湖泊流域动态

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新文速递

Widespread deoxygenation of temperate lakes

Jane, Stephen F; Hansen, Gretchen J A; Kraemer, Benjamin M; 等.

The concentration of dissolved oxygen in aquatic systems helps to regulate biodiversity1,2, nutrient biogeochemistry3, greenhouse gas emissions4, and the quality of drinking water5. The long-term declines in dissolved oxygen concentrations in coastal and ocean waters have been linked to climate warming and human activity6,7, but little is known about the changes in dissolved oxygen concentrations in lakes. Although the solubility of dissolved oxygen decreases with increasing water temperatures, long-term lake trajectories are difficult to predict. Oxygen losses in warming lakes may be amplified by enhanced decomposition and stronger thermal stratification8,9 or oxygen may increase as a result of enhanced primary production10. Here we analyse a combined total of 45,148 dissolved oxygen and temperature profiles and calculate trends for 393 temperate lakes that span 1941 to 2017. We find that a decline in dissolved oxygen is widespread in surface and deep-water habitats. The decline in surface waters is primarily associated with reduced solubility under warmer water temperatures, although dissolved oxygen in surface waters increased in a subset of highly productive warming lakes, probably owing to increasing production of phytoplankton. By contrast, the decline in deep waters is associated with stronger thermal stratification and loss of water clarity, but not with changes in gas solubility. Our results suggest that climate change and declining water clarity have altered the physical and chemical environment of lakes. Declines in dissolved oxygen in freshwater are 2.75 to 9.3 times greater than observed in the world's oceans6,7 and could threaten essential lake ecosystem services2,3,5,11.

（来源：NATURE 卷:594 期:7861 页: 66-70 出版年: 2021, **DOI:** 10.1038/s41586-021-03550-y）

Watersheds may not recover from drought

Tim J. Peterson,M. Saft, M. C. Peel, 等

The Millennium Drought (southeastern Australia) provided a natural experiment to challenge the assumption that watershed streamflow always recovers from drought. Seven years after the drought, the runoff (as a fraction of precipitation) had not recovered in 37% of watersheds, and the number of recovered watersheds was not increasing. When recovery did occur, it was not explained by watershed wetness. For those watersheds not recovered, ~80% showed no evidence of recovering soon, suggesting persistence within a low-runoff state. The post-drought precipitation not going to runoff was found to be likely going to increased evapotranspiration per unit of precipitation. These findings show that watersheds can have a finite resilience to disturbances and suggest that hydrological droughts can persist indefinitely after meteorological droughts.

（来源：SCIENCE 卷: 372 期: 6543 页: 745-749 出版年: 2021, **DOI:** 10.1126/science.abd5085）

Overriding water table control on managed peatland greenhouse gas emissions

Evans, C. D.; Peacock, M.; Baird, A. J.; 等.

Global peatlands store more carbon than is naturally present in the atmosphere(1,2). However, many peatlands are under pressure from drainage-based agriculture, plantation development and fire, with the

equivalent of around 3 per cent of all anthropogenic greenhouse gases emitted from drained peatland(3-5). Efforts to curb such emissions are intensifying through the conservation of undrained peatlands and re-wetting of drained systems(6). Here we report eddy covariance data for carbon dioxide from 16 locations and static chamber measurements for methane from 41 locations in the UK and Ireland. We combine these with published data from sites across all major peatland biomes. We find that the mean annual effective water table depth (WTDe; that is, the average depth of the aerated peat layer) overrides all other ecosystem- and management-related controls on greenhouse gas fluxes. We estimate that every 10 centimetres of reduction in WTDe could reduce the net warming impact of CO2 and CH4 emissions (100-year global warming potentials) by the equivalent of at least 3 tonnes of CO2 per hectare per year, until WTDe is less than 30 centimetres. Raising water levels further would continue to have a net cooling effect until WTDe is within 10 centimetres of the surface. Our results suggest that greenhouse gas emissions from peatlands drained for agriculture could be greatly reduced without necessarily halting their productive use. Halving WTDe in all drained agricultural peatlands, for example, could reduce emissions by the equivalent of over 1 per cent of global anthropogenic emissions.

（来源：NATURE 发表日期: APR 2021, **DOI:** 10.1038/s41586-021-03523-1）

Climate change drives widespread shifts in lake thermal habitat

Kraemer, B.M., Pilla, R.M., Woolway, R.I. ,等

Lake surfaces are warming worldwide, raising concerns about lake organism responses to thermal habitat changes. Species may cope with temperature increases by shifting their seasonality or their depth to track suitable thermal habitats, but these responses may be constrained by ecological interactions, life histories or limiting resources. Here we use 32 million temperature measurements from 139 lakes to quantify thermal habitat change (percentage of non-overlap) and assess how this change is exacerbated by potential habitat constraints. Long-term temperature change resulted in an average 6.2% non-overlap between thermal habitats in baseline (1978–1995) and recent (1996–2013) time periods, with non-overlap increasing to 19.4% on average when habitats were restricted by season and depth. Tropical lakes exhibited substantially higher thermal non-overlap compared with lakes at other latitudes. Lakes with high thermal habitat change coincided with those having numerous endemic species, suggesting that conservation actions should consider thermal habitat change to preserve lake biodiversity.

