湖泊流域动态

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中国科学院南京地理与湖泊研究所
图书馆，湖泊与环境国家重点实验室
中国科学院武汉文献情报中心
江苏省海洋湖沼学会
联合编制

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Attribution of global lake systems change to anthropogenic forcing

Grant, Luke; Vanderkelen, Inne; Gudmundsson, Lukas;等

Lake ecosystems are jeopardized by the impacts of climate change on ice seasonality and water temperatures. Yet historical simulations have not been used to formally attribute changes in lake ice and temperature to anthropogenic drivers. In addition, future projections of these properties are limited to individual lakes or global simulations from single lake models. Here we uncover the human imprint on lakes worldwide using hindcasts and projections from five lake models. Reanalysed trends in lake temperature and ice cover in recent decades are extremely unlikely to be explained by pre-industrial climate variability alone. Ice-cover trends in reanalysis are consistent with lake model simulations under historical conditions, providing attribution of lake changes to anthropogenic climate change. Moreover, lake temperature, ice thickness and duration scale robustly with global mean air temperature across future climate scenarios (+0.9 degrees C degrees C-air(-1), -0.033 m degrees C-air(-1) and -9.7 d degrees C-air(-1), respectively). These impacts would profoundly alter the functioning of lake ecosystems and the services they provide. Anthropogenic climate change is impacting the temperature and ice cover of lakes across the globe, according to an attribution analysis based on hindcasts and projections from lake models.

（来源：NATURE GEOSCIENCE 卷：14 期：11 出版年：2021, **DOI:** 10.1038/s41561-021-00833-x）

Counterbalancing influences of aerosols and greenhouse gases on atmospheric rivers

Baek, SH; Lora, JM

Atmospheric rivers (ARs) are filamentary conduits of intense water vapour transport in the extratropics, accounting for the majority of poleward moisture transport in the mid-latitudes and acting as a key precipitation source for coastal regions. How ARs have responded to climate change nevertheless remains uncertain. Here we use a series of coupled model experiments to show that there was little to no change in mean AR characteristics in 1920-2005 due to opposite but equal influences from industrial aerosols, which weaken ARs, and greenhouse gases (GHGs), which strengthen them. Despite little historical change, the simulations project steep intensification of ARs in the coming decades, including mean AR-driven precipitation increases of up to similar to 20 mm per month, as the influence of GHGs greatly outpaces that of industrial aerosols. We also investigate the extent to which future AR changes are dynamically and thermodynamically driven, highlighting the need to conceptualize AR change beyond the scaling of humidity with warming.

（来源：NATURE CLIMATE CHANGE 卷:11 期:11 出版年: 2021, **DOI:**10.1038/s41558-021-01166-8）

Fluvial organic carbon cycling regulated by sediment transit time and mineral protection

Repasch, M; Scheingross, JS; Hovius, N; 等

Rivers transfer terrestrial organic carbon (OC) from mountains to ocean basins, playing a key role in the global carbon cycle. During fluvial transit, OC may be oxidized and emitted to the atmosphere as CO_2 or preserved and transported to downstream depositional sinks. The balance between oxidation and preservation determines the amount of particulate OC (POC) that can be buried long term, but the factors regulating this balance are poorly constrained. Here, we quantify the effects of fluvial transit on POC fluxes along an similar to 1,300 km lowland channel with no tributaries. We show that sediment transit time and mineral protection regulate the magnitude and rate of POC oxidation, respectively. Using a simple turnover model, we estimate that annual POC oxidation is a small percentage of the POC delivered to the river. Modelling shows that lateral erosion into POC-rich floodplains can increase POC fluxes to downstream basins, thereby offsetting POC oxidation. Consequently, rivers with high channel mobility can enhance CO_2 drawdown while management practices that stabilize river channels may reduce the potential for CO_2 drawdown.

（来源：NATURE GEOSCIENCE 卷: 14 期: 11 出版年: 2021, **DOI:**10.1038/s41561-021-00845-7）

Greenhouse gases strengthen atmospheric rivers

Zavadoff, BL

Atmospheric rivers substantially affect the global hydrologic cycle, yet their response to past and future anthropogenic forcing remains highly uncertain. New research reveals the counterbalancing effects of aerosols and greenhouse gases and how this balance will shift to favour stronger atmospheric rivers in the coming decades.

（来源：NATURE CLIMATE CHANGE 卷:11 期:11 出版年: 2021, **DOI:**10.1038/s41558-021-01181-9）

Carbon fate in lowland rivers

Ford, W; Fox, J

The fate of sedimentary carbon in rivers is determined by a combination of mineral protection and transit time. Along the fluvial journey from headwaters to sea, biogeochemical transformations control whether carbon is buried or returned to the atmosphere as CO_2.

（来源：NATURE GEOSCIENCE 卷: 14 期：11 出版年: 2021, **DOI:** 10.1038/s41561-021-00849-3）

Perseverance rover reveals an ancient delta-lake system and flood deposits at Jezero crater, Mars

Mangold, N.; Gupta, S.; Gasnault, O.;等

Observations from orbital spacecraft have shown that Jezero crater on Mars contains a prominent fan-shaped body of sedimentary rock deposited at its western margin. The Perseverance rover landed in Jezero crater in February 2021. We analyze images taken by the rover in the 3 months after landing. The fan has outcrop faces, which were invisible from orbit, that record the hydrological evolution of Jezero crater. We interpret the presence of inclined strata in these outcrops as evidence of deltas that advanced into a lake. In contrast, the uppermost fan strata are composed of boulder conglomerates, which imply deposition by episodic high-energy floods. This sedimentary succession indicates a transition from sustained hydrologic activity in a persistent lake environment to highly energetic short-duration fluvial flows.

（来源：SCIENCE 卷：374 期：6568 出版年：2021, **DOI:** 10.1126/science.abl4051）

Warming winters in lakes: Later ice onset promotes consumer overwintering and shapes springtime planktonic food webs

Hebert, Marie-Pier；Beisner, Beatrix E.；Rautio, Milla；等

Global climate warming is causing the loss of freshwater ice around the Northern Hemisphere. Although the timing and duration of ice covers are known to regulate ecological processes in seasonally ice-covered ecosystems, the consequences of shortening winters for freshwater biota are poorly understood owing to the scarcity of under-ice research. Here, we present one of the first in-lake experiments to postpone ice-cover onset (by <= 21 d), thereby extending light availability (by <= 40 d) in early winter, and explicitly demonstrate cascading effects on pelagic food web processes and phenologies. Delaying ice-on elicited a sequence of events from winter to spring: 1) relatively greater densities of algal resources and primary consumers in early winter; 2) an enhanced prevalence of winteractive (overwintering) consumers throughout the ice-covered period, associated with augmented storage of high-quality fats likely due to a longer access to algal resources in early winter; and 3) an altered trophic structure after ice-off, with greater initial springtime densities of overwintering consumers driving stronger, earlier top-down regulation, effectively reducing the spring algal bloom. Increasingly later ice onset may thus promote consumer overwintering, which can confer a competitive advantage on taxa capable of surviving winters upon ice-off; a process that may diminish spring food availability for other consumers, potentially disrupting trophic linkages and energy flow pathways over the subsequent open-water season. In considering a future with warmer winters, these results provide empirical evidence that may help anticipate phenological responses to freshwater ice loss and, more broadly, constitute a case of climate-induced cross-seasonal cascade on realized food web processes.

（来源：PNAS 卷:118 期: 48 出版年: 2021, **DOI:** 10.1073/pnas.2114840118）

Harmful algal blooms and cyanotoxins in Lake Amatitlan, Guatemala, coincided with ancient Maya occupation in the watershed

Matthew Neal Waters；Mark Brenner；Jason Hilleary Curtis；等

Human-induced deforestation and soil erosion were environmental stressors for the ancient Maya of Mesoamerica. Furthermore, intense, periodic droughts during the Terminal Classic Period, ca. Common Era 830 to 950, have been documented from lake sediment cores and speleothems. Today, lakes worldwide that are surrounded by dense human settlement and intense riparian land use often develop algae/cyanobacteria blooms that can compromise water quality by depleting oxygen and producing toxins. Such environmental impacts have rarely been explored in the context of ancient Maya settlement. We measured nutrients, biomarkers for cyanobacteria, and the cyanotoxin microcystin in a sediment core from Lake Amatitlán, highland Guatemala, which spans the last ~2,100 y. The lake is currently hypereutrophic and characterized by high cyanotoxin concentrations from persistent blooms of the cyanobacterium Microcystis aeruginosa. Our paleolimnological data show that harmful cyanobacteria blooms and cyanotoxin production occurred during periods of ancient Maya occupation. Highest prehistoric concentrations of cyanotoxins in the sediment coincided with alterations of the water system in the Maya city of Kaminaljuyú, and changes in nutrient stoichiometry and maximum cyanobacteria abundance were coeval with times of greatest ancient human populations in the watershed. These prehistoric episodes of cyanobacteria proliferation and cyanotoxin production rivaled modern conditions in the lake, with respect to both bloom magnitude and toxicity. This suggests that pre-Columbian Maya occupation of the Lake Amatitlán watershed negatively impacted water potability. Prehistoric cultural

eutrophication indicates that human-driven nutrient enrichment of water bodies is not an exclusively modern phenomenon and may well have been a stressor for the ancient Maya.

（来源：PNAS 卷:118 期: 48 出版年: 2021, **DOI:** 10.1073/pnas.2109919118）

Geomorphic change in the Ganges-Brahmaputra-Meghna delta

Paszkowski, A; Goodbred, S; Borgomeo, E;等

The Ganges-Brahmaputra-Meghna delta is home to more than 170 million people, but is vulnerable to sea level rise, subsidence and direct human disturbance. This Review examines geomorphic change in the delta and its broader impacts. More than 70% of large deltas are under threat from rising sea levels, subsidence and anthropogenic interferences, including the Ganges-Brahmaputra-Meghna (GBM) delta, the Earth's largest and most populous delta system. The dynamic geomorphology of this delta is often overlooked in assessments of its vulnerability; consequently, development plans and previous management investments have been undermined by unanticipated geomorphic responses. In this Review, we describe GBM delta dynamics, examining these changes through the Drivers-Pressures-States-Impacts-Responses framework. Since the early Holocene, the GBM delta has evolved in response to a combination of tectonics, geology, changing river discharge and sea level rise, but the dynamics observed today are driven by a complex interplay of anthropogenic interferences and natural background processes. Contemporary geomorphic processes such as shoreline change, channel migration, sedimentation and subsidence can increase flooding and erosion, impacting biodiversity, ground and water contamination and local community livelihoods. Continued human disturbances to the GBM delta, such as curtailing sediment supplies, modifying channels and changing land use, could have a more direct influence on the future geomorphic balance of the delta than anthropogenic climate change and sea level rise. In order to contribute to long-term delta sustainability, adaptation responses must therefore be informed by an understanding of geomorphic processes, requiring increased transdisciplinary research on future delta dynamics at centennial timescales and collaboration across all governing bodies and stakeholders.

（来源：NATURE REVIEWS EARTH & ENVIRONMENT 2021,12(11) **DOI:**10.1038/s43017-021-00213-4）

Natural infrastructure in sustaining global urban freshwater ecosystem services

Chung, Min Gon；Frank, Kenneth A.；Pokhrel, Yadu；等

Ecosystems that provide fresh water for cities also impact sediment flows, flood mitigation and hydropower provision. This Article looks at over 300 cities globally to gauge the interactions of natural ecosystems with built infrastructure. Rapid urbanization throughout the globe increases demand for fresh water and the ecosystem services associated with it. This need is conventionally met through the construction of infrastructure. Natural infrastructure solutions have increased to provide freshwater ecosystem services, but little global research has examined the intricate relationships between built and natural infrastructure for providing freshwater ecosystem services to cities across the globe. Using network analysis, here we examine the interrelationships between built and natural infrastructure in 2,113 watersheds for 317 cities worldwide, focusing on four key freshwater ecosystem services: freshwater provision, sediment regulation, flood mitigation and hydropower production. Our results indicate that protected wetlands contribute to sustaining freshwater provision to cities. Forest cover in protected areas can improve the capacity of large dams in reducing sediment loads and producing hydropower, but cities

mainly depend on reduced impervious surfaces and more green spaces within urban areas for flood mitigation. Improved understandings of the role of natural infrastructure in urban water networks must underpin strategic decision-making to sustainably provide freshwater ecosystem services to global cities.

（来源：NATURE SUSTAINABILITY 出版年: 2021, **DOI:** 10.1038/s41893-021-00786-4）

Global syndromes induced by changes in solutes of the world's large rivers

Wu, Jiang; Xu, Nan; Wang, Yichu; 等.

Solute-induced river syndromes have grown in intensity in recent years. Here we investigate seven such river syndromes (salinization, mineralization, desalinization, acidification, alkalization, hardening, and softening) associated with global trends in major solutes (Ca2+, Mg2+, Na+, K+, SO42-, Cl-, HCO3-) and dissolved silica in the world's large rivers (basin areas >= 1000 km(2)). A comprehensive dataset from 600 gauge stations in 149 large rivers reveals nine binary patterns of co-varying trends in runoff and solute concentration. Solute-induced river syndromes are associated with remarkable increases in total dissolved solids (68%), chloride (81%), sodium (86%) and sulfate (142%) fluxes from rivers to oceans worldwide. The syndromes are most prevalent in temperate regions (30 similar to 50 degrees N and 30 similar to 40 degrees S based on the available data) where severe rock weathering and active human interferences such as urbanization and agricultural irrigation are concentrated. This study highlights the urgency to protect river health from extreme changes in solute contents. Rivers are increasingly plagued by syndromes, i.e. salinization, mineralization, desalinization, acidification, alkalization, hardening and softening. A global look at river biogeochemistry reveals dramatically increased flux estimates and anthropogenic drivers of syndromes.

（来源：NATURE COMMUNICATIONS 卷:12 期: 1 出版年: 2021, **DOI:** 10.1038/s41467-021-26231-w）

Diverse sediment microbiota shape methane emission temperature sensitivity in Arctic lakes

Emerson, Joanne B.; Varner, Ruth K.; Wik, Martin; 等

Northern post-glacial lakes are significant, increasing sources of atmospheric carbon through ebullition (bubbling) of microbially-produced methane (CH_4) from sediments. Ebullitive CH_4 flux correlates strongly with temperature, reflecting that solar radiation drives emissions. However, here we show that the slope of the temperature- CH_4 flux relationship differs spatially across two post-glacial lakes in Sweden. We compared these CH_4 emission patterns with sediment microbial (metagenomic and amplicon), isotopic, and geochemical data. The temperature-associated increase in CH_4 emissions was greater in lake middles-where methanogens were more abundant-than edges, and sediment communities were distinct between edges and middles. Microbial abundances, including those of CH_4-cycling microorganisms and syntrophs, were predictive of porewater CH_4 concentrations. Results suggest that deeper lake regions, which currently emit less CH_4 than shallower edges, could add substantially to CH_4 emissions in a warmer Arctic and that CH_4 emission predictions may be improved by accounting for spatial variations in sediment microbiota. Arctic lakes are strong and increasing sources of atmospheric methane, but extreme conditions and limited observations hinder robust understanding. Here the authors show that microbes in the middle of Arctic lakes have elevated methane producing potential, and are poised to release even more in the future.

（来源：NATURE COMMUNICATIONS 卷:12 期: 1 出版年: 2021, **DOI:** 10.1038/s41467-021-25983-9）

Stable isotopes in global lakes integrate catchment and climatic controls on evaporation

Vystavna, Yuliya; Harjung, Astrid; Monteiro, Lucilena R.;等

Global warming is considered a major threat to Earth's lakes water budgets and quality. However, flow regulation, over-exploitation, lack of hydrological data, and disparate evaluation methods hamper comparative global estimates of lake vulnerability to evaporation. We have analyzed the stable isotope composition of 1257 global lakes and we find that most lakes depend on precipitation and groundwater recharge subsequently altered by catchment and lake evaporation processes. Isotope mass-balance modeling shows that ca. 20% of water inflow in global lakes is lost through evaporation and ca. 10% of lakes in arid and temperate zones experience extreme evaporative losses >40 % of the total inflow. Precipitation amount, limnicity, wind speed, relative humidity, and solar radiation are predominant controls on lake isotope composition and evaporation, regardless of the climatic zone. The promotion of systematic global isotopic monitoring of Earth's lakes provides a direct and comparative approach to detect the impacts of climatic and catchment-scale changes on water-balance and evaporation trends. An isotope synthesis of 1257 global lakes revealed on average 20% of inflow is lost to evaporation, but 10% of Earth's lakes show extreme evaporative losses. Stable water isotope monitoring is an effective way to detect comparative climatic and catchment-scale impacts on lake water-balance budgets.

（来源：NATURE COMMUNICATIONS 卷:12 期: 1 出版年: 2021, **DOI:** 10.1038/s41467-021-27569-x）

The importance of lake breach floods for valley incision on early Mars

Goudge, Timothy A.; Morgan, Alexander M.; de Quay, Gaia Stucky; 等

Lake breach flooding rapidly eroded almost a quarter of the volume of incised valleys on early Mars, influencing the topography of the wider Martian landscape. The surface environment of early Mars had an active hydrologic cycle, including flowing liquid water that carved river valleys(1-3) and filled lake basins(4-6). Over 200 of these lake basins filled with sufficient water to breach the confining topography(4,6), causing catastrophic flooding and incision of outlet canyons(7-10). Much past work has recognized the local importance of lake breach floods on Mars for rapidly incising large valleys(7-12); however, on a global scale, valley systems have often been interpreted as recording more persistent fluvial erosion linked to a distributed Martian hydrologic cycle(1-3,13-16). Here, we demonstrate the global importance of lake breach flooding, and find that it was responsible for eroding at least 24% of the volume of incised valleys on early Mars, despite representing only approximately 3% of total valley length. We conclude that lake breach floods were a major geomorphic process responsible for valley incision on early Mars, which in turn influenced the topographic form of many Martian valley systems and the broader landscape evolution of the cratered highlands. Our results indicate that the importance of lake breach floods should be considered when reconstructing the formative conditions for Martian valley systems.

（来源：NATURE 卷:597 期: 7878 出版年: 2021, **DOI:** 10.1038/s41586-021-03860-1）

Subglacial discharge controls seasonal variations in the thermal structure of a glacial lake in Patagonia

Sugiyama, Shin; Minowa, Masahiro; Fukamachi, Yasushi;等

Water temperature in glacial lakes affects underwater melting and calving of glaciers terminating in lakes. Despite its importance, seasonal lake temperature variations are poorly understood because taking

long-term measurements near the front of calving glaciers is challenging. To investigate the thermal structure and its seasonal variations, we performed year-around temperature and current measurement at depths of 58-392 m in Lago Grey, a 410-m-deep glacial lake in Patagonia. The measurement revealed critical impacts of subglacial discharge on the lake thermal condition. Water below a depth of -100 m showed the coldest temperature in mid-summer, under the influence of glacial discharge, whereas temperature in the upper layer followed a seasonal variation of air temperature. The boundary of the lower and upper layers was controlled by the depth of a sill which blocks outflow of dense and cold glacial meltwater. Our data implies that subglacial discharge and bathymetry dictate mass loss and the retreat of lake-terminating glaciers. The cold lakewater hinders underwater melting and facilitates formation of a floating terminus.

（来源：NATURE COMMUNICATIONS 卷:12 期: 1 出版年: 2021, **DOI:** 110.1038/s41467-021-26578-0）

摘要精选

Lowered nutritional quality of plankton caused by global environmental changes

Lau, Danny C. P.; Jonsson, Anders; Isles, Peter D. F.; 等.

Global environmental changes are causing widespread nutrient depletion, declines in the ratio of dissolved inorganic nitrogen (N) to total phosphorus (DIN:TP), and increases in both water temperature and terrestrial colored dissolved organic carbon (DOC) concentration (browning) in high-latitude northern lakes. Declining lake DIN:TP, warming, and browning alter the nutrient limitation regime and biomass of phytoplankton, but how these stressors together affect the nutritional quality in terms of polyunsaturated fatty acid (PUFA) contents of the pelagic food web components remains unknown. We assessed the fatty acid compositions of seston and zooplankton in 33 lakes across south-to-north and boreal-to-subarctic gradients in Sweden. Data showed higher lake DIN:TP in the south than in the north, and that boreal lakes were warmer and browner than subarctic lakes. Lake DIN:TP strongly affected the PUFA contents-especially eicosapentaenoic acid (EPA) and docosahexaenoic acid (DHA)-in seston, calanoids, and copepods (as a group), but not in cladocerans. The EPA+DHA contents increased by 123% in seston, 197% in calanoids, and 230% in copepods across a lake molar DIN:TP gradient from 0.17 to 14.53, indicating lower seston and copepod nutritional quality in the more N-limited lakes (those with lower DIN:TP). Water temperature affected EPA+DHA contents of zooplankton, especially cladocerans, but not seston. Cladoceran EPA+DHA contents were reduced by ca. 6% for every 1 degrees C increase in surface water. Also, the EPA, DHA, or EPA+DHA contents of Bosmina, cyclopoids, and copepods increased in lakes with higher DOC concentrations or aromaticity. Our findings indicate that zooplankton food quality for higher consumers will decrease with warming alone (for cladocerans) or in combination with declining lake DIN:TP (for copepods), but impacts of these stressors are moderated by lake browning. Global environmental changes that drive northern lakes toward more N-limited, warmer, and browner conditions will reduce PUFA availability and nutritional quality of the pelagic food web components.

（来源：GLOBAL CHANGE BIOLOGY 卷: 27 期:23 出版年: 2021, **DOI:** 10.1111/gcb.15887）

Human impacts alter driver-response relationships in lakes of Southwest China

Zheng, Wenxiu; Zhang, Enlou; Wang, Rong;等

Biodiversity and ecological stability are closely linked, and over recent timescales, anthropogenic impacts have accelerated losses in both from local to global scales. We attempt to show the combined response of diversity and stability of an aquatic community to changes in human activity as a driver. To address this, we measured the diversity and variability of chironomids and their drivers and nature of response to external conditions over the last century, based on 4 lake sediment sequences from Southwest China, one of world's 36 biodiversity hotspots. Our results showed that the driver-response relationship was linear in a lake without direct human impacts but nonlinear in human directly impacted lakes. Recent decreases in alpha diversity and increases in beta diversity were commonly recorded in all four lakes, suggesting that both species loss and a faster replacement of chironomid taxa are a regional phenomenon. However, in the same context of human-induced global warming, increased variability and regime shifts only occurred in lowland lakes, directly disturbed by humans, highlighting that direct human impacts have overcome natural forcing as the determinant driver shaping the chironomid composition in these sites. In addition, we found that increases in beta diversity occurred prior to a regime shift and its character depends on how the community responds to the key external pressure. Our findings reveal that direct human disturbances have largely reshaped the chironomid composition and induced an earlier regime shift at the cost of species loss, resilience loss, and a change in driver-response type.

（来源：LIMNOLOGY AND OCEANOGRAPHY 出版年: 2021, **DOI:** 10.1002/lno.11946）

Chlorophyll a estimation in lakes using multi-parameter sonde data

Liu, Xiaofeng; Georgakakos, Aris P.

The Algae blooms are of considerable concern in freshwater lakes and reservoirs worldwide. In-situ Chlorophyll a (Chl-a) fluorometers are widely used for rapid assessments of algae biomass. However, accurately converting Chla fluorescence to an equivalent concentration is challenging due to natural variations in the relationship as well as nonphotochemical quenching (NPQ) which occurs commonly in surface waters during daytime. This study is based on water quality data from a freshwater lake from October 2018 to December 2020. Initial analysis of sonde Chl-a fluorescence and laboratory extracted Chl-a concentrations shows that the two data sets exhibit a nonlinear relationship with positive correlation and significant errors. A bias correction method was next developed based on (1) concurrent sonde measurements of other water quality parameters (to account for nonlinearities) and (2) a bias correction approach for nonphotochemical quenching effects in surface waters. The new Chl-a model exhibits much improved accuracy, with a root mean square error (RMSE) less than 0.95 mu g/L. The new method facilitates accurate Chl-a characterization in freshwater lakes and reservoirs based on readily obtainable in-situ fluorescence sonde measurements.

（来源：WATER RESEARCH 卷: 205 出版年: 2021, **DOI:** 10.1016/j.watres.2021.117661）

Internal loop sustains cyanobacterial blooms in eutrophic lakes: Evidence from organic nitrogen and ammonium regeneration

Xue, Jingya; Yao, Xiaolong; Zhao, Zhonghua;等

Algal bloom species can live upon internal regenerated ammonium (NH4+) for growth during the nitrogenlimited period. However, the linkages between NH4+ regeneration and phytoplankton biomass

and community composition dynamics remain largely unknown. To unravel the interactions between NH4+ regeneration and phytoplankton community, we measured water column NH4+ regeneration rates (REGs) during a continuous phytoplankton growing period and a contrast summer/winter turnover in eutrophic Lake Taihu. Measured REGs were higher in summer than in winter and significantly correlated to total phytoplankton biomass, Cyanophyta biomass and its biomass proportions, and the concentrations of particulate nitrogen and dissolved organic carbon as well as the relative abundance of labile components (proteins and lipids). Random forest regression analyses displayed that variation of REGs were mainly controlled by water temperature and algal-related parameters (including chlorophyll a, total phytoplankton biomass, and Cyanophyta biomass). Partial least squares path model further revealed that algal-related parameters were the direct and significant factors regulating REGs, and contributed to the largest effect of the variance in REGs. Of the algal community, Cyanophyta was the dominant phylum to accelerate REGs. Correspondingly, rapid internal NH4+ turnover may strongly support the persistence of cyanobacterial blooms, thus forming a positive feedback between cyanobacterial blooms and REGs during the nitrogen-limited summer months. We therefore deduced that the internal loop between cyanobacterial blooms and REGs during summer may be a key self-maintenance mechanism of continuous cyanobacterial blooms.

（来源：WATER RESEARCH 卷: 206 出版年: 2021, **DOI:** 10.1016/j.watres.2021.117724）

Multi-proxy approaches to investigate cyanobacteria invasion from a eutrophic lake into the circumjacent groundwater

Ye, Sisi; Gao, Li; Zamyadi, Arash;等

To verify whether cyanobacteria can travel from eutrophic lakes into the surrounding groundwater, a large-scale field investigation, laboratorial incubations, and quartz column penetration tests were carried out in Lake Taihu (China). High-throughput sequencing of 16S rRNA gene amplicons indicated that cyanobacteria operational taxonomic units (OTUs) were present at fifteen out of forty total wells in four cardinal directions at varying distances from the shore of Lake Taihu, up to a maximum of forty-three kilometers. Six cyanobacteria genera were detected including Microcystis, Dolichospermum, Phormidium, Leptolyngbya, Pseudanabaena and Synechococcus. The proportions of Phormidium, Microcystis and Synechococcus OTUs in the total cyanobacterial community were 45.2%, 32.2% and 19.4%, respectively. The qRT-PCR results showed that cyanobacterial abundance decreased with increasing distance from the shore of Lake Taihu. Based on the microscopic analysis of cultures inoculated with groundwater, we found Microcystis, Dolichospermum and Phormidium. Five cyanobacterial genera were able to penetrate columns filled with quartz particles ranging from 100 similar to 200 mu m. Finer layers of quartz sands were found to be impenetrable. The rating of infiltration capabilities was Microcystis > Synechococcus > Nostoc > Phormidium > Cylindrospermopsis. Deficient concentrations of microcystins were found (< 1 mu g L-1) in the groundwater samples. Based on the consideration of different factors (cyanobacterial composition in Lake Taihu, peripheral groundwater, and algal soil crusts), it was deduced that Microcystis likely originated from the lake. Still, Phormidium was probably originated from the soil infiltration. These results suggest that cyanobacteria and their toxins could travel in the groundwater, but this is a size-dependent mechanism.

（来源：WATER RESEARCH 卷: 204 出版年: 2021, **DOI:** 10.1016/j.watres.2021.117578）

Vertical environmental gradient drives prokaryotic microbial community assembly and species coexistence in a stratified acid mine drainage lake

She, Zhixiang; Pan, Xin; Wang, Jin;等.

