展战略，财政部日前印发《中央财政关于推动黄河流域生态保护和高质量发展的财税支持方案》，支持建立以财政投入、市场参与为总体导向的资金多元化利用机制。

根据方案，中央财政设立黄河流域生态保护和高质量发展奖补资金，用于支持沿黄河省区统筹做好加强生态环境保护、保障黄河长治久安、推进水资源节约集约利用、推动黄河流域高质量发展、保护传承弘扬黄河文化等工作；研究设立黄河流域生态保护和高质量发展基金，支持沿黄河省区规范推广政府和社会资本合作（PPP），鼓励各类企业、社会组织参与支持黄河流域生态保护和高质量发展。

此外，方案明确支持建立以防洪治理、水沙调控为重点方向的灾害防治保障机制 ，以税费引导、专项奖励为调节手段的水资源节约集约利用机制 ，以整体治理、分段施策为基本思路的生态保护补偿机制等。

（来源：新华网，http://www.news.cn/fortune/2022-09/06/c_1128981673.htm,根据相关资料编译）

青海湖流域生态环境监测实现全覆盖

日前，青海湖流域完成 300 个各类生态监测站点的布设工作，由此，这个流域的生态环境监测实现全覆盖。这为青海湖流域的监测、科研与保护工作提供了重要支撑。

记者从青海省生态环境厅获悉，自 2010 年来，青海省相关部门依托青海湖流域生态环境保护与综合治理工程项目，开展了青海湖流域生态监测系统的建设工作。目前，青海湖流域建立了以生态定位监测综合站、专业定位监测点、工程跟踪监测点等生态监测站点为主，流动监测（巡测）站为辅的生态环境监测体系，实现了流域生态环境监测全覆盖。

地处青藏高原东北部的青海湖是我国最大的内陆咸水湖，这片巨大而独特的水域是青藏高原上宝贵的物种基因库，对于维系西北地区生态系统平衡具有重要作用。

“生态监测系统的不断完善将为青海湖流域生态保护、科研开展、青海湖国家公园建设等工作提供有效数据支撑。”青海省生态环境厅相关负责人表示。

借助生态监测系统，青海省生态环境厅开展了青海省咸水湖、盐湖水体监测体系和青海湖生态环境监测与综合分析平台建设，建立了青海湖水体环境评价指标体系和水体生态安全评估指标体系，为青海湖流域的进一步研究奠定了基础。

此外，青海省生态环境、林草等部门持续推进青海湖山水林田湖草沙冰一体化保护和系统治理，实施了一批青海湖湿地保护与修复、生物多样性保护等生态保护工程，青海湖水生态环境质量不断改善。

卫星遥感监测数据显示，截至 2021 年底，青海湖平均水位达 3196.51 米，平均水位对应面积为 4528.1 平方公里；青海湖流域主要入湖河流布哈河、沙柳河、哈尔盖河、黑马河水质达到Ⅱ类，水质状况达优。青海湖流域生态环境状况稳中向好。

（来源：新华社，http://qh.news.cn/2022-09/08/c_1128988976.htm，根据相关资料编译）

青海湖流域气候趋于暖湿化 生态环境稳中向好

青海省生态环境厅最新生态监测数据显示，近10年来，中国最大内陆咸水湖青海湖流域气候趋于暖湿化，其生态环境状况等级以“良”为主，流域生态系统类型、生态环境状况稳中向好。

青海湖是中国最大的内陆高原咸水湖，是维系青藏高原东北部生态安全的重要水体，也是控制西部荒漠化向东蔓延的天然屏障。青海湖的生态环境特征及其演变在很大程度上反映着青藏高原整体生态环境的变化趋势，对柴达木盆地、三江源、祁连山等地区均有较大影响。

据介绍，从2010年开始，依托青海湖流域生态环境保护与综合治理工程项目实施，青海省生态环境厅会同省自然资源厅、省水利厅等多家技术单位持续开展青海湖流域生态监测工作，实现了流域生态环境监测全覆盖。同时运用卫星遥感影像数据，开展青海湖流域土地利用/土地覆盖状况、生态系统构成与格局、生态环境状况、草地状况、土壤侵蚀状况、积雪面积等遥感监测，获取了系统连续的地面和遥感监测数据，编制年度监测成果报告。还建立了青海湖流域生态环境综合数据平台，积累生态环境要素系统连续监测数据，为青海湖生态保护和国家公园建设提供有效数据支撑。

“监测显示，2021年，长江、黄河、澜沧江、黑河、湟水流域、柴达木内陆河流域及青海湖流域共设99个国、省控水质监测断面，其中97个水质监测断面中，Ⅰ类水质监测断面12个，Ⅱ类水质监测断面74个，Ⅲ类水质监测断面10个；青海湖(咸水)下社、沙陀寺2个水质监测断面水质保持自然状态。”青海省生态环境厅副厅长司文轩日前发表数据称。

青海省生态环境厅表示，近10年来生态监测结果表明，青海湖流域气候趋于暖湿化，流域湖泊、湿地面积和水资源量有所增加，旗舰物种普氏原羚种群数量和裸鲤资源量明显增加，区域环境空气、地表水、集中式生活饮用水水源地环境质量达到环境功能区目标。青海湖流域生态环境状况等级以“良”为主，流域生态系统类型、生态环境状况稳中向好。