Acid mine drainage (AMD) lakes are typical hydrologic features caused by open pit mining and represent extreme ecosystems and environmental challenges. Little is known about microbial distribution and community assembly in AMD lakes, especially in deep layers. Here, we investigated prokaryotic microbial diversity and community assembly along a depth profile in a stratified AMD lake using 16S rRNA gene sequencing combined with multivariate ecological and statistical methods. The water column in the AMD lake exhibited tight geochemical gradients, with more acidic surface water. Coupled with vertical hydrochemical variations, prokaryotic microbial community structure changed significantly, and was accompanied by increased diversity with depth. In the surface water, heterogeneous selection was the most important assembly process, whereas stochastic processes gained importance with depth. Meanwhile, microbial co-occurrences, especially positive interactions, were more frequent in the stressful surface water with reduced network modularity and keystone taxa. The pH was identified as the key driver of microbial diversity and community assembly along the vertical profile based on random forest analysis. Taken together, environmental effects dominated by acid stress drove the community assembly and species coexistence that underpinned the spatial scaling patterns of AMD microbiota in the lake. These findings demonstrate the distinct heterogeneity of local prokaryotic microbial community in AMD lake, and provide new insights into the mechanism to maintain microbial diversity in extreme acidic environments.

（来源：WATER RESEARCH 卷: 206 出版年: 2021, **DOI:** 10.1016/j.watres.2021.117739）

Historical changes of sedimentary P-binding forms and their ecological driving mechanism in a typical grass-algae eutrophic lake

Ding, Shuai; Liu, Yan; Dan, Solomon Felix;等.

With the transformation of lake ecosystem from clear water to turbid water, the residual phosphorus (P) accumulated in sediments may slow down the process of aquatic ecological restoration, and the related mechanisms are complex and need to be better understood. In this study, high-resolution systematic investigation and analysis of P-binding forms in the sediments showed that Lake Dianchi, the largest plateau lake in Southwest China, was enriched with NaOH-rP, HCl-P and Res-P, but depleted in NH4Cl-P, BD-P and NaOH-nrP. The BD-P, NaOH-nrP and NaOH-rP were the main contributors to potential P release from sediments, while the release potential of NH4Cl-P was relatively weak (<1%). When the external P loading gradually decreased, the internal P loading of Lake Dianchi was estimated to be 522 mg P/(m(2).a) in the past 30 years. The succession of grass-algae type in Lake Dianchi coincided with reduced absorption and transformation of potential mobile P and decreased accumulation of stable P, especially the Res-P. Meanwhile, the temporal variation of potential mobile P was a good predictor of ecological degradation and reduced ecosystem sustainability in Lake Dianchi.

（来源：WATER RESEARCH 卷: 204 出版年: 2021, **DOI:** 10.1016/j.watres.2021.117604）

Estimation of total flux of polycyclic aromatic hydrocarbons facilitated by methane ebullition into water column from global lake sediments

Sun, Tingting; Li, Wenxuan; Yin, Ke 等.

Methane ebullition and contamination are two typical characteristics from lakes, however, these two are generally studied independently. In fact, the exchange of matter and energy between methane bubbles and their surrounding environment can be very active to enhance the contaminant transport. There is limited research on understanding the characteristics and trends of gas ebullition facilitated contaminant emissions in large areas considering water and air as receptors. We herein estimate the transport capacity of methane ebullition for polycyclic aromatic hydrocarbons (PAHs) out of the sediment from global lakes, which may reach an average of 71 (up to 159) t yr- 1. Methane bubbles could transfer one third of the total PAH flux from sediments, or equivalent of 1.3-3.0 ng L-1 of additional PAHs, into the water column with the rest going into air, offsetting from 52 to 118% of dry PAH deposition flux into global lakes sediment per year. Given the PAH concentration in lake water is often in the range of 0.1-100 ng L-1, ebullition facilitated PAH flux may increase PAH concentration by a factor of 1.4 to 2.4 until 2,100, being a significant contributor for the PAH increment in lake waters.

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Sensitivity of phytoplankton to climatic factors in a large shallow lake revealed by column-integrated algal biomass from long-term satellite observations

Zhang, Yuchao; Hu, Minqi; Shi, Kun;等

There are some uncertainties of using chlorophyll a (Chla) concentrations in water surface to address phytoplankton dynamics, especially in large shallow lakes, because of the dramatic vertical migration of phytoplankton. The column-integrated algal biomass (CAB) can reflect the whole water column information, so it is considered as a better indicator for phytoplankton total biomass. An algal biomass index (ABI) and an empirical algorithm were proposed previously to measure algal biomass inside and outside euphotic zone from the Moderate Resolution Imaging Spectrometer (MODIS) data. A long-term CAB time series was generated in this study to clarify the temporal and spatial changes in phytoplankton and address its sensitivity to climatic factors in Lake Chaohu, a shallow eutrophic lake in China, from 2000 to 2018. Overall, the CAB for Lake Chaohu showed significant temporal and spatial dynamics. Temporally, the annual average CAB (total CBA within the whole lake) was increased at rate of 0.569 t Chla/y, ranging from 62.06 +/- 8.89 t Chla to 76.03 +/- 10.01 t Chla during the 19-year period. Seasonal and periodic variations in total CAB presented a bimodal annual cycle every year, the total CAB was highest in summer, followed by that in autumn, and it was the lowest in winter. The pixel-based CAB (total CAB of a unit water column), ranging from 112.42 to 166.85 mg Chla, was the highest in the western segment, especially its northern part, and was the lowest in the central parts of eastern and central segments. The sensitivity of CAB dynamics to climatic conditions was found to vary by region and time scale. Specifically, the change of pixel-based algal biomass was more sensitive to the temperature change on the monthly and annual scales, while wind speed impacted directly on the short-term spatial-temporal redistribution of algal biomass. High temperature and low wind speed could prompt the growth of total CAB for the whole lake, and the hydrodynamic situations affected by wind and so on determined the spatial details. It also indicated that Lake Chaohu may face more severe challenges with

the future climatic warming. This study may serve as a reference to support algal bloom forecasting and early warning management for other large eutrophic lakes with similar problems.

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Warming combined with experimental eutrophication intensifies lake phytoplankton blooms

Salk, Kateri R.; Venkiteswaran, Jason J.; Couture, Raoul-Marie;等

Phytoplankton blooms are a global water quality issue, and successful management depends on understanding their responses to multiple and interacting drivers, including nutrient loading and climate change. Here, we examine a long-term dataset from Lake 227, a site subject to a fertilization experiment (1969-present) with changing nitrogen:phosphorus (N:P) ratios. We applied a process-oriented model, MyLake, and updated the model structure with nutrient uptake kinetics that incorporated shifting N:P and competition among phytoplankton functional groups. We also tested different temperature and P-loading scenarios to examine the interacting effects of climate change and nutrient loading on phytoplankton blooms. The model successfully reproduced lake physics over 48 yr and the timing, overall magnitude, and shifting community structure (diazotrophs vs. non-diazotrophs) of phytoplankton blooms. Intra- and interannual variability was captured more accurately for the P-only fertilization period than for the high N:P and low N:P fertilization periods, highlighting the difficulty of modeling complex blooms even in well-studied systems. A model scenario was also run which removed climate-driven temperature trends, allowing us to disentangle concurrent drivers of blooms. Results showed that increases in water temperature in the spring led to earlier and larger phytoplankton blooms under climate change than under the effects of nutrient fertilization alone. These findings suggest that successful lake management efforts should incorporate the effects of climate change in addition to nutrient reductions, including intensifying and/or expanding monitoring periods and incorporating climate change into uncertainty estimates around future conditions.

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Eutrophication and temperature drive large variability in carbon dioxide from China's Lake Taihu

Xiao, Qitao; Duan, Hongtao; Qin, Boqiang; 等

Eutrophication and warming are changing the functioning of lake ecosystems, and their impacts on lake carbon dioxide (CO2) variability have received increasing attention. However, how eutrophication and warming change lakes' carbon cycle has not been determined. Here, the surface partial pressure of CO2 (pCO(2)) and CO2 flux in Lake Taihu, a large and eutrophic lake in eastern China, was investigated based on monthly samplings over a 24-yr period (1992-2015), during which the lake experienced profound anthropogenic and climate changes. The results showed that eutrophication caused by nutrient enrichment plays a role in three aspects: (1) nutrient concentrations controlled the CO2 variability on decadal scales; (2) peak pCO(2) and CO2 fluxes occurred in river mouths due to large external nutrient loading inputs; and (3) eutrophication effects on CO2 varied among subzones, which was linked to external inputs and in-lake primary production. Meanwhile, temperature controls the seasonal variation in CO2 by stimulating primary production, leading to significantly lower pCO(2) and CO2 fluxes in warm seasons with algal blooms. Further analysis suggested that temperature effects varied spatially and temporally, high nutrient loading may confound the temperature effects via stimulating CO2 production.

To our knowledge, this study presents the longest field measurements (24 yr) of CO2 from such large and ice-free freshwater lakes with monthly surveys, which may provide a powerful example to demonstrate that eutrophication and warming can shape CO2 variability from a temporal perspective. Future studies should focus on the interactive warming and eutrophication effects to accurately predict future CO2 emission.

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Confronting Uncertainties of Simulated Air Pollution Concentrations during Persistent Cold Air Pool Events in the Salt Lake Valley, Utah

Sun, Xia; Ivey, Cesunica E.; Baker, Kirk R.; 等

Air pollutant accumulations during wintertime persistent cold air pool (PCAP) events in mountain valleys are of great concern for public health worldwide. Uncertainties associated with the simulated meteorology under stable conditions over complex terrain hinder realistic simulations of air quality using chemical transport models. We use the Community Multiscale Air Quality (CMAQ) model to simulate the gaseous and particulate species for 1 month in January 2011 during the Persistent Cold Air Pool Study (PCAPS) in the Salt Lake Valley (SLV), Utah (USA). Results indicate that the temporal variability associated with the elevated NOx and PM2.5 concentrations during PCAP events was captured by the model (r = 0.20 for NOx and r = 0.49 for PM2.5). However, concentrations were not at the correct magnitude (NMB = -35/12% for PM2.5 during PCAPs/non-PCAPs), where PM2.5 was underestimated during PCAP events and overestimated during non-PCAP periods. The underestimated PCAP strength is represented by valley heat deficit, which contributed to the underestimated PM2.5 concentrations compared with observations due to the model simulating more vertical mixing and less stable stratification than what was observed. Based on the observations, the dominant PM2.5 species were ammonium and nitrate. We provide a discussion that aims to investigate the emissions and chemistry model uncertainties using the nitrogen ratio method and the thermodynamic ammonium nitrate regime method.

（来源：LIMNOLOGY AND OCEANOGRAPHY 出版年：2021, **DOI:** 10.1021/acs.est.1c05467）

Coupling Suspect and Nontarget Screening with Mass Balance Modeling to Characterize Organic Micropollutants in the Onondaga Lake-Three Rivers System

Wang, Shiru; Perkins, MaryGail; Matthews, David A.;等.

Characterizing the occurrence, sources, and fate of organic micropollutants (OMPs) in lake-river systems serves as an important foundation for constraining the potential impacts of OMPs on the ecosystem functions of these critical landscape features. In this work, we combined suspect and nontarget screening with mass balance modeling to investigate OMP contamination in the Onondaga Lake-Three Rivers system of New York. Suspect and nontarget screening enabled by liquid chromatography-high-resolution mass spectrometry led to the confirmation and quantification of 105 OMPs in water samples collected throughout the lake-river system, which were grouped by their concentration patterns into wastewater-derived and mixed-source clusters via hierarchical cluster analysis. Four of these OMPs (i.e., galaxolidone, diphenylphosphinic acid, N-butylbenzenesulfonamide, and triisopropanolamine) were prioritized and identified by nontarget screening based on their characteristic vertical distribution patterns during thermal stratification in Onondaga Lake. Mass balance modeling performed using the

concentration and discharge data highlighted the export of OMPs from Onondaga Lake to the Three Rivers as a major contributor to the OMP budget in this lake-river system. Overall, this work demonstrated the utility of an integrated screening and modeling framework that can be adapted for OMP characterization, fate assessment, and load apportionment in similar surface water systems.

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The shift from macrophytic to algal particulate organic matter favours dissimilatory nitrate reduction to ammonium over denitrification in a eutrophic lake

Jiang, Xingyu; Gao, Guang; Hu, Yang;等

In eutrophic lakes, the shift from a macrophyte-dominated state to an algae-dominated state changes the particulate organic matter (POM) sources, which in turn alters organic matter quality that is released and that sinks to the benthos. However, the influences of this shift on denitrification and dissimilatory nitrate reduction to ammonium (DNRA) are unclear in eutrophic lakes. Here, we elucidated how various POM sources influenced these nitrate reduction pathways in a eutrophic lake. The lake sediments from August were incubated under algae, macrophyte, and soil treatments in aquarium tanks. Potential denitrification and DNRA rates and related functional gene abundances were measured periodically. Meanwhile, the n-alkanes composition of POM and fluorescence excitation-emission matrices of dissolved organic matter were measured before and during incubations, respectively, to aid in the analysis of the potential mechanisms by which organic matter quality affect nitrate reduction. The results indicated that algal detritus was more labile and decomposed faster than other POM, coupled with higher DNRA rates and nrfA gene abundances. Macrophyte treatments resulted in nitrate accumulation and the increase of gene abundances related to denitrification, but no increase in denitrification rates was observed. In soil treatments, nitrate reduction processes were not significantly influenced by the addition of POM. Overall, compared with other sources, algae-derived POM can produce high-quality organic carbon, low dissolved oxygen and nitrate concentrations, which is more conducive to DNRA than denitrification. A loss of macrophytes and increase in algal biomass will induce changes in autochthonous POM quality and potentially drive nitrogen recycling in eutrophic lakes.

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Cyanobacterial bloom associated with a complete turnover of a Daphnia population in a warm-temperate eutrophic lake in Eastern China

Ma, Xiaolin; Deng, Zhixiong; Blair, David;等.

The effect of cyanobacterial blooms on aquatic ecosystems has received wide attention, yet little is known about their impacts on zooplankton genetic structure. For 26 months (April 2012-May 2014), we monitored zooplankton in a warm-temperate ice-free lake in Eastern China, with an emphasis on seasonal population dynamics of the cladoceran, Daphnia galeata. There was a seasonal succession in the zooplanktonic community (composed of Cladocera, Copepoda, and Rotifera). Genetic analysis (based on 14 microsatellite loci) of the 21 monthly samples in which D. galeata was present demonstrated that several clones could successfully overwinter and/or persist for many months. However, all clones, including these long-lived clones, were completely replaced by new ones after October 2013, probably due to cyanobacteria blooms in that summer. A high clonal richness coupled with high turnover

rate was observed in the D. galeata population overall, suggesting frequent sexual reproduction. Daphnia galeata experimentally fed with a diet of Microcystis aeruginosa (the most abundant toxic cyanobacterial species in the lake) had a substantially reduced survivorship, consistent with the field observations. Our findings highlight the changes of zooplanktonic population dynamics in terms of both community and clonal structure in a warm-temperate ice-free lake, and call for further investigation on ecological responses of zooplankton to cyanobacterial blooms.

（来源：FRESHWATER BIOLOGY，出版年: 2021 , **DOI:** 10.1111/fwb.13858）

Characteristics of humic substance in lake sediments: The case of lakes in northeastern China

Song, Xinyu; Zhang, Chunhao; Su, Xinya;等.

As an important part of lake ecosystems, sediments play a key role in the carbon cycle in lakes. Due to the complex sources of organic matter in sediments, the link between sequestration and transformation of humic substance is largely unknown. Therefore, it is essential to understand the characteristics of humic substance in lake sediments. In this study, the relationship between the characteristics of humic substance and environmental conditions was found in sediment samples from six typical lakes of northeast China. The structure of humic substance (HS), fulvic acid (FA) and humic acid (HA) tended to be simplified with decreasing lake depth. Pearson analysis indicated that characteristics of humic substances in deep lake sediments were dominantly determined by nutrient factors (e.g., NO3-N, NO2-N, NH4+-N) and physicochemical factors (e.g., pH, water temperature, dissolved oxygen), while the changes of HS in shallow lake sediments were dominantly determined by physicochemical factors (e.g., pH, water temperature, dissolved oxygen). Variation partitioning results also indicated that nutrient factors and physicochemical factors explained 64% and 24.2% of the variations of HS content in boreal deep lakes. In comparison, physicochemical factors explained most of the variation (35.6%) of HS composition, while nutrient factors only explained 3.4% of the variation in shallow lakes. Structural equation models further confirmed that complex components were transformed into simple components by nutrient and physicochemical factors with decreasing lake depth. This study suggests that changes in environmental conditions with lake depth may result in changes in the quality of HS in lake sediments.

（来源：JOURNAL OF HYDROLOGY 卷: 603 出版年: 2021, **DOI:** 10.1016/j.jhydrol.2021.127079）

New method improves extraction accuracy of lake water bodies in Central Asia

Xu, Yuyue; Lin, Jing; Zhao, Jianwei;等.

Lakes play an important role in terrestrial ecosystems and have a significant impact on human production and life. Remote sensing techniques have been widely used to monitor changes in lakes. Several studies have been conducted pertaining to extraction of lake bodies using optical remote sensing images; however, owing to the influence of ice and snow in the lake and other parameters such as noise, the accuracy and stability of lake extraction still need to be improved. This study designed a new method by combing K-means clustering and the flood fill method (KCFFM) to improve the accuracy and stability of extraction results from complex backgrounds. Using Landsat 8 Operational Land Imager (OLI) data for five lakes in Central Asia, the accuracy and stability of KCFFM in summer and winter were evaluated and compared with those of five other methods. KCFFM showed the highest accuracy and stability among all the methods, especially during the lake ice period. For KCFFM, the Kappa coefficient was greater than

0.97 and 0.92 and the overall accuracy was greater than 99% and 98% in summer and winter, respectively. The area error rate of KCFFM was less than 3%, except for Lake Alakol (less than 10%). In addition, KCFFM significantly decreased the area error rate compared to other methods (1% to 15% in summer and 10% to 50% in winter). The proposed method optimized the time continuity, accuracy, and stability of lake body extraction. Thus, KCFFM can provide valuable basic data for monitoring lake water bodies.

（来源：JOURNAL OF HYDROLOGY 卷: 603 出版年: 2021, **DOI:** 10.1016/j.jhydrol.2021.127180）

Notable changes of carbon dioxide in a eutrophic lake caused by water diversion

Xiao, Qitao; Liu, Zhenjing; Hu, Zhenghua;等.

Artificial water diversion project has been increasingly implemented to control eutrophication and alleviate water shortage of lakes. Water diversion can affect the biogeochemical cycles, however, carbon dioxide (CO2) sensitivity in lakes to water diversion was poorly understood. This study addressed the issue based on the famous Water Diversion project from the Yangtze River to eutrophic Lake Taihu, which has been carried out regularly since 2002 in China. The partial pressure of CO2 (pCO(2)) at two regions of the eutrophic lake, water-receiving Gonghu Bay and non-water-receiving Central Zone, was investigated over 16 years (2002-2017) field measurement with high sampling frequency. Results showed the river-to-lake water diversion decreased phytoplankton biomass, increased nutrient loadings, and significantly elevated the pCO(2) and associated CO2 emission. Meanwhile, the water diversion project accounted for the notable CO2 spatial heterogeneity between regions and within region. However, weak CO2 seasonal variability was observed at Gonghu Bay during water diversion period. The estimated CO2 emission flux increased averagely by 54% due to water diversion, primarily resulting from phytoplankton dilution, nutrient enrichment, and external CO2 input. Water diversion and ammonia nitrogen together explained 69% of interannual variability pCO(2) at Gonghu Bay, implying water diversion should be considered to better understanding the contribution of lake CO2 emissions to C budget under a changing environment. These findings were expected to serve as a reference to evaluate the water diversion effects, further study should focus on the sources of the excess CO2 to make the project a CO2-neutral option.

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Determining water allocation scheme to attain nutrient management objective for a large lake receiving irrigation discharge

Liu, Xuemei; Zhang, Guangxin; Xu, Y. Jun;等.

Irrigation discharge is a relevant water resource for lake ecosystems in arid and semi-arid regions. However, high concentrations of nitrogen and phosphorus in the irrigation discharge raise concerns over potential lake eutrophication in these regions. A Delft3D hydrodynamic-water quality model was used to explore the effects of multiple water sources on water quality of a large shallow lake in the semi-arid west of Northeast China, which is surrounded by irrigated rice paddies. Eighteen scenarios in a combination of different precipitation rates, irrigation discharge operations, and flow conditions were simulated to analyze time and water allocation required in order to achieve nutrient standards of total nitrogen (TN) <= 1.5 mg/L and total phosphorus (TP) <= 0.1 mg/L. The results showed that time required for the optimal combination to achieve nutrient management objectives displayed an increasing trend from the east to

west. In the best control scenario where the irrigation discharge was regulated into the lake, TN and TP concentrations could be reduced by 60% and 70%, respectively. Water diversion from a freshwater reservoir can effectively improve lake water quality even though sediment nutrient resuspension could occur in the eastern region of lake. The findings suggest that using multi-source water supplies can attain nutrient management objectives in order to reduce eutmphication risk for a lake that receives nutrient-rich irrigation discharge. The study also demonstrates the great usefulness of hydrodynamic-water quality modeling for assessing water resource allocation and science-based decision making in intensive agriculture practices.

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A statistical framework to track temporal dependence of chlorophyll-nutrient relationships with implications for lake eutrophication management

Qiu, Qianlinglin; Liang, Zhongyao; Xu, Yaoyang;等.

A reliable chlorophyll-nutrient relationship (CNR) is essential for lake eutrophication management. Although the spatial variability of CNRs has been extensively explored, temporal variations of CNRs at the individual lake scale has rarely been discussed. The paucity of information about temporal dependence in CNRs may in part be due to the lack of a suitable statistical framework that helps guide such investigations. In order to reveal temporal dependence of CNR, this study develop a novel statistical framework. In the framework, we employ quantile regression to generate overall (the entire dataset), annual (subsets for each year), and accumulative (subsets collected before a certain year) CNRs. We aim to 1) show biases of annual relationships by comparing the overall and annual relationships and 2) determine whether or not data accumulation is enough to develop a reliable CNR. We use Lake Champlain and Lake Kasumigaura as case studies to illustrate the necessary steps needed to utilize this novel framework. Results show that large interannual variations exist for CNRs. Accumulative relationships tend to converge to the overall relationship, indicating that overall relationships are reliable for informing lake-specific eutrophication management in the two case study lakes. The novel statistical framework that we propose for a procedure to estimate reliable CNRs is important for informing lake-specific eutrophication control decision-making processes.

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The consecutive lake group water storage variations and their dynamic response to climate change in the central Tibetan Plateau

Zhang, Run; Zhu, Liping; Ma, Qingfeng;等.

Lakes on the Tibetan Plateau (TP) are a reliable indicator of local and global climate changes. Surveying lake water storage (LWS) and understanding the causes of lake variations are crucial to regulate water resources and protect local ecology. However, the lake bathymetric survey and the analysis of consecutive lake changes were absent on the TP. In this study, we investigated the LWS for seven lakes in the central TP and estimated their water storage variations during the period of 1976-2018 by utilizing long-term time series Landsat images and bathymetric data. Then, the driving factors of lake water storage variations were also analyzed based on the data of the meteorological station. The results suggested that the LWS of the seven lakes (Co Nag, Daru Co, Dung Co, Pung Co, Co Ngoin, Bam Co, and Neri Punco) in the central TP expanded by 2.54 km(3) (22.12%) from 1976 to 2018, with total lake

area increased by 183.42 km(2) (22.73%), especially experienced obviously increasing trend between 1997 and 2006. The growth of LWS between 1997 and 2006 explained 70.63% of the net increase during the whole period. While the correlation analysis of LWS and climate change revealed that temperature, precipitation, and evaporation all had impacts on the changes of LWS, temperature and precipitation dominated the main role for the expansion of these lakes during the period of 1997-2006, and LWS had approximately 3 years of lag time in response to precipitation. We also found that the time of the abrupt increase of LWS was probably associated with the step change point of annual precipitation.

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Quantifying the spatiotemporal dynamics of recharge in a composite Great Lakes watershed using a high-resolution hydrology model and multi-source data

Kang, Guoting; Luo, Lifeng; Pokhrel, Yadu;等.

Understanding the timing, location and rates of recharge is important for sustainable groundwater management and effective management of groundwater-dependent ecosystems. This paper explores the spatiotemporal distributions of large- and small-recharge events in a composite watershed in the Great Lakes region and examines the impacts of climate, land use/land cover, soils, and topography on simulated recharge. Novel aspects of the work include recharge estimation using an integrated hydrologic model and constraining the model using field observations of baseflows in both perennial and intermittent streams in the region as well as the United States Geological Survey (USGS) streamflows, groundwater heads, and satellite-based evapotranspiration (ET) products. Simulated high (low) recharge values were associated with high (low) elevations and regions of low (high) ET. The temporal dynamics of recharge are dominated by interannual climate variations, but are also affected by land cover types and soil types. Recharge occurred year-round in agricultural lands but intermittently in forested lands with both recharge and discharge occurring at different times within the same grid cell. Major recharge pulses were associated with spring snowmelt and also occurred in summer and fall and sometimes in late fall but there was considerable variability from year to year depending on the dominant land use and climate. Our approach based on the use of an integrated hydrologic model combined with multi-source data can be used in larger areas and is suitable for studying climate change impacts on groundwater resources.

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Thermal mixing of Lake Erhai (Southwest China) induced by bottom heat transfer: Evidence based on observations and CE-QUAL-W2 model simulation

Zhao, Lei; Cheng, Sihang; Sun, Yanxin;等.

The thermal structure of a lake is strongly associated its hydrodynamics and climatic conditions, and is an important basis to understand the physical, chemical, and ecological processes of the lake. Lake Erhai (100 degrees 05-100 degrees 17'N and 25 degrees 36'-25 degrees 58'E) is a large and deep lake in Yunnan Province, located on the Yunnan-Guizhou Plateau of Southwest China. Some deep lakes located in areas adjacent to Lake Erhai with similar climatic conditions and water depths are warm monomictic lakes. However, the historical data of the surface water temperature and bottom water temperature for the past 15 years (2004-2018) showed small differences (<1 degrees C). However, ours and some other studies on the vertical water temperature profile showed mixing of the entire water

column in different seasons. We have applied a well-established hydrodynamics model (CE-QUAL-W2) to explore the main process that induces the particular thermal structure of Lake Erhai. Model calibration was conducted twice, once with the extinction coefficient (K-d) and fraction of solar radiation absorbed in the surface layer (BETA) as the main calibrated parameters, and the other considering the process of bottom-water heat exchange, represented by the sediment temperature (TSED) parameter in the CE-QUAL-W2 model. The simulation results showed that the model can reproduce water level and surface water temperature accurately with the first calibration (TSED is 14.8 degrees C), however, only when the TSED is greater than 24 degrees C, the RMSE can be less than 2 degrees C. The model reproduces the bottom water temperature well when the TSED value was 29.6 +/- 0.37 degrees C. Moreover, a series of scenarios were conducted to quantify the effect of wind speed and/or tributary inflows temperature on the thermal structure of Lake Erhai, and two stability indices (Schmidt stability, Birgean work) were calculated to quantify the energy required for stratification and mixing. These results demonstrated that the most likely process to establish the holomixis of Lake Erhai is geothermal heat transfer from sediment to water column, and an additional 12% heat flux from sediment plus the actual external energy supplies from sediment are required to mix the entire water column of Lake Erhai in summer.

（来源：JOURNAL OF HYDROLOGY 卷: 603 出版年: 2021, **DOI:** 10.1016/j.jhydrol.2021.126973）

Response of supraglacial rivers and lakes to ice flow and surface melt on the northeast Greenland ice sheet during the 2017 melt season

Lu, Yao; Yang, Kang; Lu, Xin;等.

Fast ice flow and substantial surface runoff form distinct and extensive supraglacial rivers and lakes on the northeast Greenland Ice Sheet (GrIS). These supraglacial rivers and lakes play an important role in controlling surface meltwater routing and storage. However, the hydromorphology of these complex supraglacial features remains poorly quantified. In this study, we mapped the multi-temporal supraglacial rivers and lakes on the northeast GrIS (area similar to 3 x 10(4) km(2)) using sixty-five 10 m Sentinel-2 multispectral satellite images acquired during the 2017 summer, and quantified their primary hydromorphology, including meltwater area fraction, meltwater volume, supraglacial river length, river sinuosity, river depth, supraglacial lake area, lake shape, and lake depth. The quantified hydromorphology was compared with variable ice flow regimes and regional climate model (RCM) runoff. The results indicate that widespread supraglacial rivers and lakes maximally cover 5.3% of the northeast GrIS, which is more than double the previous estimates and only slightly lower than that for the strongly melting southwest GrIS (similar to 7.0%). As the surface runoff increases and the snowline retreats, supraglacial rivers and lakes migrate from the ice sheet margin (similar to 400 m) to high elevations (similar to 1400 m). The satellite-mapped surface meltwater area fraction for the entire study area is positively correlated with the RCM surface runoff before the timing of peak melt (August 1), but decreases relatively slowly (by 32-45%) compared to the rapidly decreasing runoff (by 84-96%) in August. Large elevational variations were found for the peak magnitude and timing of the meltwater extent and volume. High (800-1400 m) elevation bands achieve peak values over two weeks later than low (400-800 m) elevation bands, and the 800-1000 m elevation band yields maximum peak values due to the wide distribution of supraglacial rivers. Furthermore, the supraglacial drainage patterns vary with different ice flow regimes. There are long rivers and few lakes in areas where ice deformation controls the ice flow velocity while there are short rivers and large, narrow lakes in areas where basal sliding is a major component of the ice flow. Meanwhile, long, sinuous rivers and small lakes form on the floating ice. In

general, this study conducts a preliminary investigation of supraglacial rivers and lakes on the poorly-studied northeast GrIS and reveals that surface melt and ice flow control the hydromorphology of supraglacial rivers and lakes.

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A remote sensing-based area dataset for approximately 40 years that reveals the hydrological asynchrony of Lake Chad based on Google Earth Engine

Li, Huan; Luo, Zengliang; Xu, Yue;等.

As the second largest lake in Africa, the extent of Lake Chad has over 50% seasonal variations with large parts of water under aquatic vegetation. Although a great area shrinkage since the 1960s divided the lake into two parts, namely, the northern and southern basins, it still feeds millions of people from four countries around it. Given sparse in situ measurements, remote sensing with seamless spatial coverage has served for acquiring the long-term area series of Lake Chad. This study retrieves the open (unvegetated) surface water area series of Lake Chad and the total inundation area, including open water and water under macrophytes, combining multiple remote sensing data from around 1980 to 2020 with satellite-based water level and in situ observations at the Bol gauge as validation and auxiliary. Results show that the total inundation area continuously recovered at a rate of 145 km(2)/year from 1982 to 2020 with large annual fluctuations. Approximately two- to three-month time lags between the open surface water and the total inundation area reveal the hydrological asynchrony of Lake Chad, which can be attributed by the large area of rooted macrophytes. The overspill of the southern surface water flowing over the Great Barrier into the northern lake also has a one-month lag with the open surface water of the southern lake. The Google Earth Engine-based online application can be easily shared for use and data downloaded by the general public, and the open code can be adjusted for any other lakes worldwide.

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An accuracy-improved flood risk and ecological risk assessment in an interconnected river-lake system based on a copula-coupled hydrodynamic risk assessment model

Yang, Rui; Wu, Shiqiang; Gao, Xueping;等.

Understanding flood event-related risk in an interconnected river-lake system (IRLS) is a prerequisite for developing water resource management strategies and enhancing disaster resilience. Previous flood event-related risk assessments either hardly consider the context in which water diversion encounters flood events or hardly consider the physical process, stochastic analysis and multivariate interactions of flood event characteristics simultaneously, thereby resulting in a less reliable assessment of flood event-related risk. To resolve this limitation, a copula-coupled hydrodynamic risk assessment model (CHRAM) is proposed to characterize the physical, multivariate, and stochastic nature of risk, improving the accuracy of risk assessment. In this study, CHRAM is capable of accurately quantifying flood event-related risks (i.e., flood risk and ecological risk) of the Nansi Lake Basin in the flood season under the operation of the eastern route of the South-to-North Water Diversion Project in China. Our findings revealed that the total flood volume (R-sum) and duration (T-d) of flood events were significantly sensitive characteristic indexes for flood risk and ecological risk. In addition, the security domains of flood risk (R-sum < 35 mm and T-d < 23 d) and ecological risk (R-sum < 50 mm and T-d < 27 d) were determined

based on the analysis of the relationship between sensitive characteristic indexes and risk indicators. The results also showed that the impact of T-d on flood risk, ecological risk and flood-ecological combined risk was 3-14 times greater than the impact of R-sum. The occurrence probability of flood-ecological combined risk was smaller than that of flood risk but greater than that of ecological risk, with the corresponding maximum risk probabilities of 11.2%, 36.5%, and 4.7%, respectively. This study extends the current knowledge about risk assessment in IRLS and is beneficial to instruct the management of projects for similar systems.

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Mapping inter- and intra-annual dynamics in water surface area of the Tonle Sap Lake with Landsat time-series and water level data

Gu, Zhenkui; Zhang, Yao; Fan, Hui

Surface water monitoring is the foundation of water resources management. However, large-scale surface water monitoring based on long-sequence Landsat images is easily affected by cloud cover. In this study, taking the Tonle Sap Lake in the lower Mekong as an example, a series of water-land boundaries with height attributes based on water level data were extracted from multi-temporal Landsat images without cloud cover using the optimal water index and the lakeshore elevation model (LEM) of Tonle Sap Lake was constructed. On this basis, with the help of the limited land-water boundary provided by the Landsat image over a longer period, long-term monitoring of the changes in the water area of the entire lake area was realized. The results show that the Landsat image data in conjunction with the LEM can effectively remove the effect of cloud cover in monitoring the change of long time series water bodies. Reconstruction of historical data on changes in the waters of Tonle Sap Lake with the proposed method shows that in the past 30 years, there has been no significant change in the water areas of Tonle Sap Lake in either the dry or rainy seasons. Water area changes of the lake have a delayed response of 1-3 months to changes in the water level of the Mekong River, which is more affected by the mainstream recharge. The water area of the lake is unaffected in the dry season; however, it is weakly affected in the rainy season by the Xiaowan and Nuozhadu hydropower stations in China.

（来源：JOURNAL OF HYDROLOGY 卷: 601 出版年: 2021, **DOI:** 10.1016/j.jhydrol.2021.126644）

Turnover of lake sediments treated with sediment microbial fuel cells: a long-term study in a eutrophic lake

Lu, Xinyu; von Haxthausen, Karl August; Brock, Andreas Libonati;等.

Sediment microbial fuel cells (SMFCs) have previously been successfully used to reduce phosphate release from the sediments of eutrophic lakes. In this study, we investigate the risk that SMFCs stimulate sediment decompo-sition with the unwanted side effect being the release of legacy pollutants stored in sediments. Electrode pairs (16 m(2) each) were installed in a eutrophic lake in Denmark and the electricity production was monitored over more than a year at three electrode fields. Equations were derived that allow calculation of the substrate turnover by the SMFCs from the working potential, the open circuit potential, and the external resistance of the SMFCs. The resulting turnover data suggest that the decomposition of the sediment is only slightly expedited by the SMFCs, and that the decomposition process is not significantly stimulated by the type of SMFCs installed in the lake. The measured maximum power density with stainless steel electrodes in the lake sediment was 0.9 mW/m(2), which was sufficient to reduce P outflux from sediment. At this power density, the decomposition half-life of the

lake sediment (top 5 cm) is calculated to be 277 years, which is only about 10% of natural lake sediment decomposi-tion half-lives. Higher power densities are not necessary for P fixation but inadvertently increase the risk that leg-acy pollutants buried in the sediment are released.

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Distribution and sedimentation of microplastics in Taihu Lake

Zhang, Qiji; Liu, Tong; Liu, Liu;等

Microplastics have been reported in environmental media for decades, but gaps in our knowledge about them still remain. We investigated the third biggest freshwater lake in China - Taihu Lake - and the 30 major rivers around it. Microplastics were detected in lake water and sediment, and in river water, at abundances varying from 1.7 to 8.5 items/L, 460 to 1380 items/kg and 1.8 to 18.2 items/L, respectively. Inflow rivers were more polluted with microplastics than outflow rivers. The most common shape was fragment. Microplastic sizes of <100 mu m dominated in inflow rivers, 100-200 mu m dominated in lake water and outflow rivers. The average size of microplastics in outflow rivers (200.4 mu m) was larger than that in inflow rivers (166.2 mu m). Microplastics of <100 mu m only accounted for 28% in the lake surface water but were as high as 70% in the sediment, indicating that smaller microplastics may more easily settle in the lake. The main components of the microplastics were identified as being polyvinyl chloride and polyethylene. There were about 1.2E06 items/s microplastics entered Taihu Lake. Four main rivers located at northwestern lake accounted for 79% of the total inflow microplastic fluxes.

（来源：SCIENCE OF THE TOTAL ENVIRONMENT 卷 795 出版年: 2021, **DOI:** 10.1016/j.scitotenv.2021.148745）

Metagenomics analysis revealing the occurrence of antibiotic resistome in salt lakes

Liang, Hebin; Wang, Fan; Mu, Rong;等.

Although antimicrobial resistance genes (ARGs) in dozens of environments have been well documented, the distribution of ARGs in salt lake ecosystems has been less intensively investigated. In this study, the broad-spectrum ARG profiles, microbial community composition and the comprehensive associations between microbiome and antimicrobial resistome in four salt lakes were investigated using a metagenomic approach. A total of 175 ARG subtypes affiliated with 19 ARG types were detected, and ARGs conferring resistance to multidrug, bacitracin, and macrolide-lincosamide-streptogramin (MLS) accounted for 71.2% of the total ARG abundance. However, the abundance of ARGs significantly decreased with the increasing salinity in the lakes. Both ARG profiles and microbial community structure presented remarkable discrepancies in different lakes, as well as in different sample types. Microbes such as genera Azoarcus, Aeromonas, Pseudomonas, and Kocuria, significantly co-occurred with multiple ARGs, indicating that these bacteria are potential ARG hosts in salt lake ecosystems. Collectively, this work provides new insights into the occurrence and distribution of ARGs in salt lake ecosystems.

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Phosphorus cycling in freshwater lake sediments: Influence of seasonal water level fluctuations

Wu, Xiancang; Ma, Teng; Du, Yao;等.

Freshwater lakes experience drastic water level fluctuations because of climate change and human activities. However, the influence of such fluctuations on phosphorus cycling in sediments has rarely been investigated. We conducted a geochemical investigation on the phosphorus cycle in a shallow freshwater lake, Dongting Lake; under the influence of human activities and climate change, its water regime undergoes drastic changes. Irrespective of the permanent inundation zone (PIZ) or seasonal inundation zone (SIZ), the phosphorus cycle in sediments was found to be dominated by the reductive dissolution of iron (Fe) (oxyhydr)oxides, degradation of organic matters, and conversion between authigenic phosphorus (Ca-P) and detrital phosphorus in individual seasons. From winter to summer, with increasing water level, the content of Fe-bound phosphorus and organic phosphorus increase due to the deposition of suspended matter, thus increasing total phosphorus in PIZ. Moreover, the rising water level also reduces the dissolved oxygen content and promotes the reductive dissolution of Fe (oxyhydr)oxides. The mineralization of increased organic matter can release CO2 and reduce pH in the vicinity, which can further result in the acidic dissolution of detrital apatite. In turn, most of the released phosphorus can be adsorbed or co-precipitated with calcium minerals, resulting in the significant increase of Ca-P. The mechanisms of phosphorus transformation in SIZ are similar to those in PIZ, but most of the increased organic matter and total P in a core from SIZ are attributable to the decomposition of plant matter. Therefore, the water level rise not only changes the conservative speciation of phosphorus in sediments to active speciation, but also triggers the release of phosphorus adsorbed to oxides and further increases the risk of phosphorus release from sediments to overlying water. Thus, our findings have major implications for freshwater shallow lakes and their P driven productivity.

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Driving mechanisms of gross primary productivity geographical patterns for Qinghai-Tibet Plateau lake systems

Jia, Junjie; Wang, Yafeng; Lu, Yao;等.

Being a fundamental property of aquatic systems, gross primary productivity (GPP) is affected by complex environmental factors, such as salinity, nutrients, pH, and sunlight. Under conditions of intensified anthropogenic activity and climate change, it is critical to understand the driving mechanisms of GPP in alpine lakes. In this study, we investigated GPP and associated environmental factors of 23 lake systems in the Qinghai-Tibet Plateau (QTP) along an altitudinal range (from 2500 m to 4500 m). Results showed an increase in chlorophyll a (Chl a) content as altitude increased and a corresponding decrease as salinity increased. Furthermore, geographical patterns of GPP were higher at the mid-gradient and lower at the extreme gradient. Higher solar radiation and water temperatures, stronger evaporation and higher salinity levels, and lower pH and higher nutrient content were all driving mechanisms of GPP in low altitudinal lake systems within high latitudinal regions. Such conditions have collectively resulted in the current GPP pattern via the promotion or inhibition of phytoplankton growth and photosynthesis. Specifically, geographical features and climate change jointly drive algal growth and GPP of alpine lake systems via internal circulation processes; however, anthropogenic activities interfere with external circulation processes for most of lower-middle altitudinal lake systems, thus playing a certain role in regulating environmental factors and GPP alongside climate change.

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Unique T4-like phages in high-altitude lakes above 4500 m on the Tibetan Plateau

Zang, Lin; Liu, Yongqin; Song, Xuanying;等.

Viruses are the most abundant biological entities in the biosphere; however, little is known about viral ecology in high altitude lakes. Here, we characterized viruses from 13 lakes, nine of which located >= 4500 m above sea level, on the Tibetan Plateau, the highest plateau on Earth. The abundance of virus-like particle (VLP) in Tibetan lakes ranged from 4.8 +/- 0.2 x 10(5) VLPs mL(-1) to 6.0 +/- 0.2 x 10(7) VLPs mL(-1) and the virus-to-bacterium ratio was in the lower range of values reported for other lakes. The viral population size was positively correlated with turbidity and negatively correlated with particulate organic carbon concentration. Highly diverse VLP morphologies, including large (similar to 300 nm) morphotypes, were observed. Phylogenetic analysis of T4-like bacteriophages based on major capsid gene (g23) identified a novel viral group, which were detected in abundance in hyposaline and mesosaline Tibetan lakes. Adaptation to lake evolution, water source (glacier-fed or non-glacier-fed) and environmental conditions (e.g., salinity, phosphorus concentration and productivity) are likely responsible for the variation in T4-like myovirus community composition in contrasting Tibetan lakes. This first investigation of viruses in high-altitude alpine lakes above 4500 m could contribute to our understanding of viral ecology in global alpine lakes.

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Response of sediment and water microbial communities to submerged vegetations restoration in a shallow eutrophic lake

Chao, Chuanxin; Wang, Ligong; Li, Yang;等.

Submerged macrophytes are the main primary producers in shallow lakes and play an important role in structuring communities. Aquatic microbes are also an important component of aquatic ecosystems and play important roles in maintaining the health and stability of ecosystems. However, little is known about the interactions between macrophytes and microbes during the reintroduction of submerged vegetation. Here, we chose restored zones dominated by four different submerged vegetations and a bare zone in a shallow eutrophic lake to unveil the microbial diversity, composition and structure changes in sediment and water samples after submerged macrophytes were recovered for one and a half years (July 2019) and two years (April 2020). We found that the recovery of submerged vegetations decreased phosphorus content in water and sediments but increased nitrogen and carbon content in sediments. We observed that the transparency of water in the restored zones was significantly higher than that in the bare zone in July. The recovery of submerged vegetations significantly influenced the alpha diversity of bacterial communities in sediments, with higher values observed in restored zones than in bare zones, whereas no significant influence was found in the water samples. In July, the macrophyte species showed strong effects on the bacterial community composition in water and relatively little effect in sediment. However, a strong effect of the macrophyte species on the composition of bacterial communities in sediments was observed in April, which may be related to the decomposition of plant litter and the decay of detritus. Additionally, the dissimilarity of the sedimentary bacterial community may increase more slowly with environmental changes than the planktonic bacterial community dissimilarity. These results suggest that the large-scale restoration of aquatic macrophytes can not only improve water quality and change sediment characteristics but can also affect the diversity and compositions of bacterial communities, and these effects seem to be very long-lasting.

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High methane emissions from thermokarst lakes on the Tibetan Plateau are largely attributed to ebullition fluxes

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

Ebullition has been shown to be an important pathway for methane (CH_4) emissions from inland waters. However, the CH_4 fluxes and their magnitudes in thermokarst lakes remain unclear due to limited research data, especially on the Tibetan Plateau (TP). The magnitude and regulation of two CH_4 pathways, ebullition and diffusion, were investigated in 32 thermokarst lakes on the TP during the summer of 2020. CH_4 emissions from thermokarst lakes on the TP showed significant spatiotemporal heterogeneity. Diffusion fluxes in lakes averaged 2.6 mmol m(-2) d(-1) (ranging from 0.003 to 48.4 mmol m(-2) d(-1)), and ebullition fluxes in lakes averaged 6.6 mmol CH_4 m(-2) d(-1) (ranging from 0.002 to 140.0 mmol m(-2) d(-1)). Together, these ebullition fluxes contributed 66.1 +/- 24.9% (ranging 5.4 to 100.0%) to the total (diffusion + ebullition) CH_4 emissions, indicating the importance of ebullition as a major CH_4 transport mechanism on the TP. In general, thermokarst lakes with higher CH_4 diffusion fluxes and ebullition fluxes occurred in alpine meadows (2.5 +/- 5.3 mmol m(-2) d(-1); 8.2 +/- 20.6 mmol m(-2) d(-1)), followed by alpine steppes (0.6 +/- 5.3 mmol m(-2) d(-1); 0.7 +/- 10.8 mmol m(-2) d(-1)) and desert steppes (0.2 +/- 0.2 mmol m(-2) d(-1); 0.6 +/- 0.8 mmol m(-2) d(-1)). The organic matter contents in water and sediment were found to be important factors influencing the seasonal variations in CH_4 diffusion fluxes. However, the ebullition CH_4 fluxes did not show a clear seasonal variation pattern. Our findings highlight the importance of considering the large spatiotemporal variations in ebullition CH_4 fluxes to improve the accuracy of large-scale estimations of CH_4 fluxes in thermokarst lakes on the TP. Greater insight into these aspects will increase the understanding of CH_4 dynamics in thermokarst lakes on the TP, which is essential for forecasting and climate impact assessments and to better constrain feedback to climate warming.

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Both pH and salinity shape the microbial communities of the lakes in Badain Jaran Desert, NW China

Banda, Joseph Frazer; Zhang, Qin; Ma, Linqiang;等

Badain Jaran Desert (BJD), characterized by extremely arid climate and tallest sand dunes in the world, is the second largest desert in China. Surprisingly, there are a large number of permanent lakes in this desert. At present, little is known about the composition and distribution of microbial communities in these desert lakes, which are an important bioresource and play a fundamental role in the elemental cycles of the lakes. In this study, the physicochemical characteristics and microbial communities of water samples from 15 lakes in BJD were comparatively investigated. The results showed that the lakes were rich in Na+, Cl-, CO32- and HCO3- while Ca2+ and Mg2+ were scarce, with pH 8.52-10.27 and salinity 1.05-478.70 g/L. Bacteria dominated exclusively in low saline lakes (salinity < 50 g/L) while archaea were predominant in hypersaline lakes (salinity > 250 g/L), which abundance increased along salinity gradient linearly. Genera Flavobacterium, Synechocystis and Roseobacter from phyla Bacteroidetes, Cyanobacteria, Alphaproteobacteria were the major members in low saline lakes whereas Halomonas,Aliidiomarina and Halopelagius from Gammaproteobacteria and Euryarchaeota were abundant in moderately saline lakes (salinity 50-250 g/L). The hypersaline lakes were predominated by

extreme halophiles such as Halorubrum, Halohasta and Natronomonas from Euryarchaeota. The correlation among the microbes in the lakes was mainly positive, suggesting they can survive in the harsh environments through synergistic interactions. Statistical analyses indicated that physicochemical characteristics rather than spatial factors shaped the microbial communities in the desert lakes. The pH was the most important environmental factor controlling alpha diversity, while salinity was the major driver determining microbial community structure in BJD lakes. In contrast, geographic factors had no significant impact on the microbial community compositions.

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Chronological records of sediment organic carbon at an entrance of Dongting Lake: Response to historical meteorological events

Ran, Fengwei; Nie, Xiaodong; Li, Zhongwu;等

Lake sediments are the products of soil erosion and are strongly influenced by climate variability, particularly extreme meteorological events. Sediment organic carbon (SOC) can reflect environmental changes that affect sediment transport. However, the response of SOC chronological records to major meteorological events is relatively unknown. This study explored the chronological regularity of SOC and verified its variations using major historical meteorological events. Based on three sediment profiles with a depth of 230 cm at the Yuan River entrance to the West Dongting Lake (Hanshou entrance), the SOC chronology was reconstructed by employing the sedimentation rates calculated by Cs-137 and Pb-210. The sedimentary environment then was interpreted via comparisons and quantitative analysis. The grain distribution and the S-shaped distribution of SOC reflected the general deposition regularity of organic carbon in lake sediments, which gradually stabilized with depth. The average sedimentation rates based on Cs-137 and Pb-210 were 1.310 and 1.319 cm a(-1), respectively. Accordingly, SOC records covered the past 76 years via dating (0-100 cm), during which the SOC content first increased and subsequently stabilized. By comparing the data with the occurrence of 11 major historical meteorological events, we found that SOC generally increased after these events. Moreover, the frequent occurrence of meteorological events stabilized the SOC content. Severe floods had a greater impact on SOC content than severe droughts, causing SOC to change by up to 20.24% and 8.77%, respectively. Our findings suggest that major historical meteorological events can verify SOC chronological records, thereby highlighting their significant impacts on organic carbon variations in sediments.

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Spatial differentiation identification of influencing factors of agricultural carbon productivity at city level in Taihu lake basin, China

Xiong, Chuanhe; Wang, Guiling; Xu, Liting

Improving carbon productivity is the main way to deal with climate change under China's targets for carbon emissions to peak by 2030 and carbon neutrality by 2060. This study identified the spatial differentiation of influencing factors of agricultural carbon productivity at the city level in Taihu lake basin, and formed differentiated agricultural management strategies. The results show that: (1) Spatial differentiation of agricultural carbon productivity is obvious at city level. It can be divided into three echelons: the first echelon is Shanghai and Hangzhou (agricultural carbon productivity>_10,000 Yuan/t in 2019 with a growth rate >_ 600% compared with 1992), the second echelon is Suzhou, Wuxi and Changzhou (9000 Yuan/t <_ agricultural carbon productivity<10,000 Yuan/t in 2019 with 381% <_ growth

rate < 600% compared with 1992), and the third echelon is Zhenjiang, Huzhou and Jiaxing (agricultural carbon productivity<9000 Yuan/t in 2019 or a growth rate < 381% compared with 1992). (2) There is a synergetic evolution law between agricultural carbon productivity and agricultural economy, that is, agricultural economic development level is the first factor affecting agricultural carbon productivity, whether in the whole basin or in the city level. (3) There are significant differences in the influencing factors of agricultural carbon productivity at the city level. Finally, according to the spatial differentiation characteristics of influencing factors of agricultural carbon productivity at the city level in Taihu lake basin, we put forward different emphases of agricultural development in different cities.

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Enhancing the retention of phosphorus through bacterial oxidation of iron or sulfide in the eutrophic sediments of Lake Taihu

Fan, Xianfang; Xing, Xigang; Ding, Shiming

Microbial activity can enhance the sequestration of phosphorus (P) in sediments, but little is known about the mechanisms behind it. In this study, sediment cores were sampled from the most eutrophic Meiliang Bay of Lake Taihu, and three treatments were set up in a laboratory incubation experiment, involving (a) the non treated sediment cores, (b) inoculation, and (c) sterilization. The dissolved and labile iron (Fe) and P were obtained by high-resolution dialysis and the diffusive gradients in thin films (DGT) technique, respectively. AgI-based DGT was used for measuring the 2D distribution of labile sulfide. The bacterial community was investigated using a scanning electron microscope and 16S rRNA high throughput sequencing technique. The results showed that sterilization reduced the capacity of sediment to immobilize P, and that the critical sediment depth layer for microbial P sequestration was 0-10 mm. In addition, sterilization or inoculation significantly changes the structure of bacterial communities. Fe or S oxidation under micro-aerobic or anaerobic conditions played an important role in bacterial retention of P in the sediments. Nitrate-reducing coupling Fe(II)-oxidizing bacteria (Acidovorax) in the inoculated sediment and electrogenic sulfur-oxidizing bacteria (Candidatus Electronema) in the non-treated sediment were identified as the key bacterial genera responsible for the retention of P in sediments. This implies that bacterial communities could quickly establish the ability for negative feedback regulation by inoculation once the function and structure of indigenous sediment bacteria are seriously impaired, although this needs further validation in the field.

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Occurrence and risk assessment of pharmaceuticals and personal care products (PPCPs) against COVID-19 in lakes and WWTP-river-estuary system in Wuhan, China

Chen, Xiangping; Lei, Lei; Liu, Sitian;等

The consumption of pharmaceuticals and personal care products (PPCPs) for controlling and preventing the COVID-19 would have sharply increased during the pandemic. To evaluate their post-pandemic environmental impacts, five categories of drugs were detected in lakes and WWTP-river-estuary system near hospitals of Jinyintan, Huoshenshan and Leishenshan in the three regions (J, H and L) (Regions J, H and L) in Wuhan, China. The total amount of PPCPs (ranging from 2.61 to 1122 ng/L in water and 0.11 to 164 ng/g dry weight in sediments) were comparable to historical reports in Yangtze River basin, whereas the detection frequency and concentrations of ribavirin and azithromycin were higher than those

of historical studies. The distribution of concerned drugs varied with space, season, media and water types: sampling sites located at WWTPs-river-estuary system around two hospitals (Regions L and J) usually had relatively high waterborne contamination levels, most of which declined in autumn; lakes had relatively low waterborne contamination levels in summer but increased in autumn. The potential risks of detected PPCPs were further evaluated using the multiple-level ecological risk assessment (MLERA): sulfamethoxazole and azithromycin were found to pose potential risks to aquatic organisms according to a semi-probabilistic approach and classified as priority pollutants based on an optimized risk assessment. In general, the COVID-19 pandemic did not cause serious pollution in lakes and WWTPs-river estuary system in Wuhan City. However, the increased occurrence of certain drugs and their potential ecological risks need further attention. A strict source control policy and an advanced monitoring and risk warning system for emergency response and long-term risk control of PPCPs is urgent.

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Effects of ecological protection and restoration on phytoplankton diversity in impounded lakes along the eastern route of China's South-to-North Water Diversion Project

Zhang, Xiaojing; Wang, Guoqiang; Tan, Zhongxin;等.

Traditional lake phytoplankton diversity studies do not take into account the impact of ecological protection and restoration project policies. Here, a difference-in-differences (DID) model, which is commonly used to analyze the relative importance of economic factors, was used to evaluate the impact of such policies on phytoplankton diversity in lakes. Dongping Lake was used as the experimental group, and the upstream Nansi Lake was used as the control group. The phytoplankton diversity index of the experimental group and the control group was used as the explanatory variable of the DID model. Six environmental and socioeconomic factors, temperature and precipitation, were used as control variables in the DID model. The effects of ecological protection and restoration project policy on phytoplankton diversity in lakes were analyzed. Under the influence of policy implementation, the phytoplankton diversity in the experimental lake was improved by 2.79% compared with that in the control lake. Temperature and precipitation were the main factors affecting phytoplankton diversity in the two connected shallow lakes in the Shandong Peninsula. This study verified that DID models can be used to quantitatively analyze the impact of ecological protection and restoration project policies on phytoplankton diversity in lakes.

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Systematic evaluation of management measure effects on the water environment based on the DPSIR-Tapio decoupling model: A case study in the Chaohu Lake watershed, China

Duan, Tingting; Feng, Jiashen; Zhou, Yanqing;等

Watershed management measures have been widely implemented worldwide to reduce the water quality deterioration in rivers and lakes, which continue to face increasing stresses from human activities. Due to the complexity of influential factors within watersheds, systematic and reliable approaches are urgently needed to evaluate the effects of watershed managerial practices on scientific applications. In this study, the driving force-pressure-state-impact-response (DPSIR) model integrated by Tapio decoupling analysis was established using 30 quantitative indicators to systematically evaluate their effects on overall

watershed water environmental health of Chaohu Lake watershed, China, which was under intensive management practices during 2000-2019. The DPSIR model outcomes revealed that the driving force subsystem with 7 indictors accounted for 34.2% of the watershed water environmental health, in which gross domestic product (GDP), gross industrial output value, crop planting and urbanization contributed a larger proportion. Management measure implementation positively improved the watershed water environmental health, with the second largest proportion being 23.4%. During the study period, a trend of simultaneous improvement in the water quality of the rivers and lakes existed. The Tapio decoupling analysis indicated that watershed water quality was weakly decoupled with socioeconomic development and related pressures, and management responses. The response strategy is the main force in alleviating the pressure from socioeconomic development on the watershed water quality. Overall, the method proposed in this study would improve the understanding of watershed management practice effects and provide guidance for future management measure applications.