（来源：中国新闻网，https://www.chinanews.com.cn/gn/2022/09-07/9846727.shtml，根据相关资料编译）

湾东河流域滑坡堰塞湖溃决洪水危险性低

今日从成都理工大学地灾防治与地质环境保护国家重点实验室获悉，泸定地震引发了湾东河流域滑坡堰塞湖险情，该实验室强震地质灾害研究团队完成了对堰塞湖灾害链的评估及预测：堰塞湖规模较小，目前溃决洪水危险性低，但未来如出现强降雨，可能引发次生灾害。

5 日 20 时，四川省水利厅发布灾情通报：大渡河一级支流湾东河已断流近 6 小时。根据当日遥感卫星影像分析，四川泸定县 6.8 级地震造成大渡河支流湾东河湾东村上游 1.4 公里处发生 3 处山体滑坡，其堵塞河道形成堰塞湖。堰塞湖下游有村庄 2 个(湾东村、何家山村)，水电站 4 处(湾东水电站、湾东河口水电站、飞水沟水电站、罗家坝水电站)，但滑坡规模、堰塞湖方量等信息缺乏，影响救援人员对于灾情的评估。

湾东河位于四川省泸定县得妥乡境内，为大渡河右岸的一级支流。所在的湾东河流域位于贡嘎山东坡，流域面积 170.7km2，流域内最高点高程 6410m，沟口高程 1050m，沟床纵比降 137.5‰。该区域降雨充沛，年降雨量约 1000-2000mm，水资源丰富。流域内山坡陡峻临空面发育，坡度约 30°-50°，有利于崩塌滑坡等灾害发生，对居民安全造成威胁。湾东村是沟内主要居民聚集点，主要集中在沟口附近，其他位置零星分布。

该实验室强震地质灾害研究团队教授范宣梅介绍，据现场信息与无人机数据，湾东河湾东村上游 1.4 公里处发现 3 处山体滑坡，堵塞河道形成堰塞湖，最大堆积区面积 0.11km2，影像显示水体面积约 0.03km2。这说明网上普遍流传的关于震区形成大范围堰塞湖的信息是不准确的。无人机 6 日航拍数据显示，3 处滑坡规模均较小，并未造成大规模堵江，且堰塞湖面积较小。

范宣梅提醒，目前该堰塞湖已过流，对大渡河干流及下游影响较小，但震后坡体和沟道内都存在大量松散物质，未来几天如果出现强降雨，可能造成二次堵江灾害。建议密切关注湾东河流域未来的天气情况。

强震地质灾害研究团队第一时间对此次地震诱发地质灾害空间概率进行预测，结果表明湾东河流域中下游是地质灾害易发区。经过 9 月 6 日的无人机影像对流域灾害进行校核，在调查区域内(沟口附近)，滑坡灾害近 300 处，与预测结果基本吻合，并且灾害数量较震前明显增加。

由于数据有限，目前还难以对整个流域滑坡情况进行系统整理。但从地质灾害空间概率分布图看，地震将会在流域内产生大量滑坡。地震过后，松散物质将堆积在坡面和沟道内，为泥石流发生提供良好的物源条件。一旦发生强降雨，易引发泥石流灾害，威胁流域内居民的生命财产安全。因此，进一步科学评估流域内泥石流灾害发展趋势尤为重要。

（来源：中国新闻网，https://www.chinanews.com.cn/sh/2022/09-07/9846765.shtml，根据相关资料编译）

中国最大淡水湖鄱阳湖再创进入极枯水期最早纪录

中国最大淡水湖鄱阳湖 9 月 6 日提前进入极枯水期，2022 年为有记录以来由枯水位退至极枯水位最快的年份。

记者当日从江西省水文监测中心获悉，8 月以来，受持续高温少雨和长江来水偏少共同影响，鄱阳湖水位快速下降。9 月 6 日 8 时，鄱阳湖星子站水位退至 7.99 米，为 1951 年有记录以来历史同期最低水位，鄱阳湖进入极枯水期，继 8 月 6 日、8 月 19 日最早进入枯水期(12 米以下)、低枯水期(10 米以下)后，鄱阳湖再次刷新进入极枯水期最早纪录，较原最早出现年份(2019 年 11 月 30 日)提前 85 天，较有记录以来平均出现时间提前 115 天。

江西省水文监测中心表示，从 12 米退至 8 米，仅用 31 天，历史罕见，鄱阳湖日均退幅 0.13 米，日最大退幅 0.33 米，2022 年为有记录以来由枯水位退至极枯水位最快的年份。

根据气象预测，未来一周江西仍以高温少雨天气为主，加之长江流域来水偏少，鄱阳湖水位仍将持续走低。

江西水利部门提醒各部门按照相关抗旱应急预案，做好提水、保水工作，保障湖区生活用水、农业灌溉，防范鄱阳湖水位快速下降对湖区及周边带来的不利影响。

（来源：中国新闻网，https://www.chinanews.com.cn/sh/2022/09-06/9845741.shtml，根据相关资料编译）