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Effects of iron-carbon materials on microbial-catalyzed reductive dechlorination of polychlorinated biphenyls in Taihu Lake sediment microcosms: Enhanced chlorine removal, detoxification and shifts of microbial community

Xu, Yan; Tang, Yanqiang; Xu, Lei;等.

Nano zero-valent iron particles (nZVI, 0.09 wt%), micro zero-valent iron particles (mZVI, 0.09 wt%), granular activated carbon (GAC, 3.03 wt%), GAC supported nZVI (nZVI/GAC, 3.12 wt%) and nZVI&GAC (nZVI 0.09 wt%, GAC 3.03 wt%) were evaluated for their effects on polychlorinated biphenyls (PCBs) anaerobic reductive dechlorination, detoxification, as well as microbial community structure in Taihu Lake (China) sediment microcosms. The results showed that all of these five materials could stimulate PCBs reductive dechlorination, especially for dioxin-like PCB congeners, and nZVI&GAC had the best removal effect on PCBs. The reduction of total PCBs increased from 13.5% to 33.2%. H-2 generated by zero-valent iron corrosion was utilized by organohalide-respiring bacteria (OHRB) to enhance the dechlorination of PCBs predominantly via mew chlorine removal in the short term. The addition of ZVI had little impact on the total bacterial abundance and the microbial community structure. The adsorption of GAC and potential bioremediation properties of attached biofilm could promote the long-term removal of PCBs. GAC, nZVI/GAC, nZVI&GAC had different influences on the microbial structure. These findings provide insights into the biostimulation technique for in situ remediations of PCBs contaminated sediments.

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Remote sensing of brine shrimp cysts in salt lakes

Qi, Lin; Yao, Yao; English, David E.; 等

Using laboratory and field experiments as well as spectral analysis of satellite images, we demonstrate that surface aggregations of brine shrimp (Artemia) cysts (BSC) in salt lakes can be identified unambiguously in satellite imagery. This is because of the unique reflectance spectral shapes of the BSC image slicks, where a sharp and monotonic increase in reflectance is found at wavelengths >550 nm and two inflection points are found around similar to 550 nm and similar to 650 nm. Such spectral characteristics differentiate BSC slicks from other floating matters. Based on this principle, a deep

learning model is developed to extract BSC features from MERIS (Medium Resolution Imaging Spectrometer, 2002-2012) and OLCI (Ocean and Land Color Instrument, 2016 - present) satellite images to quantify BSC abundance, spatial distribution patterns, and their temporal changes in the Great Salt Lake (GSL), the world's largest contributor of BSC commercial products. A clear seasonality is found in BSC abundance, with the primary peak in April - May and secondary peak in October - November. The two peaks may be explained by food availability to brine shrimp. The inter-annual variability and the recent increasing trend in BSC abundance, on the other hand, are difficult to explain by fluctuations in wind, temperature, or salinity, while recent increase in commercial harvest does not appear to be associated with the variability in BSC abundance estimated by satellites. Because many salt lakes around the world, for example the Aral Sea, Lake Urmia, and the Dead Sea, also show BSC slicks in satellite imagery, this study suggests that it is possible to perform a systematic evaluation of BSC abundance and possibly brine shrimp populations in all major salt lakes, especially under a changing climate and increased human activities.

（来源：REMOTE SENSING OF ENVIRONMENT 卷:266 出版年: 2021, **DOI:** 10.1016/j.rse.2021.112695）

Satellite estimation of dissolved organic carbon in eutrophic Lake Taihu, China

Liu, Dong; Yu, Shujie; Xiao, Qitao;等.

Dissolved organic carbon (DOC) in lakes serves as a substrate for heterotrophic bacterial growth, a regulator of the global carbon cycle, and a light absorption agent. DOC in eutrophic lakes is greatly influenced by phytoplankton phenology and terrigenous input by rivers. Therefore, it is necessary and significant to dynamically monitor the concentration, storage, and riverine exchange flux of DOC. By using in-situ DOC measurements from 2004 until 2018 (N = 2019), a machine learning algorithm, namely, a multilayer back-propagation neural network (MBPNN) model, was developed in this work to improve the remote sensing estimation of DOC concentrations in eutrophic Lake Taihu. The model yielded a mean estimation error of 15.14% for the testing dataset. The monthly mean DOC concentration significantly increased from 2003 to 2018 (N = 192, $p < 0.01$). High DOCs were observed in lake bays with high chlorophyll a (Chl-a) levels, and phytoplankton growth explained more than 50% of the monthly DOC variations. Then, given the evenly mixed DOC in the water column on the monthly and annual scales, we further estimated the monthly mean DOC storage in the lake from 2003 until 2018 and DOC fluxes (input and output) due to rivers during 2008-2018. Although the mean net riverine DOC input (50.56 +/- 32.22 x 10(3) t C) was approximately 5.2 times the average DOC storage (9.73 +/- 1.23 x 10(3) t C), phytoplankton growth controlled DOC variations, which indicated that much terrigenous DOC was transformed into other carbon forms after entering Lake Taihu. This study verified the feasibility of remote sensing of DOC (surface concentration, storage, and riverine exchange flux) in eutrophic lakes.

（来源：REMOTE SENSING OF ENVIRONMENT 卷:264 出版年: 2021, **DOI:** 10.1016/j.rse.2021.112572）

50 years of lake ice research from active microwave remote sensing: Progress and prospects

Murfitt, Justin; Duguay, Claude R.等.

Lake ice is an important feature of the physical landscape at northern latitudes. Not only does the presence of lake ice help modulate weather and climate but it also plays an important role in travel between northern communities. Furthermore, the thickness of ice cover can impact overwintering fish

habitat and access to fresh water during winter months. Lake ice cover and lake ice thickness are two notable climate proxies identified by the Global Climate Observing System (GCOS) as Essential Climate Variables (ECVs). Changes in ice thickness can impact lakes freezing to bed which in turn affect permafrost thaw while longer periods of open water can impact heat transfer to the atmosphere. With recent climate warming in the Northern Hemisphere, there are general trends towards thinner ice and an increase in the length of the open water season. However, the paucity of in-situ observations in many countries has led to remote sensing playing an ever-increasing role for lake ice monitoring. This paper reviews progress in lake ice research conducted using active microwave remote sensing over the last 50 years and highlights areas where future developments are needed. Analysis of the literature found that the diversity of study areas where this work is taking place has increased, incorporating more lake sites from the midlatitudes in North America, Europe, and Asia. Additionally, clear connections can be made between the launch of synthetic aperture radar (SAR) satellites and patterns in the use of certain radar frequencies in scientific studies. This review also discusses evolving theories concerning the scattering mechanisms associated with lake ice as well as the current state of lake ice cover and ice thickness retrieval methods. The paper concludes with a suite of recommendations for future research, highlighting work that is needed on: 1) advancing our understanding of the response of active microwave signals to lake ice properties; 2) applying machine learning algorithms to lake ice classification; 3) further exploring the retrieval of ice thickness from imaging SAR and radar altimetry data; and 4) other considerations such as data availability and the topic of snow on lake ice.

（来源：REMOTE SENSING OF ENVIRONMENT 卷:264 出版年: 2021, **DOI:** 10.1016/j.rse.2021.112616）

Periphyton responses to nitrogen decline and warming in eutrophic shallow lake mesocosms

Pacheco, Juan Pablo; Aznarez, Celina; Levi, Eti Ester;等.

Periphyton is a key primary producer in shallow lakes, sensitive to global warming and changes in nutrient balances. Reduced nitrogen availability due to accelerated denitrification at higher temperatures or in response to reduced N loadings aimed to reduce the eutrophication may affect periphyton biomass and composition, to compensate for the low N availability (e.g. promoting N-2-fixing). We analysed periphyton responses to N decline in 12 eutrophic shallow lake mesocosms during one year of low N compared to high N, under three temperature scenarios: ambient, A2 IPCC scenario and A2 increased by 50%. We used two submerged macrophytes (Potamogeton crispus and Elodea canadensis) and artificial imitations of these as substrates for periphyton growth. Nitrogen decline increased periphyton biomass and induced compositional changes irrespective of season, plant type, and temperature. Periphyton biomass was negatively associated to phytoplankton and positively to plant complexity. Warmer scenarios negatively affected periphyton exclusively at high N loadings. Low N conditions were associated with lower periphyton taxonomic richness, lower N-2-fixing cyanobacteria biovolume and increased biovolume of large-sized chlorophytes and non-N-2-fixing cyanobacteria. Our results suggest that low N conditions promoted periphyton due to a more efficient use of nutrients and improved light conditions resulting from lower phytoplankton biomass and contrasting effects of temperature.

（来源：HYDROBIOLOGIAY 出版年: 2021, **DOI:** 10.1007/s10750-021-04755-y）

Carbon fluxes in subtropical shallow lakes: contrasting regimes differ in CH4 emissions

Colina, Maite; Kosten, Sarian; Silvera, Nicolas; 等

Fluxes of carbon dioxide (CO2) and methane (CH4) in shallow lakes are strongly affected by dominant primary producers which mostly has been studied in temperate and boreal regions. We compared summer CO2 and CH4 fluxes (diffusion and ebullition) in littoral and pelagic zones of three subtropical shallow lakes with contrasting regimes: clear-vegetated, phytoplankton-turbid, and sediment-turbid, and assessed fluxes in different seasons in the clear-vegetated system. Significant differences among the lakes occurred only for CH4 fluxes. In the sediment-turbid lake we found undersaturated CH4 concentrations were below atmospheric equilibrium, implying CH4 uptake (< 0 mg m(-2) day(-1)), likely due to low availability of organic matter. Differences between zones occurred in the clear-vegetated and phytoplankton-turbid lakes, with higher total CH4 emissions in the littoral than in the pelagic zones (mean: 4342 +/- 895 and 983 +/- 801 mg m(-2) day(-1), respectively). CO2 uptake (< < 0 mg m(-2) day(-1)) occurred in the littoral of the phytoplankton-turbid lake (in summer), and in the pelagic of the clear-vegetated lake even in winter, likely associated with submerged macrophytes dominance. Our work highlights the key role of different primary producers regulating carbon fluxes in shallow lakes and points out that, also in the subtropics, submerged macrophyte dominance may decrease carbon emissions to the atmosphere.

（来源：HYDROBIOLOGIAY 出版年: 2021, **DOI:** 10.1007/s10750-021-04752-1）

Invasive plant mats promoted the decomposition of native leaf litter by micro-, meio-, and macroinvertebrates in an eutrophic freshwater lake in the Three Gorges Reservoir area, China

Chen, Shaojun; Xiao, Hongyan; Xie, Xiaohua;等.

To investigate the effect of invasive Alternanthera philoxeroides mats on native leaf litter decomposition, we allocated two native leaf species of contrasting recalcitrance (Neosinocalamus affinis and Ficus virens) in litterbags with four different mesh sizes (0.025, 0.042, 0.5, and 5 mm) and the bags were either incubated under floating A. philoxeroides mats (Vegetated site) or under floating plastic foam boards without A. philoxeroides mats (Unvegetated site) for 65 days in Jianhu Lake, China, in July 2020. The average decomposition rates increased with pore size of litterbags. The interaction intensity of the site effect in leaf mass loss was negative in 0.025 mesh and positive in other meshes, while no significance existed between two native species in the same mesh sizes and sites. The contribution of microbes to decomposition was more than 50% in both sites. The contribution in the vegetation site was as follows: microbes > microinvertebrates > meioinvertebrates > macroinvertebrates, compared with microbes > macroinvertebrates > meioinvertebrates > microinvertebrates in the unvegetated site. The results suggest that A. philoxeroides mats can promote the decomposition of native leaf litter, and that the roles of micro-, meio-, and macroinvertebrates in decomposition are important but underestimated.

（来源：HYDROBIOLOGIAY 出版年: 2021, **DOI:** 10.1007/s10750-021-04721-8）

Depth-specific benthic specialization of Arctic char in an oligotrophic subarctic lake

Fournier, Eli B.; Schindler, Daniel E..

Fishes consume prey from across both benthic and pelagic habitats, thereby stabilizing the food webs of freshwater lakes. How fish exploit vertical and horizontal heterogeneity within the benthic environment, however, remains unclear. We characterized spatial variation in the C and N stable isotopes of a dominant benthic grazer (snails) along a water depth gradient in an oligotrophic, western Alaska lake to assess the effects of water depth on isotope characteristics in the benthic food web. Importantly, carbon stable isotopes in snails become substantially more depleted in C-13 with increasing water depth. We compared this distribution of snail isotope values to those found in Arctic char (Salvelinus alpinus) diets to estimate the vertical location of char foraging on benthic resources. We found that Arctic char tended to prey on snails at greater than 10 m depth; however, individual fish specialized at a narrower range of water depths spanning from 5 to > 20 m. We used an isotope mixing model to assess the validity of using only shallow-water benthic invertebrates to represent all benthic resources in food web reconstructions and found that mixing models that only used shallow benthic prey underestimated the importance of benthic resources by about 50%. These results can help refine our understanding of how benthic prey contribute to the stability of aquatic food webs and highlight the need to account for spatial variation in the isotope composition of benthic resources in models of lake food webs.

（来源：AQUATIC SCIENCES 卷:83 期:4 出版年: 2021, **DOI:** 10.1007/s00027-021-00827-2）

Spatial variation of diatom diversity with water depth at Huguang Maar Lake, Southern China

Li, Jingjing; Wang, Luo; Zou, Yafei; 等

An investigation of changes in lake diatom assemblages and diversity with water depth can help determine whether the biodiversity of a single sediment core is representative of that of the entire lake, as well as can improve our understanding of the relationship between diatom assemblages and water depth. In this study, Huguang Maar Lake in Southern China was investigated in order to explore the spatial patterns of diatom diversity and diatom assemblages of 95 surface sediment samples from different locations and depth zones within the lake. The results show an essentially constant diatom diversity, dominated by planktonic diatoms, in the open deep water zone (OD), and consistent diatom diversity in the northern gently-sloping shallow water zone (NS). However, there is a much higher diatom diversity in different microhabitats in the southern and western shallow water zone (SWS), where the bathymetry is much steeper. This difference may reflect the influence of the bathymetry on the occurrence of sediment slumping. In the steeply-sloping SWS zone, frequently influenced by wave action and sediment slumping, diatom diversity is less representative of that of the entire lake, possibly due to the presence of diatoms from different sources and of different depositional ages. The results indicate that for relatively strongly mixed lakes with a simple morphometry, water depth has little influence on diatom diversity; however, the possible influence of local lake basin topography should be considered when reconstructing past diatom diversity changes from sediment cores.

（来源：JOURNAL OF PALEOLIMNOLOGY 出版年: 2021, **DOI:** 10.1007/s10933-021-00218-5）

Cold fronts induce changes in phycoperiphyton structure in a shallow lake: Wind forces drive algae succession and nutrient availability

de Faria, Denise Matias; Cardoso, Luciana de Souza; Marques, David Motta

We evaluated wind as the main structuring force in driving phycoperiphyton structure, community composition and succession in a warm, polymictic shallow lake in southern Brazil. Mangueira Lake is continuously mixed due to its exposure to wind, and during cold fronts the wind changes from the dominant NE direction to a SSW direction. Our question was: could changes in wind forces induce phycoperiphyton succession and determine population structure? To answer this question, we studied the phycoperiphyton successional response to a change in wind forces under three different situations: on clean macrophyte leaves in an open site (Open) and in an enclosed site protected from the wind (Enclosure), and the Natural community growing on uncleaned macrophyte leaves in an open site. Cold fronts improved nutrient availability and changed the algal community. The phycoperiphyton natural community was dominated by Epithemia spp bound in gross masses of green filaments during cold fronts. However, the wind direction typically changes when cold fronts are over (NE-E) and wind blowing from the off-shore direction dislodged the attached algae biomass and pushed it toward to lake shore, inducing community changes. The macrophyte bank exhibited rapid colonization and acted as a refuge for phycoperiphyton, providing habitat heterogeneity, whereas the enclosure acted as a buffer against wind forces, delaying the succession derived from settlement of loosely adhered algae. Furthermore, in the enclosure, the succession only started after a strong disturbance (rain and wind > 10 m s(-1)) in which lake water flooded the mesocosm inducing colonization. Phycoperiphyton showed resilience and recovered rapidly after the disturbance, when the rain supplied inocula and wind favored colonization with growth forms that take advantage of local conditions, depending of wind dynamics.

（来源：LIMNOLOGICA 卷:91 出版年: 2021, **DOI:** 10.1016/j.limno.2021.125926）

Impacts of climate change on groundwater in the Great Lakes Basin: A review

Costa, Diogo; Zhang, Helen; Levison, Jana

Climate change has the potential to alter the physical and chemical properties of water in the Great Lakes Basin, in turn impacting ecological function. This study synthesizes existing research associated with the potential effects of a changing climate on the quality and quantity of groundwater in the Great Lakes Basin. It includes analyses of impacts on (1) recharge, (2) groundwater storage, (3) discharge and groundwater-surface water (GW-SW) interactions, (4) exacerbating future urban development impacts on groundwater, (5) groundwater quality, and (6) ecohydrology. Large spatial and temporal (i.e., seasonal) variability in groundwater response to climate change between regions is anticipated. Most studies combine field observations with modelling, but many have focused only on small/medium basins. At these small scales, groundwater systems are generally projected to be fairly resilient to climate change impacts. However, modelling studies of larger basins (e.g., Grand River, Saginaw Bay, Maumee River) predict an increase in groundwater storage. Uncertainty in model simulations, particularly from climate models that are used to force hydrological models, is a major challenge. There have been too few studies to date that investigate the interplay of climate change and groundwater quality in the Great Lakes Basin to draw conclusions about future groundwater quality and ecohydrology. A summary of methods, models, and technology is provided. Model uncertainty has become an increasingly important topic and is also discussed. The study concludes with a synthesis of the main science needs to understand groundwater impacts in order to adapt to a changing climate in the Great Lakes Basin.

（来源：JOURNAL OF GREAT LAKES RESEARCH 卷:47 期:6 出版年: 2021, **DOI:** 10.1016/j.jglr.2021.10.011）

Distribution, abundance and spatial variability of microplastic pollution on the surface of Lake Superior

Cox, Kara; Brocious, Emily; Courtenay, Simon C.;等.

In 2014, 94 paired neuston net samples (0.5 mm mesh) were collected from the surface waters of Lake Superior. These samples comprise the most comprehensive surface water survey for microplastics of any of the Great Lakes to date, and the first to employ double net trawls. Microplastic abundance estimates showed wide variability, ranging between 4000 to more than 100,000 particles/km(2) with most locations having abundances between 20,000 to 50,000 particles/km(2). The average abundance in Lake Superior was similar to 30,000 particles/km(2) which was similar to previous estimates within this Laurentian Great Lake and suggests a total count of more than 2.4 billion (1.7 to 3.3 billion, 95% confidence interval) particles across the lake's surface. Distributions of plastic particles, characterized by size fraction and type, differed between nearshore and offshore samples, and between samples collected in the eastern versus western portion of the lake. Most of the particles found were fibers (67%), and most (62%) were contained in the smallest classified size fraction (0.50-1 mm). The most common type of polymer found was polyethylene (51%), followed by polypropylene (19%). This is consistent with global plastics production and results obtained from other studies. No statistically significant difference was detected between the paired net samples, indicating that single net sampling should produce a representative estimate of microplastic particle abundance and distribution within a body of water.

（来源：AQUATIC SCIENCES 卷:83 期:4 出版年: 2021, **DOI:** 10.1007/s00027-021-00827-2）

Cold and wet: Diatoms dominate the phytoplankton community during a year of anomalous weather in a Great Lakes estuary

Mancuso, Jasmine L.; Weinke, Anthony D.; Stone, Ian P.;等

As sentinels of climate change and other anthropogenic forces, freshwater lakes are experiencing ecosystem disruptions at every level of the food web, beginning with the phytoplankton, a highly respon-sive group of organisms. Most studies regarding the effects of climate change on phytoplankton focus on a potential scenario in which temperatures continuously increase and droughts intersperse heavy precip-itation events. Like much of the conterminous United States in 2019, the Muskegon River watershed (Michigan, USA) experienced record-breaking rainfall accompanied by unusually cool temperatures, affording an opportunity to explore how an alternate potential climate scenario may affect phytoplank-ton. We conducted biweekly sampling of environmental variables and phytoplankton in Muskegon Lake, a Great Lakes Area of Concern that connects to Lake Michigan. We compared environmental variables in 2019 to the previous eight years using long-term data from the Muskegon Lake Observatory buoy, and annual monitoring excursions provided historical phytoplankton data. Under cold and wet conditions, diatoms were the single dominant division throughout the entire growth season - an unprecedented sce-nario in Muskegon Lake. In 10 of the 13 biweekly sampling days in 2019, diatoms comprised over 75% of the phytoplankton community in the lake by count, indicating that the spring diatom bloom persisted through the fall. Additionally, phytoplankton seasonal succession and abundance patterns typically seen in this lake were absent. In a world experiencing reduced predictability, increased variability, and regio-nal climate anomalies, studying periods of extreme weather events may offer insight into how natural systems will be affected and respond under future climate scenarios.

（来源：JOURNAL OF GREAT LAKES RESEARCH 卷:47 期:5 出版年: 2021, **DOI:** 10.1016/j.jglr.2021.07.003）

Do rusty crayfish (Faxonius rusticus) invasions affect water clarity in north temperate lakes?

Szydlowski, Daniel K.; Daniels, Melissa K.; Larson, Eric R.

Invasive crayfish can cause shifts in lakes from clear, macrophyte-dominated states to eutrophic, phytoplankton-dominated states because of their burrowing and foraging behavior. While invasive crayfish populations have been linked to declines in water clarity of shallow lakes and wetlands in Asia and Europe, little research has been done on the potential for similar effects of invasive rusty crayfish (Faxonius rusticus) in large temperate lakes of the Midwestern USA. We related F. rusticus abundance in 17 lakes of northern Wisconsin, USA over time (1984-2018) to measures of lake clarity (chlorophyll a concentration and Secchi disc depth) estimated from remote sensing (Landsat imagery). Contrary to the effects of invasive crayfish in other study systems, we found a weak, positive association between F. rusticus abundance and water clarity. We propose that lake clarity may increase if declines in small fishes caused by F. rusticus lead to population growth of zooplankton and consequent decreases in phytoplankton through a trophic cascade. Alternatively, F. rusticus could be passengers to, rather than drivers of, lake clarity trends, responding positively to increased littoral benthic productivity when lakes are clearer. Future research should aim to determine if F. rusticus causes or responds to changes in water clarity, but should also investigate the impacts of crayfish invasions on water clarity across a greater variety of lentic ecosystems.

（来源：LIMNOLOGY 出版年: 2021, **DOI:** 10.1007/s10201-021-00683-x）

Rainfall and drainage basin shape strongly control temporal and spatial variation of dissolved organic matter in a tropical lake

Mello Brandao, Luciana Pena; Staehr, Peter Anton; Brighenti, Ludmila Silva;等.

Dissolved organic matter (DOM) is a central driver of many processes in aquatic environments. Here, we address the issue of spatial and temporal variations in DOM quantity and quality in a deep tropical lake (Brazil). We measure DOC, Chl-a, suspended solids, nutrients and CDOM metrics in surface water samples taken from 21 sampling sites during six campaigns, and we quantify their links with water depth and rainfall estimates. Temporal effects explain between 74.5 and 94.5% of the variance in DOC, SUVA(254), a(CDOM440), and Chl-a, and all those parameters were influenced by rainfall. In contrast, spatial variations affect more S275-295 and a(CDOM254). The contributing drainage area varies spatially in morphology and geometry, and each portion affects a specific part of the lake, resulting in a spatial variation in DOM quantity and quality. Our findings demonstrate the importance of the input of allochthonous DOM (which depends on seasonal rainfall and drainage area shape) to DOM dynamics in a tropical lake. The study area is receiving lower rates of precipitation in recent times, and our results suggest that this may alter the seasonal patterns of input of DOM and nutrients in the lake, with possible impacts on water quality, aquatic biota and ecosystem functioning.

（来源：LIMNOLOGY 出版年: 2021, **DOI:** 10.1007/s10201-021-00684-w）

A combined GIS-MCDA approach to prioritize stream water quality interventions, based on the contamination risk and intervention complexity

Fernandes, ACP; Terencio, DPS; Pacheco, FAL; 等

Water management decisions are complex ever since they are dependent on adopted politics, social objectives, environmental impacts, and economic determinants. To adequately address hydric resources issues, it is crucial to rely on scientific data and models guiding decision-makers. The present study brings a new methodology, consisting of a combined GIS-MCDA, to prioritize catchments that require environmental interventions to improve surface water quality. A Portuguese catchment, Ave River Basin, was selected to test this methodology due to the low water quality. First, it was calculated the contamination risk of each catchment, based on a GIS-MCDA using point source pressures, landscape metrics, and diffuse emissions as criteria. This analysis was compared to local data of ecological and chemical status through ANOVA and the Tukey test. The results showed the efficiency of the method since the contamination risk was lower for catchments under a good status and higher in catchments with a lower classification. In a second task, it was calculated the intervention complexity using a different GIS-MCDA. For this approach, it was chosen five criteria that condition environmental interventions, population density, slope, percentage of burned areas, Strahler order, and the number of effluent discharge sites. Both multicriteria methods were combined in a graphical analysis to rank the catchments intervention priority, subdividing the prioritization into four categories from 1st to 4th' giving a higher preference for catchments with high contamination risk and low intervention complexity. As a result, catchments with a good status were dominantly placed under low intervention priority, and catchments with a lower ecological status were classified as a high priority, 1st and 2nd. In total, 248 catchments were spatially ranked, which is an essential finding for decision-makers, that are willing to safeguard the catchment water quality.

（来源：SCIENCE OF THE TOTAL ENVIRONMENT 卷:798 出版年: 2021, **DOI:** 10.1016/j.scitotenv.2021. 149322）

Carbon footprint and embodied carbon transfer at the provincial level of the Yellow River Basin

Yuan, XL; Sheng, XR; Chen, LP; 等

The ecological conservation and high-quality development of China's Yellow River Basin is a national strategy pro-posed in 2019. Under China's goal of achieving a carbon peak by 2030 and carbon neutrality by 2060, clarifying the carbon footprint of each province and the transfer paths of embodied carbon emissions is crucial to the carbon reduc-tion strategy for this region. This paper uses input-output model and multi-regional input-output model to account for the carbon footprint of nine provinces in the Yellow River Basin, and to estimate the amount of embodied carbon transfer between provinces and industrial sectors. Social network analysis is applied to identify the critical industries in the inter-provincial embodied carbon emission transfers from the three major industries. We found that the per capita carbon footprint of the Yellow River Basin decreased by 23.4% in 2017 compared to 2012. Among the sectoral composition of the carbon footprint of each province, Processing and manufacturing of petroleum, coking, nuclear fuel, and chemical products, Construction, Other services, and Metal processing and metal, non-metallic prod-ucts are the four sectors with a higher proportion of emissions. The embodied carbon emission transfer between the provinces in middle and lower reaches of the Yellow River Basin is much

higher than that between the upstream provinces. Among carbon emission transfer network of three major industries in nine provinces,the secondary in-dustry in Shaanxi has the highest centrality and is the most critical industry. This study provides a theoretical basis and data support for formulating carbon emission reduction plans in the Yellow River Basin.

（来源：SCIENCE OF THE TOTAL ENVIRONMENT 卷: 803 出版年: 2022 **DOI:**10.1016/j.scitotenv.2021.149993）

Past variations and future projection of runoff in typical basins in 10 water zones, China

Guan, XX; Zhang, JY; Bao, ZX; 等

Understanding the historical and future changing characteristics of key climatic variables and runoff in 10 major river zones in China is essential for water resources evaluation and management. To this end, the historical and future changing trends of key hydrometeorological variables, including precipitation, potential evapotranspiration, and runoff were analyzed in detail for each water zone across China. The climate elasticity method was also established to quantify the impacts of climate change and human activities on historical runoff variations. The results indicate that the characteristics and causes of runoff variations in China were generally spatially heterogeneous. The runoff in water-scarce river basins of northern China decreased significantly during the period of 1961-2018, variations of which were more sensitive to human activities. For southern water zones in China, the runoff showed no significant trend and climate change was the main influencing factor. On basis of 9 Coupled Model Intercomparison Project Phase 6 (CMIP6) climate model ensemble simulations under three different shared socioeconomic pathways (ssp126, ssp245 and ssp585), the future runoff in 10 typical basins of the water zones were projected and the results suggested an increasing trend of runoff over China, thanks to increasing precipitation in the rest 21 century. While under ssp585, the rising air temperature tends to evaporate more water and offset the effect of precipitation increase to some extent, resulting in that the increments of runoff under ssp585 are not necessarily greater than those under ssp245 and ssp126. Overall, our study could be used as a basis to support climate adaptation strategies and policies to cope with future water resources conditions.

（来源：SCIENCE OF THE TOTAL ENVIRONMENT 卷: 798 出版年: 2021 **DOI:**10.1016/j.scitotenv.2021.149277）

Functional microbial community structures and chemical properties indicated mechanisms and potential risks of urban river eco-remediation

Sun, J; Lin, ZY; Ning, DL; 等

To investigate the mechanisms and potential risks of river eco-remediation, river water, sediment, and biofilms in remediation facilities were sampled from a 2-year full scale eco-remediation site in an urban river in southeastern China. The samples from both remediated and adjacent control areas were analyzed for chemical properties and functional microbial community structures. The eco-remediation significantly changed the community structures in the river and introduced much more diverse functional microorganisms in facility biofilms. Corresponding to effective reduction of organics and ammonium in river water, some labile-organics-degrading and ammonia-oxidizing gene families showed higher abundances in river water of remediated area than control area, and were obviously more abundant in facility biofilms than in river water and sediment. The ecoremediation facilities showed obvious absorption of N, P, and heavy metals (Mn, Cr-VI, Fe, Al, As, Co), contributing to nutrients and metals

removal from river water. The eco-remediation also increased transparency and sedimentation of some heavy metals (Cu, Pb, Zn), which probably associated with colloids breakdown. Various metal-resistance microorganisms showed different abundances between facility biofilms and sediment, in accordance with relative metals. Most detected pathogens were not significantly affected by eco-remediation. However, our measurements in sediment and facilities showed heavy metals accumulation and development of some pathogens and several antibiotic-resistance pathogens, alerting us to investigate and control these potential risks to ecosystem and human health.

（来源：SCIENCE OF THE TOTAL ENVIRONMENT 卷: 803 出版年: 2022 **DOI:** 10.1016/j.scitotenv.2021.149868）

Evaluating the impact of watershed development and climate change on stream ecosystems: A Bayesian network modeling approach

Qian, SS; Kennen, JG; May, J; 等

A continuous-variable Bayesian network (cBN) model is used to link watershed development and climate change to stream ecosystem indicators. A graphical model, reflecting our understanding of the connections between climate change, weather condition, loss of natural land cover, stream flow characteristics, and stream ecosystem indicators is used as the basis for selecting flow metrics for predicting macroinvertebrate-based indicators. Selected flow metrics were then linked to variables representing watershed development and climate change. We fit the model to data from two river basins in southeast US and the resulting model was used to simulate future stream ecological conditions using projected future climate and development scenarios. The three climate models predicted varying ecological condition trajectories, but similar worst-case ecological conditions. The established modeling approach couples mechanistic understanding with field data to develop predictions of management relevant variables across a heterogeneous landscape. We discussed the transferability of the modeling approach.

（来源：WATER RESEARCH 卷:205 出版年: 2021 **DOI:**10.1016/j.watres.2021.117685）

Microbial community coalescence: does it matter in the Three Gorges Reservoir?

Gao, Y; Zhang, WL; Li, Y

The microbial community coalescence describes the mixing of microbial communities and the merging of their surrounding environments. Despite its prevalence in natural ecosystems and its potential influence on ecological processes, little research focused on the extent of coalescence between aquatic microbial communities. In this research, we analyzed the microbial communities in the Three Gorges Reservoir, a typical deep-water reservoir on the Yangtze River. The biogeography and the coalescence of microbial communities in water and sediment were illustrated and analyzed based on 16S rRNA gene amplicon sequence variants (ASVs). Differences in composition and diversity were identified between microbial communities in water and sediment, and microbial communities in sediment were more diverse than those in water. Between adjacent communities, by calculating the proportion of overlapped taxa, adopting the SourceTracker algorithm, and quantifying the connectivity of microbial cohesion, we found that the extent of intra-medium coalescence was strong (19.8%) and inter-media coalescence was faint (0.2%). 50 keystone species were selected using the cohesion metric. They displayed a stronger coalescence extent than average, and formed an accumulating pattern from upstream to downstream in the Three Gorges Reservoir, exhibiting their importance in the ecological network. Potential influencing

factors of microbial community coalescence in aquatic environments were discussed, including environmental conditions, types of habitats, suspended particles in water, and microscale microbial activities. To summarize, this research depicted the coalescence of microbial communities in a deep-water reservoir and emphasized its ecological importance. We anticipate more attention and further research on the processes of microbial coalescence in the aquatic environment, which might provide new insights into turnover of microbial keystone species and changes in aquatic ecological conditions.

（来源：WATER RESEARCH 卷:205 出版年: 2021 **DOI:**10.1016/j.watres.2021.117638）

How environmental stress leads to alternative microbiota states in a river ecosystem: A new insight into river restoration

Shang, JH; Zhang, WL; Chen, XQ; 等

Catastrophic shifts in river ecosystems can abruptly degrade their structures and functions, often reducing the efficacy of traditional remediation targeting physicochemical properties. Alternative stable states theory can not only explain this phenomenon but also provide a new insight into river restoration; however, little is known about the existence and implications of alternative stable states in a river. Considering the important role of benthic microbiota in sustaining river ecosystem structures and functions, ecological theory and high-throughput sequencing were combined to firstly investigate multi-stability in microbial communities and its relationship with environmental factors in river sediments. The Nanjing reach of the Yangtze River was selected as the study area because of its huge spatial heterogeneity and varying degrees of pollution. Bimodal distributions combined with temporal variations of microbiota status provided direct evidence of bistability by showing the instability at the intermediate. In addition, environmental stress, particularly concentrations of NH4+-N and NO3--N, was identified as an important driver of alternative microbiota states from the perspectives of the behavior of bistable ecosystems. Comparison of alpha-diversity indices and network properties between two alternative microbiota states revealed that the diversity and co-occurrence pattern of microbial communities will be high if they are settled in favorable environments (i.e., comprehensive sediment quality identification index > 3.7). Key taxa, including Clostridiales, Nitrospirales and Myxococcales, were discerned by combining LEfSe and network analysis, and their strong interspecies interactions were believed to be an important factor in triggering alternative microbiota states. This study suggests alternative stable states theory should be considered in river remediation to better understand the response of river ecosystems to environmental stress and the effect of hysteresis, benefiting the implementation of effective monitoring and restoration strategies in a river of urban area.

（来源：WATER RESEARCH 卷: 203 出版年: 2021, **DOI:** 10.1016/j.watres.2021.117538）

Density currents reduce nitrous oxide emissions in a tributary bay of Three Gorges Reservoir

Guo, XJ; Liu, J; Liu, DF; 等

Reservoirs are a significant source of the potent greenhouse gas nitrous oxide (N2O), but there are few data on N2O in the world's largest reservoirs and limited understanding of the factors controlling their emission rates. Here we analyzed high-resolution measurements of dissolved N2O concentrations and fluxes in a typical tributary bay of Three Gorges Reservoir. The surface water was oversaturated in N2O during both low and high water level (8.6 - 16.4 nmol/L, 107% - 180% saturation) and N2O fluxes varied nearly tenfold (0.2 and 1.6 mu mol/(m(2) h)). Dissolved N2O concentrations were characterized by

pronounced vertical gradients, which were controlled by bidirectional density currents. The river water with high concentrations entered the bay as an underflow along the riverbed, the upper part of the water column was formed by intrusive backwater of Three Gorges Reservoir having significantly lower N2O concentrations. In consequence, the N2O emission potential of the impoundment was reduced compared to pre-impoundment conditions. These results reveal the importance of hydraulic conditions on N2O emission from large reservoirs and suggest that flow regulation can be a potential tool for mitigating greenhouse gas emissions from manmade impoundments.

（来源：WATER RESEARCH 卷: 190 出版年: 2021, **DOI:** 10.1016/j.watres.2020.116750）

Sources and main controls of dissolved organic and inorganic carbon in river basins: A worldwide meta-analysis

Chaplot, V; Mutema, M

Despite dissolved carbon (C) exports from continents being crucial in the connection between terrestrial, atmospheric and oceanic C pools, the relative contribution and process controls on dissolved organic (DOC) and inorganic (DIC) fluxes within river basins are not fully understood. This paper presents an analysis of data from 843 sites worldwide from 45 Web of Science SCI-Expanded (ex ISI) indexed papers that report both the DOC and DIC contents and fluxes in conjunction with chemical elements, such as Si, Na and C-13 abundance, to investigate the likely origin, pathways and fate of the dissolved C. The reviewed papers also report on selected environmental factors (e.g., MAP and MAT: mean annual precipitation and temperature respectively; Climate, LU: land use, A: basin surface area). Regarding dissolved C fluxes rivers transported on average, 8.4 GT C yr(-1) of dissolved C with 7.7 GT C yr(-1) (92%) being DIC and remaining (8%) DOC. Asia has the highest within-river dissolved C transport (5.8 GT C yr(-1)) followed by Europe (2.0 GT C yr(-1)), America (0.4 GT C yr(-1)), and Africa (0.1 GT C yr(-1)). The dissolved C fluxes tend to increase with river water fluxes and contribution of interflow as seen in the tropical climate, which results in the export of relatively fresh DOC with low aromaticity. In contrast, the lower river water fluxes in sub-tropical and temperate climates corresponds to high concentration of comparatively more decomposed DOC, which pointed to a high proportion of groundwater contribution to the water fluxes. The results also imply that surface area and morphology of the river basins, as well as land use, has insignificant impact on dissolved C dynamics. Such quantitative results, including on the important role of climate on the dynamics of dissolved C in river basins, are helpful in improving predictions on the impact of climate change on the global C cycle. New and innovative multidisciplinary research on the subject is called for.

（来源：JOURNAL OF HYDROLOGY 卷:603 出版年: 2021 , **DOI:** 10.1016/j.jhydrol.2021.126941）

Evolution of Arctic rivers recession flow: Global assessment and data-based attribution analysis

Guo, XJ; Liu, J; Liu, DF; 等

Due to polar amplification of climate change, high latitudes are warming up twice as fast as the rest of the world. This warming leads to permafrost thawing, which increases the thickness of the overlying active layer and modifies the subsurface hydrologic regime of the draining watershed, therefore affecting baseflow to surface water and modifying recession characteristics. The active layer thickening and the subsurface flow modification are assumed to be linearly correlated. The objective of this study is to test this assumption by quantifying the correlation between the temporal evolution of hydrologic parameters

(recession slope and initial recession outflow) and 11 controlling factors (all linked to surface, subsurface and climatic conditions) for 336 Arctic catchments from 1970 to 2000. Contrary to previous studies, we demonstrate a clear decrease in recession slope and initial recession outflow over 1970-2000 for a majority of catchments at any significance level. We explain this result by identifying high topography and low permafrost extent as controlling factors that complexify the relationship between trends in recession parameters and active layer thickness evolution. The study goes further by identifying the mechanisms behind the complexification of the relationship: permafrost-extent loss, hydrologic-connectivity increase, flow-path-diversity increase, contributing drainage area multiplication. The novel aspect of the study lay behind the large number of studied catchments and the large range of controlling factors tested.

（来源：JOURNAL OF HYDROLOGY 卷: 601 出版年: 2021, **DOI:** 10.1016/j.jhydrol.2021.126577）

Divergent trends of water bodies and their driving factors in a high-latitude water tower, Changbai Mountain

Qi, P; Huang, XR; Xu, YJ;等

The importance of natural water towers to water resource demand of the ecological environment and human activities is self-evident. They are also vulnerable and extremely sensitive to the effects of anthropogenic activities and climate change. However, water bodies change in water towers have not received sufficient attention. Therefore, Changbai Mountain, a typical high-latitude water tower, which is the source of Second Songhua River, Tumen River, and Yalu River, was selected to analyze the change of water bodies and its response to interaction of driving factors over recent decades by the methods of Correlation analysis and Geodetector. Results showed that there was an obviously divergent trend in water bodies, with a significant increase in surface water area (SWA) and a significant decrease in terrestrial water storage (TWS) in the high-latitude water tower, which was firstly found. The strong increase in water use was the dominant factor causing the divergent trends of water bodies in Tumen River. Changes in water bodies in the other two basins were all the result of the combined effects of climate change and anthropogenic activities. It is worth mentioning that snowpack had a noticeable influence on the change of water storage in this water tower. Meanwhile, reduced water conservation capacity due to degradation of complex forest-wetland ecosystems and altered snowmelt processes in the context of climate warming may be two key underlying causes. In addition, we innovatively found that the enhanced interactivity of the driving factors was an inherent reason. The results of this study will be beneficial for ecosystem conservation and stability of downstream water supply in this high-latitude water tower.

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Hydrological analysis in watersheds with a variable-resolution global climate model (VR-CESM)

Xu, ZX; Di Vittorio, A

Taditionally, watershed-scale hydrology is simulated by distributed hydrological models with offline meteorological forcing data, or by regional regional climate models that link atmospheric and land hydrology interactions. Global climate model (GCMs) are rarely used to study watershed-scale hydrology due to the relatively coarse grid resolution, computationally expensive downscaling, and simplified physical processes. Recently, however, watershed-scale hydrology analysis has become possible in GCMs due to the development of variable-resolution GCMs that dynamically couple the hydrological

processes between atmospheric and land systems at fine resolutions in selected regions and coarse resolution elsewhere. In this study, we used the variable-resolution Community Earth System Model (VR-CESM) with refined-resolution (14 km) in the western U.S. and eastern China to evaluate smaller watershed-scale hydrology. We compared the historical VR-CESM outputs with gauge measurements and other hydrological models (e.g., National Water Model in the U.S.) and calibrated the subsurface runoff capacities in four mountainous watersheds. An RCP8.5 projection from 2007 to 2050 is used to estimate the impact of changing precipitation and snow climatology on watershed hydrology. We also analyzed the long-term runoff variability and the possibility of extreme runoff events as simulated by the VR-CESM. Although calibration is not possible in larger-scale watersheds, VR-CESM simulates the long-term annual variability of watersheds and provides insights on climate change impacts on hydrology. We conclude that refined-resolution VR-CESM can be used for watershed-scale hydrology analysis to understand water resources and water balance, in addition to traditional watershed-scale hydrological models. It enables hydrological analysis at multiple watersheds in one simulation and can help understand the two-way dynamics between land surface hydrology and atmospheric processes, and is especially practical for projecting climate change impacts. However, it is challenging to apply VR-CESM for hydrologic analysis in regulated watersheds as human factors (e.g., pumping, irrigation, water diversion) have not been fully addressed in VR-CESM.

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Influence of the choice of stream temperature model on the projections of water temperature in rivers

Piotrowski, AP; Osuch, M; Napiorkowski, JJ

In the majority of studies aiming at stream temperature warming due to climate change just a single water temperature model is used. Choosing a single model may highly impact the conclusions from the study. In this paper four relatively different empirical or semi-empirical models: perceptron neural networks, product unit networks, extended logistic regression and air2stream were applied to project the impact of climate change on water temperature in rivers located in temperate climatic zones of the USA and Poland. The models were driven by daily air temperature and streamflow projected by the rainfall-runoff model. In the first step, the models were calibrated and validated. Then the projections of water temperature were derived for the historical periods and two future periods taking into account: (a) climate simulations from the CORDEX initiative (NA-CORDEX and EURO-CORDEX), (b) the GR4J rainfall-runoff model and (c) different water temperature models. The obtained results indicate that due to global warming, the stream temperatures are expected to increase by about 1-2 degrees C for 2021-2050 and by 2-3 degrees C for 2071-2100 periods. These changes are not uniformly distributed throughout the year. The largest warming in the USA is found in the summertime, in Poland - in spring and autumn. For some months the discrepancies in the projected stream temperature between various stream temperature models are large. Product unit neural network, logistic regression-based model or air2stream occasionally led to projections that differ from those obtained by the majority of models even by 2 degrees C. We strongly recommend using at least a few stream temperature models for analysing the impact of climate change on water temperatures or the fate of the aquatic ecosystem.

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湖泊水位记录支持中国北方全新世中期降水达到最高值

曹建涛，饶志国，石福习 等

东亚夏季风北边界的湖泊水位记录所指示的区域全新世夏季风演化历史备受争议。文章以中国北方一个封闭湖泊过去 15000 年来甘油二烷基甘油四醚(GDGTs)的记录来探讨此问题。湖泊表层和岩芯沉积物数据结果显示，GDGT-0 和 brGDGTs 均来源于湖泊内部自生。从湖岸到湖中心，表层沉积物中 GDGT-0 和 brGDGTs 含量随着水深增加而逐渐增加，且由 brGDGTs 得出的温度数值逐渐减小。这是由于生产这些 GDGTs 的厌氧微生物偏向于在缺氧的底层湖水环境中生存。相应地，基于 brGDGTs 的温度与 pH 指标应该反映的是湖泊底层水的状态，而底层水状态很大程度上受控于湖泊水位或水深的变化。岩芯沉积物中 GDGTs 记录结果显示，末次冰消期到早全新世，湖泊水位逐渐增加； 9.5～5ka BP 期间水位保持高值，5ka BP 之后水位逐渐降低。本文得出的独立可靠的湖泊水位变化记录大致与该区域的孢粉记录一致，均支持全新世中期区域降水达到最高值。

（来源：中国科学:地球科学 期: 52 卷:1， https://doi.org/10.1360/N072020-0377）

蓝藻水华与淡水鱼类的生态相互作用研究进展

谷孝鸿，李红敏，毛志刚 等

鱼类是淡水生态系统的重要组成部分.近年来水体富营养化和蓝藻水华暴发导致的水环境恶化、适宜栖息地丧失等生态问题，对鱼类生存及渔业经济带来巨大威胁和影响。蓝藻和鱼类的生态作用是相互的，利用鱼类调控蓝藻过度增长的生物操纵技术在某些富营养化水体治理过程中取得了一定效果。在此背景下，全面评估蓝藻水华对淡水鱼类种群的影响，以及鱼类对蓝藻生长的控制与驱动效应，是进一步推进淡水生态系统治理与保护研究的关键。本文系统归纳分析了蓝藻水华对淡水渔业的危害、有害蓝藻及其次生代谢产物对鱼类的毒性效应以及鱼类对蓝藻的生态调控作用，并对未来的重点研究方向进行展望，提出复杂蓝藻生物质或原位蓝藻水华对鱼类影响的综合效应和相关的水生态风险评价将是未来研究的重点。生物操纵技术的可行性应依据所治理水体的基本环境和生物特征，结合具体实践进行判断和决策。本文旨在为蓝藻水华的生态风险评估、淡水鱼类资源的保护，以及水生态环境的改善提供科学依据。

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黄河流域地质地表过程与重大灾害效应研究与展望

兰恒星，彭建兵，祝艳波 等

黄河流域地质构造活跃、地貌演化迅速、气候区域分异显著，流域重大灾害类型多、分布广、突发性强，且灾害往往链生成链、致灾后果严重，破坏黄河流域生态环境，影响流域地质与生态安全。目前，大江大河流域地质地表过程与重大灾害效应是地球科学研究的国际前沿与热点。为此，文章详细梳理了与黄河流域地质地表过程、重大灾害效应、风险防范有关的国内外研究现状与发展动态，探讨了研究趋势和面临的挑战，分析了亟需突破的关键科

学问题，并基于地球系统科学思想提出了研究展望。黄河流域地质地表过程与重大灾害效应研究的主要方向有:黄河流域地质、地表和气候过程及其联动孕灾机制，黄河流域上游巨型滑坡形成机理及灾害链演化，黄河流域中游黄土地区水土灾害机制与灾害链生效应，黄河流域下游巨型洪灾发生规律及链生放大效应，黄河流域重大灾害风险防范。亟待突破的关键科学问题为:如何揭示地质、地表与气候过程耦合联动孕育重大灾害机制，如何阐明重大灾害与生态互馈效应，如何构建基于人地协调的流域重大灾害风险综合防控体系。研究展望包括:以地球系统科学理论为指导，突出学科交叉融合，从“重建历史-聚焦现代-展望未来”的时间轴尺度揭示黄河流域地质、地表与气候联动孕灾机制；创新理论体系，从“地-域-河”的空间轴尺度阐明黄河流域重大灾害区域模式、动力学机制、灾害链生与生态互馈效应；突破技术瓶颈，从“人地协调观”角度建立黄河流域综合风险评估模型与防控理论，形成“全流域覆盖、分区分带管控”应用示范格局，保障流域生态地质安全，为黄河流域生态保护和高质量发展提供科学参考。

（来源：中国科学:地球科学　https://doi.org/10.1360/SSTe-2021-0115）

中国主要流域灰-绿-蓝蓄水能力时空演变

奚巧娟，钟华，王涛 等

中国大部分地区受季风气候控制,地表水资源时空分布极不均匀。灰色(如水库)、绿色(如森林)、蓝色(如湖泊)3 种基础设施相辅相成，为调控地表水资源时空分布起到了重要作用。但仍缺乏 3 种基础设施蓄水能力空间分布和时间变化规律的研究，制约了水资源协同调控和综合管理。本研究基于最新的大坝、土壤根区蓄水能力、自然湖泊等数据，在流域尺度对比分析了中国九大流域 3 种水基础设施的空间分布，并研究了三者蓄水能力的时间变化。研究发现：(1)在长江、东南诸河等高强度人类活动的流域，人工灰色蓄水能力已经超过陆地表层自然生态系统；(2) 1955～2020 年中国灰色蓄水能力显著增加，各流域快速增长的时期有所差异；(3)各流域绿色蓄水能力变化较小，松辽、淮河流域略有增加；(4)蓝色蓄水能力总体呈上升趋势，其中内陆河流域(包括青藏高原内流区)蓄水能力上升明显。本研究理清了中国主要流域灰-绿-蓝蓄水能力的本底基础信息，揭示了各蓄水能力的时空演变规律，有助于自然-人工水基础设施协同管理，为多维度优化水资源配置提供支撑。

（来源：科学通报　2021,66(34)，https://doi.org/10.1360/TB-2021-0381）

三大洋对 2020 年 6 月长江流域破纪录强降水的影响

郑佳喻，王春在

2020 年 6 月长江流域的降水量破了 1979 年以来的纪录。研究表明三个大洋(太平洋、印度洋和大西洋)都有贡献，但是大西洋起到主导作用。三大洋的海温异常可以影响两个区域的相对涡度异常：一个是位于华北地区的 200-hPa 相对涡度(华北涡度)负异常，另一个是位于南海的 850-hPa 相对涡度(南海涡度)负异常。长江流域的降水异常主要受到华北涡度相关的大气过程控制。 5 月西北大西洋的海温正异常可以引起 6 月中纬度北大西洋的位势高

度正异常，进而通过横跨欧亚大陆的大气波列影响华北涡度，从而造成长江流域的降水正异常。而印度洋和热带北大西洋，作为前一年冬季太平洋 El Nino 事件的电容器，可以引起南海涡度负异常(反气旋性环流异常)，通过进一步加强水汽输送增强长江流域的降水。本研究表明 5 月西北大西洋海温是 6 月长江流域降水很好的预测因子，并且强调三大洋海温对中国极端天气和气候事件的重要作用。

（来源：中国科学:地球科学　2021,51(10)，https://doi.org/10.1360/N072020-0412）

青藏高原第四纪孢粉研究五十年

唐领余，沈才明，吕厚远 等

20 世纪 60 年代，因西部经济建设的需要催生了青藏高原第四纪孢粉研究。最初为探索冰期(冷期)/间冰期(暖期)孢粉组合、植被与气候变化规律，且首次在青藏高原主体钻取 200 多米第四纪湖相沉积岩芯进行孢粉研究。20 世纪 70 年代，第一次青藏高原科学考察开始了高山雪冰孢粉研究；80 年代起，开展了中法、中德、中澳和中美国际合作，标志着中国第四纪孢粉学界与国际接轨，一些第四纪孢粉研究的新方法逐渐得到不断的推广和应用，使中国第四纪孢粉学开始了从定性到定量重建古植被与古气候的探索；90 年代后，众多孢粉学者在青藏高原的 60 多个湖泊/剖面及高山冰川研究点，开展了以全球变化为重点的大范围第四纪孢粉研究，探讨更新世以来高原植被的时空变化及高原气候与环境的演变。半个多世纪过去了，青藏高原第四纪孢粉研究，为中国第四纪孢粉数据库的建立及高原末次盛冰期以来植被和气候演变过程的研究作出了贡献。已有的花粉记录揭示了末次盛冰期以来青藏高原植被的时空分布，表现为森林、草甸、草原和荒漠在末次盛冰期、冰消期和全新世适宜期等不同时段的扩张和收缩。古植被反映的末次盛冰期以来古季风经历了弱→增强→强盛→减弱但仍活跃→萎缩的变化，主要受太阳辐射的影响。

（来源：中国科学:地球科学　2021,51(12)，https://doi.org/10.1360/SSTe-2020-0361）

科学视点

Nature：南极海冰变化或是解决“全新世温度谜题”的关键

距今约一万年以来的现代间冰期（全新世）是有一个大暖期还是持续变暖？由于地质记录和气候模拟的差异，这个问题成为“全新世温度谜题”，是古气候学界乃至整个气候学界最为热门的研究课题之一。

12 月 2 日，中国科学院青藏高原研究所研究员、兰州大学教授张旭和陈发虎院士在《自然》发表评论文章指出，南极海冰变化或是解决“全新世温度谜题”的关键。该评论文章是对 2021 年 1 月，美国新泽西州立大学 Bova 博士等人在《自然》杂志刊发的论文观点提出的质疑。

评论文章第一作者张旭介绍，全新世温度谜题目前主要存在两种争论：一是如全球海洋和陆地温度记录的集成结果所示，全球年均温在早中全新世有一个大暖期（距今 9-7 千年），随后全球变冷直至工业革命以来的再次全球变暖；另一种是气候模型的模拟结果所揭示的，全新世以来全球年均温持续变暖。

这两种争论至今未有定论。该分歧意味着，如果气候模型模拟正确，则用于研究古气候演变的古温度指标的指示存在偏差；如果古温度指示正确，那么用于气候变化未来预估的气候模型则存在系统性偏差。

2021 年 1 月，Bova 博士等发文，假设距现代间冰期最近的上一个温暖的末次间冰期（距今 12.8-11.5 万年）不存在冰量和温室气体变化，其全球温度的季节差异完全由不同季节的太阳辐射决定，并通过建立季节到年均温度的转换函数（Seasonal-to-mean Annual Transformation method，SAT），尝试剔除古海温指标中的季节性偏差，以此定量年均温的变化。最终得出，全新世以来，全球年均温呈线性升高趋势的结论，验证了此前气候模拟的结果。该文章发表后得到了学界的高度关注。《自然》在该文的专题报道中指出，“全新世温度谜题”或已被解决。

张旭和陈发虎对上述文章结论的可靠性提出了质疑。他们指出，Bova 等的工作忽略了气候系统内部的反馈作用对间冰期气候变化的影响，夸大了太阳辐射对温度变化的贡献。因此，结论并不可靠。他们解释到，Bova 等利用 SAT 方法定量重建指标中季节信号的前提条件是，温度变化只受控于太阳辐射。而在全新世，由于北半球冰盖融化以及大气温室气体上升，温度变化不能单纯归因于太阳辐射。在末次间冰期时期，北半球冰盖以及大气温室气体较为稳定，因此 Bova 等人认为，末次间冰期的温度变化仅与太阳辐射有关。但是，这一前提假设并不准确。在末次间冰期时段，虽然冰盖和温室气体相对稳定，但两极海冰存在显著变化。海冰变化作为一个典型的气候系统内部的正反馈过程，海冰增加会导致全球绝大部分区域乃至全球温度都会显著变冷。在现代气候学研究中，海冰因对全球变暖的迅速响应，一直被认为是一种气候的快反馈过程。

但是，在百年及以上时间尺度上，南极海冰变化，由于其地理位置的特殊性，还受到气候系统慢反馈过程（即南极冰盖和大洋深部环流）的调制。因此，在利用 SAT 对末次间冰期时段温度指标中的季节偏差进行定量估计时，应当首先将南极海冰引起的温度变化剔除；否则，将会夸大指标中的季节偏差，导致全新世的年均温呈上升趋势。更值得注意的是，Bova 等人用于支持其结论的气候瞬变模拟试验没有很好地考虑南极海冰演变的特性，导致全新世南极海冰的模拟结果与古气候重建结果不符。如果气候模型无法正确重现这些对温度变化有显著影响的气候内反馈过程，例如南极海冰的变化。那么，将模拟结果作为一种评判并解释古温度指标意义的参考标准就变得非常牵强。

该评论文章还指出，如果可以在 SAT 方法中合理考虑南极海冰变化对年均温度的影响，或将最终解决“全新世温度谜题”，这将为我们评估气候模型的可靠性，以及定量气候系统内不同反馈过程对全球温度演变的贡献提供重要的参考。相关论文信息：DOI：https://doi.org/10.1038/s41586-021-03930-4。

（来源：中国科学报，https://news.sciencenet.cn/htmlnews/2021/12/470242.shtm，根据相关资料编译）

Nature Communications：预计北极降雨将更快增加

一项模型研究表明，北极降雨量增加速率可能高于此前的预测。这项研究表明，北极总降雨量超过降雪量的时间可能比此前认为的早数十年，并造成多种气候、生态系统和社会经济后果。相关论文 11 月 30 日发表于《自然—通讯》。

人们已经知道极地变暖的速度快于全球其他地方，在该区域造成了巨大的环境变化。研究表明在 21 世纪某个阶段，北极降雨量会超过降雪量，但还不清楚这一转变将于何时发生。

加拿大曼尼托巴大学的 Michelle McCrystall 和同事利用耦合模式比较计划（CMIP6）的最新预测，评估了至 2100 年的北极水循环。作者发现，预计降水（如降雨和降雪）在所有季节都将增加。依季节和地区不同，预计降雨成为主要降水形式的时间会比此前估计早 10-20 年，这与变暖加重和海冰更快减退有关。例如，此前的模型预计北极中心将于 2090 年转变为以降雨为主，但现在预计这一转变将发生于 2060/2070 年。

作者认为，北极转变为以降雨为主的温度起点，可能比此前模型估计的更低，甚至某些地区可能只需变暖 1.5℃即会发生这种转变，如格陵兰地区。作者指出，我们需要更严格的气候缓解政策，因为当北极降水转变为以降雨为主，将会影响冰层融化、河流和野生动物种群，并且有重大的社会-生态、文化和经济影响。相关论文信息：DOI：https://doi.org/10.1038/s41467-021-27031-y。

（来源：中国科学报，https://paper.sciencenet.cn//htmlpaper/2021/12/202112116525767568303.shtm）

Nature Science Review：强化湖泊综合治理，推进区域可持续发展

近十年来，随着国家大力控制废水污染物排放等措施出台，我国河流水质普遍得到了改善，然而湖泊生态环境并没有发生根本性转变，甚至许多湖泊还出现了水质持续恶化和生态退化的现象，联合国提出的实现保护水环境和生物多样性可持续发展目标仍未达到。

针对上述我国生态恢复投入与水生态持续恶化的矛盾，在国家自然科学基金委创新研究群体等项目的资助下，秦伯强研究员领衔的研究团队以长江流域湖泊环境

修复实践为例开展研究，发现 2008-2018 年长江干流水质普遍得到明显改善，而流域内湖泊水质和生物多样性等指标并未好转。研究认为最根本的原因是我国湖泊治理策略并没有体现“生态系统是综合的有机整体”这一理念，治理方案和过程存在顾此失彼的现象，具体来说有以下几点：

首先，我国污水处理厂排放标准偏低，氮、磷等污染物排放浓度限值甚至高于湖泊环境浓度，并且随着经济高速发展，废水排放总量一直在上升，导致点源污染并没有得到根本的控制。其次，许多湖泊流域乡村面源污染的处理率较低，太湖流域目前仅约 10%的面源污染物被湿地吸纳。

针对国内湖泊治理效果不佳的现状，研究团队提出可持续地改善富营养化湖泊水质应当将污染治理与社会和经济发展关联起来。以太湖为例，通过水-粮食-能源-气候-经济关系框架，可将流域内的污染物处理与水量管理、绿色农业和制造业升级、沉积污染物处理、经济转型、应对气候变化等议题系统地结合起来，进行综合性的决策以实现可持续发展目标。而实现这一目标，则需要开发能够以更大的规模、综合性地统筹和处理不同部门工作的决策工具。值得欣慰的是，近年来启动的《长江三角洲区域一体化发展规划纲要》将太湖流域水污染治理工作包含于其中，这反映出决策层已经认识到从区域整体的角度综合性的制定环境保护计划的重要性。上述研究发表在知名综合性期刊 National Science Review。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202111/t20211126_6272304.html，根据相关资料编译）

研究揭示东亚季风区全新世降水时空变化新机制

中国科学技术大学教授周鑫课题组与国内外同行合作，发现东亚季风区全新世（11700 年前至今）降水最大期在南方出现较早，北方出现较晚，降水最大期出现时间与纬度之间呈现明显的线性关系。结合对现代降水变化时空特征和月太阳辐射变化的分析，他们提出月太阳辐射变化可能是降水最大期时变化的主要驱动因素。相关研究成果 12 月 1 日发表于《地质学》。

东亚季风区全新世降水变化特征及其驱动机制，受到古气候学界的普遍关注。然而，此前的研究大多使用反映植被或湿度变化的指标进行研究，且存在不同观点。此外，过去普遍认为轨道尺度(万年尺度)上季风降水变化受夏季太阳辐射驱动，但东亚季风区降水时空变化特征复杂，用夏季平均太阳辐射驱动难以解释。

周鑫课题组等利用严格的数据筛选条件，在充分保证年代可靠的基础上，从数百条重建记录中选取了孢粉重建的中国东部全新世降水变化序列进行分析，发现全新世季风降水最大期在南方出现较早，北方出现较晚，降水最大期出现时间与纬度

之间呈现明显的线性关系，月太阳辐射变化可能是降水最大期时变化的主要驱动因素。

这一成果创新性地提出月太阳辐射对东亚季风区内部不同纬度降水的驱动，并指出西太平洋副热带高压在其中的关键作用，进一步加深了对东亚季风区全新世降水时空变化特征与驱动机制的认识。相关论文信息：https://doi.org/10.1130/G49550.1

（来源：中国科学报，https://paper.sciencenet.cn//htmlpaper/2021/12/20211221941881568343.shtm）

土壤砾石全球分布机制及其对土壤碳氮循环的影响

砾石是指粒径大于2mm的矿物颗粒，其广泛分布在全球土壤中。以往的研究中，砾石分布特征对土壤水文过程和土壤理化性质的影响机制受到了一定的关注。但当前研究尚不清楚砾石如何作用于土壤碳氮输移循环，从而影响水环境与温室气体排放。

基于以上科学问题，中国科学院南京地理与湖泊研究所朱青研究员团队，通过收集和测定的全球和流域尺度的数据资料，结合模型情景模拟等手段，探索了全球砾石的空间分布规律，提出了砾石对土壤碳氮循环过程的影响机制，并揭示了土壤碳氮排放通量对砾石分布的响应规律。相关研究结果发表在Geoderma和Catena等期刊上，文章第一作者为赖晓明助理研究员。

通过全球尺度研究发现，气候（气温和降雨等）和地形（高程等）通过影响土壤成土和重分布过程，影响全球尺度上土壤砾石的空间分布。基于全球尺度表层土壤砾石含量与气温、降雨及高程的关系发现：（1）多年平均气温< 20℃，砾石含量随温度升高而减少，这是由于温度升高促进了母岩风化成土；而气温>20℃时，在高温干旱环境下，砾石风化成土速率受到抑制。（2）砾石含量随降雨增加而减少，这是因为湿润的环境促进母岩的物理、生物和化学风化成土。（3）砾石含量随高程降低而减少，这是由于低海拔下高温和湿润环境更有利于母岩的风化成土。

通过文献综述，发现砾石的存在影响土壤理化性质，进一步引起土壤碳氮库、土壤水文、土壤热传导、植被生长和微生物活动等的变化，从而改变土壤碳氮输移循环。砾石对土壤理化性质影响主要通过以下三个途径：（1）砾石具有跟土壤基质组分不同的理化性质（孔隙度、密度、导热等）；（2）砾石的存在产生砾石-砾石界面和砾石-基质界面的孔隙；（3）砾石的存在会引起土壤基质理化性质的改变。研究指出了目前针对砾石的研究在采样、监测、制图和模拟等方面的不足，提出了未来可能的解决方案。

通过模型情景模拟，揭示了土壤碳氮循环过程对砾石的响应规律。研究基于野外数据简化了砾石对土壤碳氮库和水力参数的影响机制，构建了多组砾石影响下的参数情景，并通过DNDC和DayCent两种在模型结构存在差异的生物地球化学模型模

拟了不同砾石含量下土壤CO2和N2O排放及N淋失通量。结果表明：（1）在综合考虑砾石影响土壤碳氮库和水力参数下，DNDC模型和DayCent模型均得出土壤CO2和N2O排放及N淋失通量随砾石增加出现先增后减的规律；（2）砾石对土壤碳氮库的影响主导着土壤CO2排放通量的变化；然而，砾石对土壤碳氮库的影响和对土壤水力性质的影响，在土壤N2O排放和N淋失中的贡献率相当。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202110/t20211028_6231274.html，根据相关资料编译）

长江流域持久性有毒污染物干流输移及湖泊生态响应

持久性有毒污染物(Persistent Toxic Substances, PTS)是 21 世纪影响人类生存与健康的重要环境问题，属于国际环境科学研究的前沿热门领域。长江流域是我国水资源配置的战略水源地，社会经济快速发展导致流域 PTS 污染负荷持续增加，严重威胁水生态安全和人民健康。解析长江干流及其流域湖泊痕量 PTS 污染时空分布格局、来源和输移特征，全面评估其生态和健康风险，是开展长江流域水环境污染综合治理的重要科学依据，是建设流域水生态系统风险防范体系的重要组成。

基于此，中科院南京地湖所湖泊环境与工程研究室赵中华等研究人员首次系统调查评估了长江干流宜昌至长江口岸线水域水体和沉积物中典型 PTS 污染物负荷的时空分布、来源特征、介质分配、生态和健康暴露风险等环境行为过程，并初步揭示了上游坝区及水库运行对中下游水环境多环芳烃 PAHs 污染输移及蓄积的潜在影响。研究表明，大型城市及重要支流汇入江段污染负荷高，受体模型溯源解析显示 PAHs 主要来源于煤炭、焦炭和交通源；丰水期流域径流输入显著增加水体 PAHs 污染水平，中下游江段沉积物低环和中环 PAHs 存在二次释放，高环 PAHs 以蓄积效应为主，丰水期下游水环境 PAHs 赋存存在较高的生态和人体暴露健康风险；上游至下游 PAHs 时空分布特征显示水流输移为主，坝区及水库运行引发泥沙迁移量急剧下降，PAHs 流域滞留效应增加，将威胁流域湖泊生态系统安全和健康。相关成果发表在国际学术期刊 Journal of Hazardous Materials 上。

针对流域湖泊生态响应方面，在全面解析长江中下游浅水湖泊典型 PTS 污染格局的基础上（Zhao et al., Limnology and Geography, 2016, 61(1):47-60），从城市湖泊沉积物 PTS 污染空间和历史变化如何响应人类活动角度进行深入探讨。研究发现，社会经济发展要素包括工农业产业结构和布局、能源消费构成等，以及污染削减能力建设（城镇 WWTP 数量和布局、污水处理强度、处理工艺等）共同决定受纳湖泊水环境典型 PTS 污染负荷。研究从污染源排放通量、流域削减管控双维度阐明了湖泊对流域 PTS 输入的响应，为受纳湖泊 PTS 污染流域管理提供思路。相关成果发表在国际学术期刊 Science of the Total Environment 上。

此外，针对湖泊内部生态环境如何响应流域 PTS 污染输入方面，通过构建太湖水体-沉积物-底栖生物三相介质传递路径，研究人员发现浮游植物对疏水性 PTS 的吸附吸收作用所表现出的“生物泵”效应，耦合浮游植物衰亡沉降作用将增加沉积物有机质含量，提升 PTS 生物有效性，最终显著增加夏季太湖底栖生物 PTS 积累，引发污染生态和健康风险。该研究揭示了富营养化湖泊生态系统中 PTS 的归趋需重点关注底栖食物链，是开展受纳湖泊末端污染治理与修复的关键环节。相关成果发表在国际学术期刊 Ecotoxicology and Environmental Safety 上。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202111/t20211103_6240674.html，根据相关资料编译）

中营养化湖泊生态与水文环境演变研究

全球多数湖泊正面临着富营养化的威胁，尤其是处于生态系统转型关键期的中营养化湖泊。浮游动物枝角类，是湖泊内部生态系统中的初级消费者，尽管体型偏小（体长 0.2-1.2 mm）左右，却是湖泊内部食物链的重要组成部分，对物质能量流动具有重要的传递作用。然而，目前这类中营养化湖泊内部浮游生物结构随着营养水平加剧而发生相应变化的研究并未得到足够多的关注。

在国家重点研发计划项目、国家自然科学基金项目和科技部基础性工作专项等项目的联合资助下，薛滨研究员团队以长江下游一个典型的中营养化湖泊南漪湖为例，全湖采集三个点位的沉积岩芯和季节性水体样品，着重分析沉积物和水体中微型甲壳类浮游动物枝角类的群落组成与丰度特征，并结合地球化学指标和以 210Pb 和 137Cs 为基础建立的年代框架，探究南漪湖枝角类属种结构的长期演变特征及其对湖泊内部营养和水文环境变化的响应研究。本项研究结果表明，以象鼻溞属为代表的枝角类是南漪湖的优势种；象鼻溞及枝角类总浓度的变化与湖泊营养盐浓度增加、南漪湖周边耕地面积变化、极端水文事件关系密切；分析结果揭示了南漪湖正处于中营养水平向富营养化转变的关键期，尤其是自 20 世纪 70 年代以来湖泊营养水平和水位均有所上升。因此，应尽快采取有效的管理措施，以遏制南漪湖富营养化的加剧态势。相关研究成果发表在国际知名期刊 Catena 上。

首先，三孔沉积岩芯分析结果表明，象鼻溞是南漪湖最主要的优势种，以中贫营养指示种 B (E.). longispina 为典型代表，三孔的平均浓度均超过 50%。自 1970s 以来，象鼻溞的总丰度呈现增加趋势，Chydorus sphaericus. sl., Alona spp., Graptoleberis testudinaria 等沿岸种的丰度则趋于下降，由此指示了南漪湖的营养水平正在逐步增加，生态型逐渐向藻型环境转变。

其次，南漪湖不同湖区枝角类密度和组成结构显著不同。湖区东部枝角类的丰度（尤其是象鼻溞）显著高于湖区西部（NY-3 的平均丰度为 67%，NY-1 和 NY-2 的

平均丰度为 82%）。这是由于东湖区（NY-1、NY-2）靠近主要河流郎溪河和新郎溪河入湖口，该区域水位波动较大，且水位较深且宽，沉积物以砂质为特征；西湖区相对较浅，水生大型植物发育，沉积物则以淤泥为主。沉积速率和沉积环境的差异、水位波动及过度捕捞鱼类等均对枝角类的丰度和组成产生了影响。

最后，过去两百年间，南漪湖流域范围内极端气候事件的发生与枝角类浮游种和沿岸种的比值（P/L）相对应，包括两次洪水记录对应 P/L 的高值段，三次干旱记录则对应 P/L 的低值段。尤其在 1930-1950 期间，象鼻溞的浓度和 P/L 值均保持较低水平，这与宣城县志所记录到的干旱期一致，由此推测南漪湖当时处于低水位时期。此外，同时期沿岸种浓度增加，枝角类总数下降也可以佐证当时湖泊水深较浅。长江中下游邻近南漪湖的其他湖区，也有类似记录，即温度增加、降水减少、湖泊水位下降等。1970s 年以来，象鼻溞的浓度和 P/L 值趋于显著增加，指示了南漪湖营养水平和湖泊水位的增加。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202111/t20211109_6247783.html，根据相关资料编译）

中哈跨境流域伊犁河-巴尔喀什湖流域水体 POPs 研究

具有持久性、挥发性、毒性的持久性有机污染物（POPs）可以通过长距离迁移，在全球范围内广泛分布，包括人类活动较少的极地和高山区。中亚干旱区的河流、湖泊是重要的水资源，多以天山冰川雪融水、降水补给为主。伊犁河-巴尔喀什湖流域从天山山区延伸到盆地最低端巴尔喀什湖，具有明显的垂直气候带及不同的人类活动强度和方式，系统研究该区水体 POPs 污染现状、解析污染原因，并全面评估其生态和健康风险是制定合理措施、保证水资源安全的重要科学依据。

在国家自然科学基金-新疆联合重点项目和中国科学院战略性先导科技专项等项目的联合资助下，中国科学院南京地理与湖泊研究所吴敬禄研究员的干旱区资源与环境研究团队基于中哈跨境流域伊犁河-巴尔喀什湖流域 POPs 数据，分析了研究区内有机污染物的浓度、空间分布特征、来源及生态效应，明确了巴尔喀什湖水体有机污染特征，揭示了空间分布差异及其原因，并评估了污染物的生态风险。相关研究成果发表在国际知名期刊 Chemosphere 上。

研究结果表明，伊犁河-巴尔喀什湖流域水体 ΣOCPs 和 ΣPAHs 浓度变化范围分别为 4.02-122.80 ng L－1 和 7.58-70.98 ng L－1。与全球范围内其它地区水体 POPs 相比，研究区有机污染物浓度除少数样点较高外（如城市附近及局部河源区），总体浓度低。进一步的污染来源分析表明，该区水体 OCPs 中，尚存少量的 DDTs 及 HCHs 可能来源于近期的使用；而 PAHs 主要来源于油类物质泄漏、生物质燃烧、煤燃烧和机动车尾气排放，各自的贡献量分别为 33.9% 、29.5%、22.6%和 14.1%。综合来源

解析和空间分布特征的结果表明，农业、工业化和城市化活动都是潜在的污染来源，而河源区的 POPs 污染反映了远距离大气迁移和沉降对污染物空间分布不可忽视的作用。

虽然该流域水体 OCPs 和 PAHs 浓度普遍较低，但持续接触 POPs，即使是非常低的水平，也会对生物和人类健康造成不利影响。因此，通过商值法（RQ）和风险系数（非致癌/HQ、致癌风险/R）两种方法，从水体生物和人体健康两个方面全面评估该区水体 POPs 可能存在的潜在生态风险。结果显示，除了局部采样点的 RQ 值高于规定的风险阈值外，该区其他采样点的 POPs 对水生生物几乎没有毒性；不同采样点的 HQ 值和 R 值均小于相应规定的阈值，表明该区水体对周边的人类健康没有明显的风险。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202111/t20211115_6255581.html，根据相关资料编译）

湖库水体溶解甲烷测定方法

甲烷是一种重要的温室气体，其温室效应是二氧化碳的 21-23 倍，对全球温室效应的贡献达到了 30%。湖库是大气甲烷的重要来源，定量测定湖库水体溶解甲烷浓度对研究碳循环以及估算全球甲烷收支具有重要意义。

传统测定水体甲烷浓度的主要方法是顶空气相色谱法（HGC），该方法无法直接测定水中溶解甲烷的浓度，需要复杂的预处理过程，而且对人的操作要求较高，费时费力。本研究介绍了一种更为快速，简便且精度高的水体溶解甲烷测定方法——膜进样质谱法（MIMS）。作为一种相对较新的测量水中溶解气体的方法， MIMS 以其高精度、方便和高效而备受关注，但该技术尚未普遍用于环境水样甲烷的测定。

在国家自然科学基金的资助下，中国科学院南京地理与湖泊研究所朱广伟研究员团队建立了利用 MIMS 测定水体溶解甲烷浓度的方法，并从大型浅水湖泊太湖采集了水样，利用 MIMS 和传统的 HGC 法测定水中溶解甲烷的浓度，对这两种方法的测定结果进行了对比分析。相关研究成果发表在国际期刊 water 上，论文通讯作者为许海副研究员。

研究结果表明：在 MIMS 系统中，无论在低浓度范围还是在高浓度范围，甲烷标样的浓度值与电信号值均呈现显著的线性关系，表明 MIMS 在测定溶解甲烷浓度方面有极高的精度。同时，在三种不同的盐度下，标准曲线均达到了令人满意的精度，说明 MIMS 可以适用于不同盐度水体甲烷的测定。

为了确定 MIMS 方法是否可靠，研究人员将 MIMS 测定结果与 HGC 的测定结果进行了对比分析。在大型浅水湖泊—太湖中选择了 29 个采样点位，分别用 MIMS 和 HGC 测定了表层水溶解甲烷的浓度。结果发现，太湖表层水溶解甲烷浓度空间差异非常大，其浓度范围为 0.02 至 0.70 μmol/L。总体而言，利用 MIMS 测定的结果与 HGC 测定的结果一致，线性关系非常显著。

对于 MIMS 方法，取样装置非常简单，每个样品仅需 12 mL 水。使用 HGC 采集样品时，为了保障水体溶解甲烷与顶空部分达到溶解平衡，至少需要摇晃 5 分，而使用 MIMS 法无需顶空，每个样品的采集在 30 秒内就能完成。室内使用 HGC 法测定每个样品大约需要 5 分钟，而使用 MIMS 法只需要不到 2 分钟的时间，这大大提高了样品测定的效率。此外，由于 MIMS 信号值对甲烷浓度变化的响应十分快，可用于实时监测水体甲烷浓度，这是 HGC 法无法实现的。该方法的建立对湖库甲烷动态的研究具有重要意义。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202111/t20211119_6265280.html，根据相关资料编译）

大型富营养化湖泊内源磷及沉积物早期成岩研究

河道输入、面源流失以及工业与生活废水等外源途径进入湖泊生态系统中的磷最终蓄积于底泥中，被称之为内源磷。蓄积于底泥中的磷并非永久被埋藏，而会在外界环境条件的影响下再次进入上覆水体，造成湖水中磷的浓度和水平升高，引起湖泊富营养化及蓝藻水华等环境问题。

大量研究表明，湖泊底泥磷释放是阻碍富营养化湖泊治理的关键。因此，弄清湖泊磷平衡及释放过程、机理对于湖泊内源磷的管理至关重要。通常，很多学者对于底泥磷释放的认识只停留在短期释放，而鲜有对底泥磷长期释放进行研究和分析。底泥磷短期释放是指“天”尺度上的底泥间隙水中磷扩散到上覆水中的速率。目前，对于短期磷释放的测定主要利用静态释放以及间隙水梯度扩散的方法（Fick 第一定律计算）获得。而另一方面，底泥中随着深度增加而减少的磷含量代表着其在长期有潜力释放的量，因此底泥磷长期释放可以通过垂向稳定层位磷（磷含量停止减少，即永久埋藏层）含量与埋藏（沉积）速率之积与稳定层位以上每层（活性层位）磷含量与相应沉积速率之积的差值进行定量。如果长期 P 长期释放≥P 短期释放，则表明该区域底泥磷长年累月对于上覆水体均为源，对水体可造成长期的污染。若反之，则表明该区域该时段（短期释放测定时期）底泥磷释放为暂时性处于高值，其长期对水体的污染低于短期水平。

此外，对于短期或长期释放来说，不同形态磷的贡献程度仍十分缺乏定量研究，即到底何种形态磷起到主导作用未进行深入研究。底泥内源磷的循环与释放过程相

当复杂，在短期内（以天、周、月、季度计）通常受到如有机质的矿化，铁氢氧化物的溶解等过程驱动而活化释放，严重时甚至能够造成如蓝藻水华等季节性发生的水环境问题；长期来看（以数年或数十年计），短期内释放的磷有可能经过各类生物地球化学过程后再分配重新转化为底泥中不同形态的磷库，而暂时被固定在铁氢氧化物上的磷（随时间推移最终会被埋入厌氧层而被释放）也可能使得计算的短期释放量被低估。总体而言，底泥磷的长期释放量取决于湖泊系统内磷的供给、固定、埋藏过程之间的物料平衡，这些过程控制着数年或数十年湖泊生态系统中磷的循环轨迹，并长期影响着水环境健康问题。至此，对于湖泊底泥磷的释放到底是怎样影响整个湖泊生态系统的，在不同的时间尺度内底泥内源磷主要通过哪些过程响应（以及如何响应）动态变化的环境条件这些问题仍缺乏深入的理解。

南京地理与湖泊研究所尹洪斌研究员课题组以我国典型的富营养化浅水湖泊——巢湖为研究对象，通过全湖的底泥采样分析，研究底泥磷的组成成分，空间分布，短期、长期磷的释放与固定的速率，柱状底泥磷的垂向分布等内容。研究阐明了巢湖底泥在湖泊富营养化问题中的重要地位，其中西巢湖平均短期（2.76 mg/m2 •d-1）与长期磷释放速率（5.34 mg/m2 •d-1）都显著高于东巢湖（短期与长期分别为 1.05，1.3 mg/m2 •d-1），全巢湖的短期与长期磷释放速率与外源磷的输入（3.56 mg/m2 •d-1）均处于同一量级。研究结果表明，西巢湖底泥内源磷的长期释放对巢湖富营养化具有严重的影响，底泥磷的长期释放为 698 吨/年，约占外源输入磷的 69%（按照巢湖年输入 1100 吨磷计）。而占巢湖面积仅为 33%的西巢湖，其底泥磷长期释放占到了整个巢湖的 70%左右。底泥磷长期释放的量级超过了巢湖出湖磷量（年出湖量约为 530 吨/年，滞留湖体的磷约 480 吨/年）。

论文还利用长短期综合研究的方式初步阐明了底泥磷释放的主控过程的发生机制，比如有机质，金属铁、铝等起到的作用：有机质的矿化仅贡献了短期磷释放量的 19%，而其他金属结合态磷贡献了 81%；铁结合态磷在底泥磷长期释放的磷库中贡献 52.1%，铝结合态磷在西巢湖底泥磷长期释放中具有潜在活性。此外，论文还阐明了西巢湖底泥磷污染状况对巢湖水质管理措施的响应。下一步的研究工作，需要以大量的采样与实验为基础，更加深入地理解巢湖中磷的循环过程，为底泥磷的动态变化模型的建立以及预测提供更多可靠的依据。以上研究成果对于巢湖水质修复措施的实践具有重要的支撑作用。

上述研究成果得到了“十三五”国家水体污染治理重大专项巢湖项目、中科院交叉团队、中科院重点部署项目以及国家自然科学基金项目的资助，成果发表于 Environmental Pollution 上。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202111/t20211123_6267539.html，根据相关资料编译）

我国西南地区湖泊摇蚊群落生物多样性与稳定性时空变化研究

水体以人类活动加强和气候变暖为主要特征的全球变化，正深刻影响着湖泊生态系统，造成湖泊生态系统功能退化以及湖泊生态系统服务的受损。生物多样性如何维持，如何决定生态系统稳定性，以及两者间的关系是生态学领域长期关注的科学问题。越来越多的研究已经证明了人类活动和气候变暖驱动下生物多样性和稳定性下降的事实，但是全球变化重塑群落生物多样性和稳定性的分布格局和驱动机制依然不清楚，不同驱动下生物多样性和稳定性之间的关系依然存在较大争议。

在国家自然科学基金、国家重点研发计划、中国科学院战略先导项目和南京地理与湖泊研究所青年科学家小组等项目的资助下，中国科学院南京地理与湖泊研究所张恩楼研究员团队联合英国南安普顿大学、安徽工业大学学者对西南地区典型湖泊摇蚊群落生物多样性和稳定性的时空变化规律开展了系统研究，取得了新进展。

前人的研究基于新陈代谢和生产力-多样性假说等理论发现多样性会随着海拔的升高而降低。本研究针对西南地区不同海拔梯度，选择了多个湖泊作为研究对象，基于湖泊底栖动物摇蚊数据库开展研究，结果表明湖泊摇蚊多样性的自然分布格局受人类活动的强烈影响，群落生物多样性在高海拔湖泊较高而在低海拔湖泊较低。研究成果发表在 Anthropocene 上。

人类活动不仅造成了湖泊摇蚊群落多样性的损失，还造成了摇蚊群落稳定性的下降。研究发现近百年来，只有在受人类活动直接影响的湖泊中才存在群落的突变。在无直接人类活动干扰的高海拔湖泊中，温度为摇蚊群落的主要驱动力，群落组成对温度呈线性响应且仍维持较高的稳定性；在有直接人类活动干扰的低海拔湖泊中，总有机碳是主要驱动力，群落对其呈非线性响应，研究发现近百年来群落的响应已经存在突变点，且突变前稳定性就已持续下降。研究发现，在全球变化驱动下，不同湖泊多样性变化呈现差异，既存在多样性增加也存在多样性下降。然而，近几十年中，包括高海拔湖泊在内，所有湖泊多样性都在下降且群落变化速率都存在显著升高。前人的研究表明多样性对稳定性起到了积极作用，而本研究的结果说明摇蚊群落的多样性丧失并不一定与稳定性下降同时发生，群落中物种功能的改变以及更新速率更加值得关注。研究成果发表在 Limnology and Oceanography 上。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202111/t20211129_6272977.html，根据相关资料编译）

中国内陆水体有害蓝藻水华发生的环境影响要素综合分析

有害蓝藻水华正在全球淡水生态系统中蔓延，对饮用水供给、水产品生产、娱乐和旅游活动造成不利影响。理解有害蓝藻水华发生的环境驱动要素和发生机制对于保护受影响水体可持续发展具有重要意义。中国幅员辽阔，地势呈三级阶梯状逐

级下降，由于不同地区的气候、地理、地质、地球化学条件千差万别，位于三级阶梯的湖泊由于形态、化学特征和气象条件的不同导致湖泊的营养浓度、营养状况和浮游植物营养盐利用效率具有明显的区域差异，因此影响有害蓝藻水华的环境要素存在明显的时空差异。

中国科学院南京地理与湖泊研究所秦伯强研究员和朱广伟研究员团队通过对中国不同湖泊和水库案例的综合分析，阐明了人类活动、气候条件和地理背景等环境要素对有害蓝藻水华动态的单独和交互影响，以期为减少中国内陆水体有害蓝藻水华提供一个前瞻性和综合性的解决方案。相关成果近期发表在国际著名期刊 Harmful Algae 上。

中国的有害蓝藻水华从南到北均有分布，但主要集中在长江中下游和云贵高原地区，如长江中下游的太湖、巢湖、鄱阳湖和洪泽湖，云贵高原的滇池、洱海和星云湖等。除了湖泊以外，有害蓝藻水华还在全国各地的许多大城市的饮用水库中扩张，如天津的于桥水库、北京的官厅水库，三峡水库。文章通过文献分析发现，湖泊的营养状况和蓝藻水华发生程度不仅受到人为因素的影响，还受到如地理位置、湖泊形态和气候等自然因素的影响。中国的贫营养湖泊主要分布在海拔较高的地区，尤其是湖泊数量最多、面积最大的青藏高原湖区，大多数湖泊都是水质清澈的贫营养湖泊，主要因为那里气候条件恶劣，人口稀少，人为活动强度低。中国有害蓝藻水华主要分布在经济发达或发展中地区的湖泊中。20 世纪 80 年代以来，人口、经济活动和废水排放的快速增长加速了中国有害蓝藻水华的发生，尤其是在高度城市化、农业化和工业化的长江中下游地区，其中太湖和巢湖是这一区域湖泊加速富营养化的典型代表。而且，与深水湖泊相比，浅水湖泊环境容量更小，积累在沉积物中的营养盐，尤其是磷，更容易再次进入真光层水体被浮游植物利用，因此，水质更易受到人类活动的影响。气候变化加剧了有害蓝藻水华的扩张，尤其是春季气温上升，风速下降使得微囊藻水华在长江中下游地区的很多湖泊发生时间提前，持续时间延长，发生程度加重。以滇池为代表的云贵高原湖泊因为全年气温更高，蓝藻水华发生的时期更早，水华持续时间更长，营养盐阈值更低，治理难度更大。同时，水文条件也显著影响蓝藻水华的发生，像洞庭湖、鄱阳湖这样的通江湖泊由于水力停留时间短，水华发生频率和程度与太湖和巢湖相比相对较低。最近几十年里，中国修建了许多水利工程，这在期间，三峡大坝、小浪底、葛洲坝以及其他大型水利工程修建完成并投入使用。大型水电和供水工程的修建显著改变了河流水体的水文状况，导致水库及其支流水力停留时间变长、热分层稳定增加，诱导有害藻类水华发生频率增加。

尽管在外部营养负荷控制方面进行了大量投资，但在太湖、巢湖和滇池以及中国其他许多相对较小的湖泊中害蓝藻水华仍未有效控制。在淡水生态系统中，磷的

有效性一直被认为是限制有蓝藻害水华繁殖的关键因素。因此，削减磷输入已成为水质管理人员的主要控制目标。在垂直分层的深水湖泊中，外源输入的磷很容易被“捕获”并被埋在底部沉积物中，很难被浮游植物利用。但是，在浅水湖泊中，频繁的水动力扰动很容易将表层沉积物中的磷重新释放到水体中，满足有害蓝藻水华的营养需求。因此只控磷的策略在相对贫营养的深水湖泊中更为有效，而在浅水富营养化湖泊中则较为缓慢。由于反硝化过程造成内源氮的损失，富营养化湖泊中外源氮负荷的减少将导致湖泊中氮浓度的相对快速降低。而且，在许多富营养化湖泊中，氮气的固定并不能弥补氮的损失。因此，在浅水生态系统中控制有害蓝藻水华必须同时减少氮和磷的输入。此外，氮磷控制策略必须考虑到气候变化导致的极端天气事件，如更强烈的暴雨、持久的热浪和干旱增加，这可能会延长有害蓝藻水华的规模和持续时间。同时，维持湖泊和河流之间的自然水文连通对于减少中国各地的有害蓝藻水华污染至关重要，控制水库的水位波动也有助于控制其支流的有害蓝藻水华。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202112/t20211203_6286845.html，根据相关资料编译）

内源营养盐循环对太湖蓝藻水华态势的影响研究

人为富营养化是全球淡水生态系统面临的重大威胁，其中有害蓝藻水华是水体加速富营养化的重要表征。氮和磷是淡水湖泊中有害蓝藻水华发生的关键控制要素，为了有效控制湖泊富营养化和蓝藻水华，必须首先要确定氮磷元素的优先控制程度。湖泊中营养盐限制模式取决于营养盐的外源负荷和内源循环过程，水体内源营养循环可以改变湖内养分的可获得性，引起氮、磷的季节性变化，从而影响蓝藻水华的发生动态。

自 2007 年无锡暴发饮用水危机之后，太湖采取了一系列措施控制富营养化和蓝藻水华。至今水危机事件已经过去 10 多年，水体总氮浓度出现明显下降，然而，蓝藻水华发生的程度和频度并没有明显降低，尤其是 2017 年，太湖发生了 2007 年以来最严重的蓝藻水华，水体总磷浓度出现明显反弹。尽管目前大家已经认识到内源营养盐循环对太湖富营养化和蓝藻水华具有深刻影响，但仍缺乏内源营养盐循环对蓝藻水华发生贡献的定量化研究。

近期，中国科学院南京地理与湖泊研究所许海等研究人员利用 2005-2018 年太湖出入湖营养盐通量数据，结合湖内底泥与水体氮磷监测数据、水位监测数据及蓝藻打捞量、鱼类捕捞量、水厂取水量、大气沉降等长期历史数据，通过质量平衡模型估算了太湖长期的营养盐收支，并定量估算了反硝化脱氮对湖内氮自净的贡献；通过同位素示踪培养实验，定量计算了铵氮再生对蓝藻水华氮素需求的贡献；通过藻类生物量季节变化估算了生物有效磷的需求量，结合季节性氮磷收支数据，估算

了季节性内源磷释放对藻类水华磷供给的贡献。相关成果发表在国际著名期刊 Limnology and Oceanography 上。

研究表明，太湖河流输入的总氮、总磷负荷分别占年输入总负荷的 91%和 83%。因此，太湖氮磷负荷主要来自河流输入。太湖外源营养盐负荷受入湖水量的显著影响，尽管流域治理做了很多工作，但入湖水量在 2010 年以后才显著下降，导致污染负荷从 2010 年才开始下降，但近年又因为极端降水而上升。营养盐从湖泊中的输出包括河流输出、饮用水消耗、藻类打捞、鱼类捕获以及反硝化作用脱除。在 2005-2018 年期间，通过河流输出的总氮、总磷分别占总输出的 32%和 70%。

太湖氮磷负荷主要从西北湖区输入，从东南湖区输出，出水水质显著好于入湖水质，表明太湖是一个具有很强自净能力的浅水湖泊。磷由于缺少气态形式，只能通过河流流出和资源获取带走，因此在湖泊中的滞留时间相对较长。根据磷负荷的输入与输出数据和湖内赋存量的变化，利用质量平衡模型估算显示，太湖每年平均可截留 63%的外源磷负荷，这些磷主要以颗粒物沉积及吸附的形式储存于底泥中。对于氮而言，湖内自净途经主要包括反硝化脱氮和颗粒物的沉积，直接估算氮的沉积比较困难。我们基于总磷净截留量和沉积物表面 TN:TP 的比例，估算了总氮沉积量和通过反硝化作用损失的氮量，反硝化脱氮量占湖内氮自净量的 80%以上，占外源总氮负荷的 43-68%（均值为 54%），表明太湖具有较强的脱氮能力，这很好地解释了为什么自 2007 年以来太湖的总氮浓度呈显著下降趋势。研究人员进一步发现，夏秋季节，NH4＋-N 的再生满足了 38-58%以微囊藻为主的蓝藻水华潜在 NH4＋-N 需求。因此，在氮匮乏时期，铵态氮的再生对维持蓝藻水华的持续发生具有重要意义。

2007 年以来，太湖水体中总磷没有像总氮一样显著下降，反而呈现波动性上升趋势，反映总磷对外源负荷治理响应缓慢，其中内源磷释放起到重要作用。浅水湖泊中内源磷释放过程十分复杂，风浪导致的沉积物重悬在太湖频繁发生，使得底泥颗粒磷频繁的进入上覆水体，当湖面平静时重悬的颗粒磷会很快重新沉降到湖底，这些颗粒磷中很大部分不具有生物有效性，不能被蓝藻利用，以颗粒磷或总磷释放来表示内源负荷会高估内源的贡献。因此，内源磷释放应集中关注生物可利用磷。水体溶解性反应性磷（SRP）是重要的生物可利用磷形态，然而底泥释放的 SRP 很快就会被藻类吸收，不容易在水体中积累，通过监测水体中 SRP 浓度的变化来确定内源 SRP 释放通量比较困难。因此，在内源磷释放研究方面一直缺乏内源释放对蓝藻水华贡献的定量化研究。在本研究中，我们基于生物有效磷和水体中浮游植物生物量（Chl a）之间的定量关系，利用水体中 Chl a 的变化来计算支持生物量增加所需要的生物有效磷。我们通过浮游植物的磷需求和季节性磷截留量之差来估算内源磷通量。结果显示，尽管水-沉积物界面磷交换在年尺度上是一个净汇，但季节性磷

释放对春夏季节蓝藻生长仍然很重要，可贡献蓝藻水华磷需求的 23%-90%(均值为 40%)。不同年份季节性内源磷释放量不同，主要取决于当年的藻华情况。2017 春季内源磷释放达到蓝藻水华生物量磷需求的 90%。主要原因是 2017 年春季水温提前升高，延长了高氮浓度时期蓝藻的生长时间，在氮还未来得及被反硝化作用完全脱除时被浮游植物吸收利用，导致有害蓝藻水华在春季大量繁殖，藻类生长从沉积物中泵吸了大量的磷进入藻体，导致 2017 年春季水柱中以藻颗粒形式存在的总磷浓度显著升高。因此，气候变化会导致内源磷负荷的强烈季节性波动，给湖内总磷浓度控制带来了严峻的挑战。

本研究成果表明，尽管外源营养盐输入在减少，但内源营养盐循环过程将有助于维持太湖蓝藻水华的持续发生。由于反硝化作用的存在，湖泊中的氮相比于磷更容易从湖体脱除，因此，同步削减外源氮和磷，相对于单独控磷措施，对遏制蓝藻水华和恢复水质将起到更快的效果。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202112/t20211206_6288680.html，根据相关资料编译）

青藏高原湖泊水量变化规律-原因-影响研究

青藏高原被称作“亚洲水塔”和“第三极”，是气候变化的敏感区和脆弱区。高原湖群是“水塔”水循环的重要组成，连接水圈、大气圈、冰冻圈等重要圈层。在高原内陆区气候暖湿化背景下，内流区湖泊出现大规模急剧扩张，对水文过程和当地人居环境造成显著影响。遥感是目前大范围湖泊水文变化监测的主要手段，但是由于不同卫星传感器服役时段长短不一、空间覆盖及精度限制等问题，青藏高原湖泊水量变化的不同研究结果存在时空代表性有限和量化结果不一致等问题。目前对于高原内陆湖泊时空差异性扩张的主控因子缺乏准确理解和统一的认识，特别是冰川融水对湖泊水量平衡的贡献仍存在争议和不确定性。此外，近几十年的湖泊快速扩张对当地人居环境的影响评估是科学界、政府管理部门和公众热切关注的问题之一。

针对上述科学问题和技术难题，在中科院战略性先导科技专项、第二次青藏高原综合科学考察研究专项、国家自然科学基金委面上项目等资助下，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河海大学、美国堪萨斯州立大学、加州大学洛杉矶分校、香港理工大学等机构的科研人员开展了一系列研究并取得进展，相关成果发表在 Remote Sensing of Environment、Journal of Hydrology、Catena、Science of The Total Environment 等。

激光测高卫星 ICESat/ICESat-2 相比传统星载雷达高度计能提供更加精确的高程观测数据，在当前湖库水位监测系统中展现了尺度和精度上的优势。基于两代激光测高卫星资料，课题组量化了青藏高原湖泊（242 个，占全区湖泊面积比例~65%）

在本世纪初近 20 年的水位与水量变化。研究结果揭示了高原 231 个湖泊水位呈不同程度上涨，平均速率为 0.22±0.04 m/y，其中有 18 个湖泊的水位上涨速度>0.5 m/yr，包括色林错、双湖及可可西里的多个湖泊；仅有 11 个湖泊水位变化速率下降，平均速度为-0.10±0.02 m/yr。在 2003-2019 年内观测湖泊水量变化速率约为 8.21±1.21 Gt/yr，将观测湖泊水位变化速率推广到其他无观测湖泊，湖泊总水量变化速率超过 11 Gt/yr。该研究极大地提高了高原湖泊水量平衡估算的空间覆盖度和时间延展度。

关于高原内陆区湖泊快速扩张的机制，存在“冰川融水主导”和“降水主导”两种争议。在气候变暖趋势下冰川融水的增加曾被推测为高原湖泊扩张的主要原因。然而，增长的冰川融水是否足够支撑湖泊水量如此快速的增长，在多大程度上贡献湖泊水量增长？回答这些问题成为理解青藏高原湖泊变化驱动机制和内流区水量平衡影响因素的关键点。针对这一问题，课题组联合河海大学柯灵红博士，基于多时相数字高程模型和遥感卫星影像，更新了以主要终端湖为中心的青藏高原内流区湖泊流域划分，并估算了 21 世纪初全流域的湖泊水量变化与冰川物质平衡及冰川-湖泊的水量变化关系。此项研究中发展了基于数字高程模型和多时相卫星影像的湖泊水量变化估算方法，对高原内流区内所有 1 平方公里以上（823 个）湖泊水位与水量变化进行了估算；利用干涉雷达反演的数字高程模型 TanDEM-X 与 SRTM DEMs 获取了全内流区（数据空间覆盖度 98%）的冰川物质平衡。研究结果表明在 2000-2014 之间内流区湖泊增长速率为 9.44 ±1.43 Gt/y， 而冰川水储量损失速率为 0.44 ± 0.80 Gt yr-1，整体上冰川物质平衡对湖泊水量增加的贡献约为 4.7 ± 8.8%，表明冰川水储量的减少量远不足以支持湖泊的水量增加。从湖泊-冰川变化的关系上来看，研究区内 20%的湖泊水储量增加与冰川作用无关（湖泊所在流域内无冰川分布），28%的水量增加所对应的湖泊流域内冰川物质平衡为正或无明显变化，剩下约 52%的水量增长所对应的湖泊流域内冰川呈现不同程度消融但其对湖泊水量增加的贡献低于 20%。此外，团队研究还针对中国最大的内流湖泊青海湖近年来水位快速恢复特征及受冰川物质平衡影响贡献和主控因子等相关问题开展研究。

青藏高原湖泊群大多分布在地势相对平坦的内流湖盆区，是藏区牧民生产生活的主要场所。21 世纪初以来湖泊的快速扩张对周边人居环境的负面影响已逐渐凸显，影响了区域生态安全和可持续发展。课题组利用卫星遥感与实地无人机遥感和访谈等方式，开展湖泊扩张影响及未来变化对当地人居环境（居民点、道路和草场）的潜在影响监测与评估。研究结果显示羌塘湖盆区已有不少草场与居民设施被淹没。在未来 20 年青藏高原内流区湖泊保持现有扩张趋势情景下，预计湖泊扩张将淹没超过 400 个居民点、近 500 公里的主要路网。淹没风险较高的道路和居民点主要位于人口相对集中的羌塘高原东南部和青海湖流域。以昂孜错典型湖泊为例，课题组开展了该湖的扩张洪泛风险评估及临近村庄（果扎村）的搬迁选址方案空间优化。该

研究有望为青藏高原湖泊现代演变对藏区人居环境的影响和未来风险提供科学参考，并在气候变化背景下为制定缓解灾害风险的预案提供科技支撑。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202112/t20211210_6292951.html，根据相关资料编译）

欧亚大陆中北部末次冰盛期以来的湖泊水位变化研究

湖泊是地球表层系统各圈层相互作用的连接点，同时，湖泊因其沉积连续、保存信息丰富、沉积速率较高等特点，忠实记录了全球不同地区气候环境演变信息。湖泊水量变化是流域范围内降水与蒸发的水量平衡的综合体现，单个湖泊水面波动往往受局部地域影响，而区域性乃至全球性的湖泊水量波动则可以较客观地指示大范围降水和湿润程度的变化，进而可以反映水汽输送与大气环流的空间格局。

欧亚大陆北部及中国北方地区面积广大，湖泊众多，加之地形地貌复杂多变，不同地区气候特征存在较大差异，是研究过去区域/全球气候变化及其机制的关键区域。该地区气候复杂，能敏感地随气候变化而改变其环境状况，同时反过来也会因下垫面的改变而影响区域气候变化。

湖泊水位高低通常能有效地指示湖盆内湿润条件的变化，进而反映区域有效降水（降水－蒸发）变化，成为重建第四纪古气候演变的重要指标之一。通过对东欧和蒙古湖泊数据库以及中国古湖泊数据库中 149 个湖泊水位变化资料的梳理总结，探讨了末次盛冰期（18 cal.ka B.P.）以来该地区干湿变化规律及区域分异。根据研究区气候特征和地理位置将其分为东欧湖泊区、中东亚干旱区和中国北方季风区三大湖区。根据不同水量记录在整个湖泊历史中出现的频率，采用三级重新分类区分出高、中、低三级水量，并把每个湖泊数字化的 3 级古水量表示成与现代的差值，得到每个湖泊样点每千年时间间隔内相对现代的 5 级水量变化（很湿润、湿润、无变化、干旱和很干旱）。结果表明，三大湖区末次盛冰期以来可能经历了不同的干湿变化过程：东欧地区湖泊水量记录在晚冰期之前较少，至全新世逐渐增多，且基本表现为早全新世干旱、中晚全新世相对湿润的状况；中东亚干旱区整体呈现出末次盛冰期至中全新世均较湿润而晚全新世干旱的气候状况，但区域内部不同湖泊在起讫时间和强度上存在显著差异；我国北方季风区的湿润期主要发生在早中全新世，但是不同湖泊有所不同。对比分析显示，早全新世时东欧地区东部气候随着斯堪的那维亚冰流的逐渐消退而逐渐变湿润，中全新世由于夏季北欧反气旋东翼的气旋气流增强而达到最湿润状态，西部地区早全新世由于强劲的西伯利亚热高压存在而整体偏干旱，中全新世由于夏季亚洲季风的渗透而转为湿润；中东亚干旱区冰期内的湿润条件可能主要与西风带降水及低温低蒸发有关，而全新世则可能主要与夏季风深入内陆导致降水增加有关；我国北方季风区全新世湿度变化可能主要受东亚季风控制。

本项成果对末次盛冰期（18 cal.ka B.P.）以来东欧及蒙古与我国北方地区湖泊空间水量变化进行分析，揭示不同区域湖泊水位变化历史及其空间分布特征，并探讨气候驱动机制下湖泊水位变化的原因，对客观认识和理解欧亚地区各气候系统之间的内在联系及深入解析全球变化机制提供一定参考。论文得到全球变化重点研发项目支持，通讯作者薛滨，全文发表于地理学报。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202112/t20211214_6298293.html，根据相关资料编译）

宽波段卫星遥感浑浊湖泊水环境方法与应用

湖泊是人类赖以生存的主要淡水储存地，相对于海洋而言，湖泊面积小，但水体环境参数的空间变化大。受限于湖泊的空间尺度和需要的观测细节，常见的海洋水色传感器难以有效监测中小型湖泊。

宽波段陆地卫星传感器具有较高的空间分辨率，是湖泊环境遥感的重要数据源之一，可有效弥补水色卫星的空间观测缺陷。作为典型的宽波段传感器，Landsat 系列传感器（TM、ETM+和 OLI）具有较高的空间分辨率和较长的观测时间两大优势，但仍存在信噪比低、带宽大、波段数量少，且缺少内陆水体叶绿素 a 的光学敏感波段等问题。因此，Landsat 等宽波段卫星传感器估算湖泊叶绿素等参数的性能和算法开发需进一步探究。

在国家自然科学基金重点、面上和青年项目的资助下，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，近三年来针对宽波段传感器估算湖泊水体参数的机理和应用问题，联合加州大学圣芭芭拉分校、NASA 戈达德太空飞行中心（GSFC）、塔尔图大学等机构的科研人员，开展系列研究并取得进展，相关成果发表在 Remote Sensing of Environment、ISPRS Journal of Photogrammetry and Remote Sensing、International Journal of Applied Earth Observation and Geoinformation 等遥感领域顶级期刊上。

（1）研究评估了宽波段传感器辐射敏感性和带宽对遥感水体光学特性的影响，确定了宽波段传感器反演湖泊水色物质浓度的理论可行性。传感器带宽的增加会显著增加传感器的波段和中心波长遥感反射率之间的差异，在 710 nm 和 665 nm 处的差异较其他波长高。分析模型反演水体吸收系数的精度受带宽影响比波段匹配、深度神经网络算法更敏感。带宽的增加主要影响叶绿素 a 估算算法的精度，对悬浮物的算法影响较弱，表明悬浮物、透明度的反演相对可行，但是叶绿素 a 的反演难度较大。同时，研究也提出了内陆水体光学遥感观测时典型波段的带宽阈值。

（2）研究分析了卫星时间分辨率变化对湖泊环境遥感时间序列“真实性”的影响。以江淮流域大型湖泊群 2003-2017 年悬浮物浓度时空分布为例，更长的时间分

辨率会显著增加其 SPM 产品与日尺度 SPM 产品间的差异，这种差异存在时空变异性。卫星不理想观测环境（如云层覆盖）和水质快速变化（如湖泊边界季节性变化、藻华和水生植被分布）是主要原因。为确保卫星获取悬浮物等数据集时间序列不确定性小于 10%，数据观测的时间分辨率的最小要求应在 5 d 之内，水质变化较大的湖泊的时间分辨率最低要求为 3 d。该结果为卫星传感器的选择和湖泊野外实地调查采样频次提供理论支撑。

（3）在空间格局观测上，以 Landsat-8 OLI 为例，开发了一种基于机器学习技术的湖泊叶绿素 a 估算算法，取得了比传统经验算法和随机森林更好的效果。研究获取了中国江淮流域 600 多个 1 km2 以上湖泊的叶绿素 a 时空格局，发现了小型湖泊的叶绿素 a 浓度较大型湖泊更高。在时间序列上，以太湖为例，评价了 TM、ETM+和 OLI 辐射一致性，将 Landsat-8 OLI 的算法扩展到 TM 和 ETM+上，得到了太湖 1984-2019 年非蓝藻水华覆盖水体的叶绿素 a 时空变化规律。虽然 Landsat 系列数据的时间分辨率有限，有效卫星观测影像偏少，该时间序列仍发现了 1984-1992、1994-1997、1999-2009 和 2012-2019 四个叶绿素 a 浓度增加的时间段，为扩展湖泊遥感参数的时间长度提供了实践的支持。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202112/t20211220_6315145.html，根据相关资料编译）

青藏高原湖泊快速扩张引发大规模的流域重组

在气候暖湿化背景下，青藏高原特别是羌塘内流区的湖泊总体呈现快速扩张趋势。现有研究主要关注湖泊面积、水位、水量、水质等要素的变化特征及其驱动机制，较少涉及湖泊扩张对流域地貌形态和水系拓扑关系的反馈影响。针对这一问题，宋春桥研究员课题组联合国内外多家科研机构合作者，结合多年野外调查和多源遥感数据开展深入研究。

研究发现：随着水位的快速上升，部分湖泊已从原有湖盆溢出，进而改变了湖盆间的水文连通性，并引发了大规模的水系流域重组织。近期，相关研究成果发表于地球科学领域权威期刊 Geophysical Research Letters(Nature index 源期刊)和地貌学领域重要刊物 Geomorphology，刘凯博士为论文第一作者。

本研究首先研发了面向湖泊间汇流关系的青藏高原内流区流域自动划分算法，利用该方法并结合多源多时相遥感观测，探测到 2000-2018 年期间青藏高原内流区共发生了 11 起流域水系拓扑关系改变与重组事件，共涉及 24 个内流湖盆，总面积约 6.1 万平方千米 (图 1)。该现象表现出两种不同演化模式：（1）合并型水系流域重组织，即空间邻近的两个终端湖随着水位上涨，越过两者间分水岭并最终合并为一个大湖；（2）溢出型水系流域重组织，即湖泊溢出后，因距离和水位差的原因无法合并为一个统一大湖，而是形成了上下游的汇流关系。

水系流域重组织的发生对湖泊自然演化过程和湖泊周边水文环境造成了显著影响。如扎日南木错 2017 年以来的快速扩张部分可解释为其北部的蔡几错发生了溢出，并通过新形成的水系成为扎日南木错的上游补给湖。汇水区域的扩大从而加速了扎日南木错的扩张，并对其周边草场、村镇以及公路等造成了威胁。此外，水系流域重组织事件并不局限于内流湖盆间，当封闭湖泊溢出、突破现有分水岭并汇入外流流域，还将引发内外流域空间范围的转变，对河源区的流域地貌整体格局与水文过程产生重要影响。如 2011 年发生的卓乃湖溃决引发了一系列的流域重组事件，最终导致了盐湖的快速扩张并逐渐逼近内外流区的分水岭。2019 年通过人工修筑水渠的方式实现了盐湖与长江流域清水河的相连，短期内消除了盐湖因为溢出乃至溃决而威胁青藏铁路的可能性。同时，水文连通性的改变也造成长江河源区吞并了盐湖所在内流河湖系统，总计溯源了约 8400 km2，而新形成的河道在长度上已超过了长江北源楚玛尔河的长度。

考虑到青藏高原暖湿化趋势在较大概率上还将持续，本研究还结合湖泊水量变化速率和湖盆地貌形态，对该区域未来潜在发生的水系流域重组织事件进行了时空预测。结果显示：假设该区域湖泊将持续 21 世纪初以来的水量变化速率，预计截止 2030 年羌塘内流区还将发生 11 起流域重组事件。对于潜在发生水系流域重组织区域需要加强观测，特别是关注突发性事件（如湖泊溃坝、冰川崩塌等）导致的流域重组可能进一步引发水文地质灾害和生态风险。

本研究为深入理解青藏高原湖泊对气候变化的响应特征及其潜在影响提供了新的支撑案例。同时，研究揭示的青藏高原内流区正在发生的大区域、高频次的水系流域重组织方式也是对传统研究关注地质年代以河流袭夺为标志的流域重组事件的重要补充。以上研究得到了中科院战略性先导科技专项、第二次青藏高原综合科学考察研究专项和国家自然科学基金项目等的资助。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202112/t20211224_6326926.html，根据相关资料编译）

中亚干旱区湖泊流域水土资源环境研究

中亚干旱区水资源时空分布不均且匮乏，在全球气候变暖背景下，社会经济发展引起的水质性缺水也日益严重。然而，目前水质水资源环境问题仍未能得到足够的关注，相关研究缺乏，由此给水质评价和水资源开发管理计划带来不确定性。

鉴于此，在国家自然科学基金新疆联合重点项目和中国科学院战略性先导专项等项目资助下，中国科学院南京地理与湖泊研究所吴敬禄研究员团队开展了中亚干旱区湖泊流域水土环境特征及其变化研究，并在河湖流域水质水资源特征、湖泊沉积记录的历史洪水环境事件以及流域沉积物环境空间分布特征等方面取得进展。

针对干旱区河湖流域水质水资源问题，团队以中哈跨境流域巴尔喀什湖-伊犁河流域为例，基于水体化学数据，结合水体氢氧同位素示踪技术，定量估算了自然和人为因素对流域水环境变化的贡献量。研究表明，流域人类活动对水体主要离子组成影响较小，平均贡献量约为 6.6%，而碳酸盐和硅酸盐等岩石矿物风化来源的贡献量分别为 55.1%和 26.7%。空间上，河流中下游地区水体受到人类活动影响明显增强。相关研究成果发表在水文领域主流刊物 Journal of Hydrology。

区域气候环境变化的信息被详细地保存在湖泊及流域沉积物中。通过对沉积物的多环境代用指标综合分析，可以有效地恢复区域气候水文变化历史及环境事件，为正确理解气候环境演化机制、评估未来变化趋势提供科学依据。在此，选取吉尔吉斯坦伊塞克湖浅孔岩芯沉积物，通过多环境代用指标分析，恢复了近 300 年来湖泊水文演化序列，并识别了多次洪水事件。研究表明，AD1860 前后流域内存在显著的气候水文事件，1860 年以来湖泊水位波动剧烈，水位总体下降，期间发生了多次流域洪水事件；近十几年来，区域降水和径流增加，湖泊水位有所回升，但洪水事件频发。通过与山地树轮、冰芯等记录比较，探讨了气候水文演化的机理。相关研究成果发表在水文领域主流刊物 Hydrological Processes。

此外，研究团队通过不同河湖体系表层沉积物元素浓度分析，对主要重金属污染特征、污染来源、生态风险进行研究。计算重金属富集因子（EF）表明，区域内 Cr、Cu 和 Ni 的富集极少，Pb 中度富集，而 Zn 显著富集。从空间分布来看，EF-Pb 值在研究区西北平原区沉积物中最高（R1），其次是伊塞克湖流域（R2），污染最小的区域是咸海流域（R3）和巴尔喀什湖流域（R5）；而 EF-Zn 值在整个研究区域普遍较高。源解析表明，该区人为排放的重金属污染物高于自然源，贡献量分别为 59.58%和 40.42%。但是生态风险评估表明，总体上重金属污染程度低，处于低风险等级。进一步不同污染源的生态风评估显示，燃料燃烧、大气沉降和工业活动等来源的污染物生态风险高于其它来源。相关研究成果发表在主流刊物 Journal of Soils and Sediments。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202112/t20211229_6329308.html，根据相关资料编译）

富营养化湖泊蓝藻毒素和异味物质的组成、分布及生态风险研究

受水体富营养化和全球气候变暖影响，蓝藻水华在全球范围内的湖泊、水库等水体中频繁暴发。蓝藻暴发带来一系列蓝藻毒素和异味物质等衍生物污染问题，对水生态系统安全产生严重威胁。鱼类是水生态系统的重要组成部分，对维持水生态系统稳定有重要作用，但富营养化水体中有害蓝藻及其代谢物的产生给鱼类生存和相关渔业资源发展带来巨大影响。

近年来，蓝藻水华引起的微囊藻毒素污染已经得到了广泛关注，但仍缺乏对富营养化水体中有害蓝藻代谢物的组成多样性、污染程度和环境行为的系统研究。此外，前人研究较多关注于用纯毒素试验对鱼类生长发育的影响，但实际水环境中蓝藻可以产生多种代谢物，它们对鱼类产生的联合作用可能更加复杂，有害蓝藻及其代谢物对鱼类的生理生态影响有待进一步揭示。

在国家重点研发计划和国家自然科学基金等项目的资助下，中国科学院南京地理与湖泊研究所谷孝鸿研究员团队，首次系统调查评估了典型富营养化湖泊太湖多种蓝藻毒素和异味物质的时空变化特征、环境驱动因子及其对人类健康产生的潜在风险，并通过受控实验揭示了常见有害蓝藻及其代谢物对鱼类早期生长发育的影响及作用机制，以期为蓝藻水华风险评估和管理提供新的见解。相关成果发表在国际期刊 Environmental Pollution 等。

研究发现太湖水体中存在多种蓝藻毒素和异味物质。除了常见的微囊藻毒素以外，首次检出柱孢藻毒素和蛤蚌毒素。夏季和秋季水体中微囊藻毒素对人类健康造成不利影响的潜在风险较高，柱孢藻毒素产生的健康风险处于中等水平。异味物质以β-环柠檬醛为主，2-甲基异莰醇次之。春、夏、秋季节，β-环柠檬醛在北部湖区污染都较为严重。研究揭示了太湖有害蓝藻代谢物组成的复杂性，除微囊藻毒素以外，其他蓝藻毒素（如柱孢藻毒素）产生的健康风险也不容忽视，蓝藻水华衍生物的综合生态风险更加需要关注。

针对有害蓝藻及其代谢物对鱼类生长发育的影响方面，通过构建毒性作用通路，发现不同有害蓝藻及其代谢物对鱼类早期胚胎生长发育的影响及机制存在一定差异：微囊藻（产生微囊藻毒素）暴露使斑马鱼胚胎的抗氧化酶活性下降并通过下调 GH/IGF 轴相关基因的表达造成生长抑制，颤藻（产生柱孢藻毒素）暴露没有对斑马鱼胚胎造成生长抑制，但明显增强了斑马鱼胚胎抗氧化酶活性和相关基因的表达。两者差异的原因不仅由于其产生的代谢物种类不同，微囊藻和颤藻细胞在胚胎绒毛膜上的黏附特征差异也可能导致不同的胚胎发育毒性。研究成果表明，仅依据已知蓝藻毒素的生态毒性并不能全面地反应蓝藻水华的危害，蓝藻水华暴发时，应综合考虑水体中蓝藻的种类组成及其可能造成的生态风险。以上研究成果发表在国际期刊 Environmental Pollution。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202112/t20211231_6331621.html，根据相关资料编译）

业界动态

水利部：充分发挥太湖流域调度协调组作用 保障流域“四水”安全

“太湖是流域洪水集散地，是长三角地区水资源调配中心，是区域水生态、水环境的晴雨表。建立流域调度协调机制是维护太湖健康生命的有效手段，是满足人民美好生活需要的必然要求，是保障长三角一体化高质量发展的重要举措。”27 日，在太湖流域调度协调组第一次全体会议上，太湖流域调度协调组组长、水利部部长李国英如是说。

太湖流域位于长三角区域一体化发展和长江经济带发展两大国家战略的交汇点，流域面积 3.71 万平方公里，人口 6755 万人，行政区划主要分属江苏、浙江、上海两省一市，城市化率达 82%，以占全国不到 0.4%的面积，养育了全国 4%的人口，创造了全国近 10%的 GDP，是我国经济最发达、人口最集中、财富最密集的地区之一。

太湖流域是典型的平原河网地区，地势低平、水流缓慢，水工程众多，科学调度水利工程是防范流域洪涝灾害、改善水资源与水环境条件、发挥工程减灾兴利综合效益的关键手段，对保障流域及区域“四水”（水灾害、水资源、水生态、水环境）安全具有重要作用。

李国英指出，党中央、国务院高度重视太湖治理工作。近年来，太湖流域各省市、国务院有关部门同心协力，大力推进太湖治理，强化流域调度，成功抗御数次流域性洪水和严重干旱，及时应对多次太湖蓝藻暴发和突发水污染事件，流域水资源配置体系不断完善，河湖长制体系率先建立，水环境综合治理全面推进，保障了流域防洪安全和供水安全。

（来源：人民网，http://finance.people.com.cn/n1/2021/0928/c1004-32240848.html）

水利部：完善流域防洪工程体系要突出流域单元 牢牢守住水旱灾害防御安全底线

12 月 14 日，水利部党组书记、部长李国英主持召开部务会议，传达学习贯彻中央经济工作会议精神，审议完善流域防洪工程体系的指导意见和实施方案、实施国家水网重大工程的指导意见和实施方案。

议指出，中央经济工作会议认真总结今年经济工作，深入分析当前经济形势，全面部署明年经济工作，系统回答了经济形势怎么看、经济工作怎么干，顺应时代要求，体现时代特征，回答时代之问，为我们凝聚共识、坚定信心、真抓实干做好明年经济工作指明了前进方向、提供了根本遵循。要深入学习贯彻中央经济工作会

议精神，着力推动新阶段水利高质量发展，为经济社会大局稳定提供坚实水利支撑和保障。要坚持稳字当头、稳中求进，积极推出有利于经济稳定的水利政策，充分发挥水利在扩大有效投资、拉动经济增长，防御水旱灾害、推动安全发展，促进资源节约、改善生态环境，助力乡村振兴、保障粮食安全等方面的重要作用。要全面梳理涉及水利重点工作，压实责任、细化措施、明确要求，确保每项工作都能落到实处、取得实效。当前要统筹做好防凌抗旱、水利安全生产、投资计划执行、南水北调冰期输水等岁末年初重点工作，慎终如始抓好疫情防控，确保今年各项工作圆满收官，明年工作起好步、开好局。

会议强调，完善流域防洪工程体系要突出流域单元，强化系统观念，从流域整体着眼把握洪水发生和演进规律，统筹上下游、左右岸、干支流，科学规划、合理布局、有序推进河道及堤防、水库、分蓄洪区建设。要加快补齐短板弱项，针对防汛救灾暴露出的薄弱环节，迅速查漏补缺，加快实施河道畅通及堤防达标建设、控制性水利枢纽建设、病险水库除险加固、分蓄洪区安全建设、中小河流治理、山洪灾害防治等，补好水旱灾害预警监测短板，补好防御水旱灾害基础设施短板。要着力提升防御能力，提高防御标准，加快推进数字孪生流域、数字孪生工程建设，实现预报预警预演预案功能，完善流域防洪调度指挥体系，强化统一规划、统一治理、统一调度、统一管理，牢牢守住水旱灾害防御安全底线。

会议指出，实施国家水网重大工程，要坚持“节水优先、空间均衡、系统治理、两手发力”治水思路，遵循确有需要、生态安全、可以持续的重大水利工程论证原则，立足流域整体和水资源空间均衡配置，科学谋划“纲”“目”“结”工程布局，统筹存量和增量，加强互联互通，协同推进国家、省、市、县四级水网建设，加快构建“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，全面增强我国水资源统筹调配能力、供水保障能力、战略储备能力，提高水资源集约节约利用水平，为全面建设社会主义现代化国家提供有力的水安全保障。

（来源：人民网，http://finance.people.com.cn/n1/2021/1215/c1004-32308667.html）

国家发改委发文推进长江经济带重要湖泊保护治理

从江苏省生态环境厅获悉，经过无人机航测、人工排查、技术核查三级排查，江苏太湖流域入河（湖）排污口排查工作基本完成，共确认各类排污口 20876 个。

太湖治理的关键在于“外源减量、内源减负、生态扩容”，而排污口排查整治，是实现外源减量的关键环节。今年 3 月中旬，江苏太湖流域入河（湖）排污口排查整治工作启动，涉及 163 条骨干河流、106 个湖泊。

“确定排污口的位置及数量只是第一步，还要进行采样监测和溯源核查，目前相关工作已有序开展。”江苏省生态环境厅有关负责人表示，有口必查、有水必测、

有源必溯、有污必治，这将有利于从源头上有效管控入河（湖）污染物排放，提升太湖流域“减磷控氮”水平，推动太湖流域生态环境质量持续改善。

（来源：经济参考报，http://www.jjckb.cn/2021-11/25/c_1310331109.htm）

南水北调工程 7 年向北方调水近 500 亿立方米

12 月 12 日是南水北调工程全面通水 7 周年。记者从中国南水北调集团有限公司了解到，南水北调工程全面通水 7 年来，已累计向北方调水近 500 亿立方米，受益人口达 1.4 亿人，40 多座大中型城市的经济发展格局因调水得到优化。

南水北调东、中线一期工程于 2014 年 12 月 12 日全面通水。东线一期工程从扬州市江都水利枢纽出发，用世界最大规模的泵站群“托举”长江水北上流入山东；中线一期工程从丹江口水库陶岔渠首闸引水入渠，由世界最大的渡槽群“护送”南水千里奔流，润泽豫冀津京。

截至目前，南水北调东、中线一期工程累计调水约 494 亿立方米。其中，东线向山东调水 52.88 亿立方米，中线向豫冀津京调水超过 441 亿立方米。

生态补水方面，南水北调东线沿线受水区湖泊蓄水稳定，生态环境持续向好；中线向北方 50 余条河流生态补水 70 多亿立方米，生态环境得到显著改善，同时使华北地区浅层地下水水位实现止跌回升。水利部相关负责人表示，南水北调工程全面通水 7 年来，改变了北方地区的供水格局，同时推动复苏受水区河湖生态环境，发挥了巨大的经济、社会和生态效益。

水质方面，目前东线输水干线水质全部达标，并持续稳定保持在地表水水质Ⅲ类以上；丹江口水库和中线干线供水水质，稳定在地表水水质Ⅱ类以上。中国工程院院士、水文水资源学家王浩表示，南水北调工程全面通水以来取得成效，主要在于以节水倒逼用水和经济发展方式转变，以环保治污推动区域水生态环境持续向好，以精准调水保障受水区供水安全，以统筹配置南水发挥工程生态效益。

南水北调东、中线工程是“四横三纵”国家骨干水网的重要组成部分。根据《南水北调工程总体规划》，以长江丰富水源为依托，南水北调东线、中线和西线工程，通过与长江、淮河、黄河、海河 4 大江河的联系，构成以“四横三纵”为主体的国家水网骨干。

“十四五”规划纲要明确提出，推动南水北调东中线后续工程建设，深化南水北调西线工程方案比选论证。目前，南水北调工程正在推进东、中线后续工程规划建设，同时开展西线工程规划方案比选论证等前期工作。

（来源：新华网，https://kepu.gmw.cn/2021-12/13/content_35376368.htm）

我国七大流域将强化流域治理管理

从水利部获悉：我国七大流域将强化流域统一规划、统一治理、统一调度、统一管理，提高流域治理管理能力和水平，推动新阶段水利高质量发展。

党和国家历来高度重视大江大河大湖流域治理管理，在黄河、长江、淮河、海河、珠江等七大流域相继设立管理机构，实施了一系列流域综合治理重大举措。黄河流域实施全流域水资源统一调度，成功实现黄河连续 22 年不断流；长江流域目前实施 107 座控制性水工程联合综合调度，实现了防洪、供水、生态、发电、航运等效益多赢；珠江流域连续 17 年实施枯水期水量调度。

水利部提出了强化流域治理管理的重点任务：统一规划上，将健全定位准确、边界清晰、功能互补、统一衔接的流域专业规划体系；统一治理上，坚持区域服从流域的基本原则，统筹协调上下游、左右岸、干支流关系，科学确定工程布局、规模、标准；统一调度上，强化流域多目标统筹协调调度，建立健全各方利益协调统一的调度体制机制，强化流域防洪统一调度、水资源统一调度、生态流量水量统一调度；统一管理上，构建流域统筹、区域协同、部门联动的管理格局，加强流域综合执法，充分发挥河湖长制作用，推进流域联防联控联治，强化河湖统一管理、水权水资源统一管理，一体提升流域水利管理能力和水平。

（来源：人民网，http://gs.people.com.cn/n2/2021/1206/c396711-35037538.html）

我国 31 省份全部设立党政双总河长

从水利部获悉，5 年来，我国全面推行河湖长制取得显著成效。31 个省份全部设立党政双总河长，明确省、市、县、乡级河湖长 30 多万名，村级河湖长（含巡（护）河员）90 万名，其中，中西部地区建档立卡贫困人口 22 万名，建立了上下贯通、环环相扣的责任链条。

水利部相关负责人表示，5 年来，水利部与各地区各部门共同努力，推动解决了一大批长期想解决而没有解决的河湖保护治理难题，我国江河湖泊面貌发生了历史性变化，人民群众的获得感、幸福感、安全感显著增强，河湖长制焕发出勃勃生机。据介绍，打通河湖长制“最初一公里”到“最后一公里”，我国河湖管护责任体系全面建立。2018 年以来，省、市、县、乡级河湖长年均巡查河湖 700 万人次。省、市、县全部设立河长制办公室，专职人员超 1.6 万名，部分乡镇也因地制宜设立河长制办公室。七大流域建立“流域管理机构+省级河长制办公室”联席会议制度，20 多个省份建立跨省界河湖联防联控机制，上下游、左右岸、干支流地区签订联合共治协议，设立联合河长湖长，开展联合巡查执法，形成了河湖管理保护强大合力。

重拳整治河湖乱象，河湖面貌持续向好。多地建立“河长+警长”“河长+检察长”机制，形成“党政负责、水利牵头、部门协同”的工作局面。面对河湖“老大难”问题，各地纪检监察机关加强执纪监督、挂牌督办，对履职不力河湖长及有关部门负责同志严肃问责，2018 年以来共问责 1.1 万人次。5 年来，水利部组织开展河湖“清四乱”专项行动，各地共清理整治河湖“四乱”（乱占、乱采、乱堆、乱建）问题 18.7 万个，整治违建面积 4000 多万平方米，清除非法围堤 1 万多公里、河道内垃圾 4000 多万吨，清理非法占用岸线 3 万公里，打击非法采砂船 1.1 万多艘。

河湖保护治理任重道远。水利部相关负责人表示，下一步，将进一步完善以党政主要领导为主体的责任体系，健全一级带一级、一级督一级，上下贯通、层层落实的河湖管护责任链，确保每条河流、每个湖泊有人管、有人护，全力把河湖长制实施向纵深推进。

（来源：人民网，https://m.gmw.cn/2021-12/14/content_1302719337.htm）

“数字巢湖”让流域水污染“标本兼治”

安徽省巢湖管理局召开了环巢湖水质监测系统改扩建工程和巢湖蓝藻水华监测预警与模拟分析平台（以下简称“数字巢湖”）项目（四标段）验收会。该标段项目主要由中国科学院南京地理湖泊研究所（以下简称南京地湖所）科研团队承担。段洪涛介绍：“南京地湖所最早介入巢湖的研究可以追溯到 20 世纪 50～60 年代，并在 80 年代末主持了巢湖富营养化‘七五’国家攻关项目的研究。2006 年至今，南京地湖所主持了‘十一五’至‘十三五’巢湖 3 个水专项项目及 6 项课题，取得一系列重要进展和成果。”

“十一五”期间，南京地湖所承担的“巢湖水污染治理与富营养化综合控制技术及工程示范”项目，主要针对巢湖东部饮用水源区的水体富营养化和蓝藻水华频发、威胁供水安全的问题，利用削减入湖污染负荷和蓝藻水华灾害防控等技术，改善了水源地水质，保障了湖泊水源地供水安全。

其中，在化解 2010 年夏季巢湖水源地因蓝藻水华引起的供水危机中，南京地湖所科研团队将蓝藻水华预测预警—智能拦截—高效无害打捞等技术进行集成，形成了湖泊水源地蓝藻水华灾害防控关键技术与设备，该技术和设备还在其它流域得到推广使用，获得显著成效。

此次段洪涛等人承担的“十三五‘水专项’”课题是“水环境目标水质管理平台集成技术巢湖流域验证应用与推广”，课题组研制出蓝藻水华监测预警模型、基于流域水情工况的入湖污染负荷削减动态优化等关键技术，在地方“数字巢湖”项目中进行示范应用，先后研发出“巢湖蓝藻水华监测预警与模拟分析平台”和“农村流域面源网格化管理系统”。

（来源：中国科学院官网，https://www.cas.cn/cm/202111/t20211110_4813423.shtml）

云南全力推进高原湖泊生态修复

10 月 13 日，在 COP15 新闻中心举行主题为“高原湖泊生态修复”的云采访活动。受邀嘉宾和线上嘉宾以昆明滇池和大理洱海为例，介绍了云南在高原湖泊生态修复方面做出的巨大努力。

习近平总书记对云南的高原湖泊保护十分重视。2015 年 1 月，习近平总书记考察云南，在洱海边嘱托“一定要把洱海保护好”。2020 年 1 月，习近平总书记再次来到云南，在滇池畔查看了由中国科学院昆明动物研究所与昆明植物所共同制作的“滇池湖泊生态系统活体展示缸”。

作为展示缸主要参与人之一，中国科学院昆明动物研究所研究员杨君兴表示，这个展示缸模拟的是云南高原湖泊治理最理想的状态，目前该生态系统已经用于滇池生态修复。“在滇池宝丰湿地，大家可以看到这个湿地就是一个放大的‘生态缸’，即以花、鱼、螺、蚌、鸟这些滇池原有的生物来修复湿地、治理滇池。”

他表示，滇池需要的是生态修复，不能简单照搬其他湖泊的治理经验。“‘生态缸’里的海菜花、金线鲃和无齿蚌分别代表的是滇池土著植物、鱼类和螺蚌，这个微缩版生态系统是今后滇池水域有望达到的理想状态。随着生态修复，会有越来越多本土物种回归、重现，不但让滇池生物多样性更丰富，还能形成立体平衡的生态系统。”

杨君兴认为，滇池的生物多样性不仅仅是属于昆明或者云南，它对于全世界来说都有着重要的生态价值。“因为很多滇池特有的物种，比如以金线鲃为代表的滇池特有鱼类就多达 12 种，而这些鱼类只有这里才有，全世界其他地方是看不见的。”

对于洱海的治理，国家水体污染控制与治理科技重大专项首席科学家孔海南在过去近 20 年里，带领团队不懈攻关，终让曾因过度开发而污染严重的洱海重现昔日大理“母亲湖”的风采。

“1996 年洱海大规模藻华暴发时，我第一时间就赶去了。当时藻华已经退去，洱海还有数十平方公里的‘水下森林’，但仅仅两三年后，‘水下森林’就消失殆尽。通常来说，‘水下森林’的面积越大，意味着湖水的水质越好。”今年 70 岁的孔海南通过视频连线回忆，洱海水环境恶化引起了国家与云南省的高度关注，洱海保护还被纳入“水体污染控制与治理”科技重大专项。

孔海南和同事们调研发现，洱海问题的根源——面源污染是一些散落在洱海周边的“小污染”，比如种植大蒜、养殖奶牛等积累起来的。为了保护好大理人民的“母亲湖”，从当地政府到流域内群众以壮士断腕的决心，对发展模式和生产方式做出了

巨大改变，当地百姓甚至放弃了传统的大蒜种植，改种其他作物，为湖泊保护让路。随着水质越来越好，对生长环境的水质要求极高的海菜花也开始在洱海重现。

“我把 20 株海菜花带回了上海交大，种在大缸里。海菜花回归的故事，正是洱海治理成果的见证，更是对‘绿水青山就是金山银山’的最佳注解。”

“现在洱海全流域已经建起截污管道，每隔 30 里设立一个污水处理厂。下一阶段的治理目标是要回到洱海原初生态，可能还要很长的一段时间。”孔海南说，“我的年纪大了，但团队里有很多年轻的‘治水人’，他们会继续干下去。同时，我们投资了 800 万元设立了洱海保护人才教育基金，希望有更多的人加入到保护洱海行动中来。”

（来源：云南日报，http://yn.people.com.cn/n2/2021/1014/c378439-34955336.html）

中国科学家首次在怒江源头冰川成功钻取冰芯

怒江是中国西南地区的大河之一，它全长3240千米，其中中国境内有2013千米，从西藏流经云南，流入缅甸，最后注入印度洋的安达曼海。

对于怒江源头的布加岗日冰川科考，过去受到攀登条件限制很难开展，这次科学家采用直升机来运输科考物资和人员，解决了难题。那么中国科学家是如何首次在怒江源头冰川成功钻取冰芯的，来看记录。

2021年10月13日，科考直升机第一次从怒江源头布加岗日冰川脚下的大本营起飞，起飞点海拔4200米，终点是6200多米的冰芯钻取点。

沿途，我们可以看到冰前湖、冰塔林、冰裂隙，还有十分震撼的完整冰川画面。由于登山难度大，这座山峰过去没有人登过，更没有展开科考。

第二次青藏科考冰川科考分队队长、中科院青藏高原研究所研究员 徐柏青：布加岗日这个地方在青藏高原东部的中段。长期以来，我们的手段不行，人是上不去的。这地方有很多的冰崖、冰瀑布区域。现在正好借助二次科考，我们有直升机这种先进的手段，能够把人和物资直接运输到冰面，实际是弥补了从南到北关于恢复季风演化的一个空白点。

即使有直升机，难度也很大，因为山顶的风力有时达到8、9级，要在6200多米的冰芯钻取营地，装卸物资，困难重重。半个小时后，直升机抵达营地。

这个黄色的帐篷就是冰芯钻取点，它搭建在1.5米深的雪坑上，这样才能防风。从10月16日开始打第一钻到10月22日，28名科考队员组成的科考队成功钻取了一根长80米、直径82毫米的透顶冰芯，也就是机械钻最后触及到岩层。到11月底，科考队总共钻取了4根冰芯，直升机飞行了58次。

徐柏青：我们总共是钻取了4根冰芯，有两根80米透底的，还有两根是打到水层，大概35米。这样的话，总共下来大概是230米左右的冰芯。

青藏高原是世界屋脊、亚洲水塔、地球第三极，也是我国重要的生态安全屏障。我国从2017年8月19日正式启动了第二次青藏科考，主要是聚焦水、生态、人类活动。通过十大任务，揭示青藏高原环境变化机理，优化生态安全屏障体系，推动青藏高原可持续发展和推进国家生态文明建设等。

这次怒江源头钻取冰芯就是十大任务中“西风、季风协同作用及其影响和亚洲水塔动态变化与影响”的重要组成。

徐柏青：主要就是要恢复不同时间尺度的季风是如何演化的，西风是如何演化的，二者如何相互作用。从不同时间尺度来恢复、发现一些规律、周期及其对青藏高原的生态系统，环境演化的影响，这是最核心的任务。最终的目的是要解决青藏高原环境变化的机理问题。

（来源：央视新闻，https://news.sciencenet.cn/htmlnews/2021/12/470167.shtm）

长江北源最大湖泊首次获精准测量

记者从青海省水文水资源测报中心获悉，科研人员已完成长江北源最大湖泊多尔改错湖的精准测量，首次获得的系列数据，将为今后生态保护等提供科学可靠数据支撑。

据悉，多尔改错湖(又称：叶鲁苏湖)位于青藏高原唯一一处世界自然遗产青海可可西里，属长江北源楚玛尔河上的外流咸水湖，湖水主要依赖楚玛尔河补给，是长江北源最大湖泊。

青海省水文水资源测报中心技术部副部长王岗介绍说，2020 年测量时，多尔改错湖面水位 4683 米，水面面积 176 平方千米，最大湖长 33.7 千米，最小湖宽 10.7 千米，最大水深 8.8 米，湖容积 4.3 亿立方米。

“面对可可西里无人区氧气稀薄、气候变化无常等极为艰苦的条件，测量过程采用了最新的测绘技术和数据处理方法。”王岗说，“本次测量获取多尔改错水下地形图、水位-面积-容积曲线等数据资料，将为多尔改错的水资源管理、环境保护和水量普查调度等提供科学可靠的数据支撑。。

（来源：中国新闻网，https://news.sciencenet.cn/htmlnews/2021/12/470261.shtm）