（来源：Nature Climate Change 卷:11 页: 521-529 出版年: 2021, **DOI:** 10.1038/s41558-021-01060-3）

Global carbon dioxide efflux from rivers enhanced by high nocturnal emissions

Gomez-Gener, Lluis; Rocher-Ros, Gerard; Battin, Tom; 等.

Carbon dioxide (CO_2) emissions to the atmosphere from running waters are estimated to be four times greater than the total carbon (C) flux to the oceans. However, these fluxes remain poorly constrained because of substantial spatial and temporal variability in dissolved CO_2 concentrations. Using a global compilation of high-frequency CO_2 measurements, we demonstrate that nocturnal CO_2 emissions are on average 27% (0.9 gC m(-2) d(-1)) greater than those estimated from diurnal concentrations alone. Constraints on light availability due to canopy shading or water colour are the principal controls on observed diel (24 hour) variation, suggesting this nocturnal increase arises from daytime fixation of CO_2 by photosynthesis. Because current global estimates of CO_2 emissions to the atmosphere from running

waters (0.65-1.8 PgC yr(-1)) rely primarily on discrete measurements of dissolved CO_2 obtained during the day, they substantially underestimate the magnitude of this flux. Accounting for night-time CO_2 emissions may elevate global estimates from running waters to the atmosphere by 0.20-0.55 PgC yr(-1). Failing to account for emission differences between day and night will lead to an underestimate of global CO_2 emissions from rivers by up to 0.55 PgC yr(-1), according to analyses of high-frequency CO_2 measurements.

（来源：NATURE GEOSCIENCE 卷: 14 期: 5 出版年: 2021, **DOI:**10.1038/s41561-021-00722-3）

Half of global methane emissions come from highly variable aquatic ecosystem sources

Rosentreter, Judith A.; Borges, Alberto, V; Deemer, Bridget R;等

Atmospheric methane is a potent greenhouse gas that plays a major role in controlling the Earth's climate. The causes of the renewed increase of methane concentration since 2007 are uncertain given the multiple sources and complex biogeochemistry. Here, we present a metadata analysis of methane fluxes from all major natural, impacted and human-made aquatic ecosystems. Our revised bottom-up global aquatic methane emissions combine diffusive, ebullitive and/or plant-mediated fluxes from 15 aquatic ecosystems. We emphasize the high variability of methane fluxes within and between aquatic ecosystems and a positively skewed distribution of empirical data, making global estimates sensitive to statistical assumptions and sampling design. We find aquatic ecosystems contribute (median) 41% or (mean) 53% of total global methane emissions from anthropogenic and natural sources. We show that methane emissions increase from natural to impacted aquatic ecosystems and from coastal to freshwater ecosystems. We argue that aquatic emissions will probably increase due to urbanization, eutrophication and positive climate feedbacks and suggest changes in land-use management as potential mitigation strategies to reduce aquatic methane emissions

（来源：NATURE GEOSCIENCE 卷: 14 期: 4 出版年: 2021, **DOI:**10.1038/s41561-021-00715-2）

The impact of glaciers on mountain erosion

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Glaciers and ice sheets erode mountains and produce vast quantities of sediments that are delivered to rivers and oceans, impacting global sediment and biogeochemical balances. Therefore, understanding how the production of sediments by glacial erosion has evolved in the past, and will evolve in a changing climate, is increasingly important. In this Review, we examine the processes that control the magnitude and timing of glacial erosion of mountains, and how models can be used to reconstruct processes during the development of mountains. Field observations reveal the important role of sliding on the erosion rate, which provide an empirical basis to explain the glacial buzzsaw and the impact of late Cenozoic cooling on erosion rates. Glacial erosion is also expected to evolve in the context of anthropogenic climate warming, as both glacier sliding and the input of meltwater related to thinning and retreat of ice will change, with large effects on downstream ecosystems and global biogeochemical cycles. Thus, the mechanics and impacts of glaciers on sediment production warrant more research, especially in regions experiencing rapid warming. Above all, there is a need for better monitoring of how erosion rates changed over the last decades and will evolve in the future.

How glaciers affect mountain height, and the links between climate and glacial erosion in mountains, are debated. This Review describes the erosion of mountains by glaciers and the broader impacts of these

processes.

（来源：Nature Reviews Earth & Environment 发表日期: MAY 2021, **DOI:** 10.1038/s43017-021-00165-9）

Glacial change and hydrological implications in the Himalaya and Karakoram

Yong Nie, Hamish D. Pritchard, Qiao Liu,等

Glaciers in the Himalaya–Karakoram mountain ranges harbour approximately half of the ice volume in High-mountain Asia and modulate the flow of freshwater to almost 869 million people within the Indus, Tarim, Ganges and Brahmaputra river basins. Since the mid-twentieth century, rising temperatures have led to unsustainably high melting rates for many glaciers, particularly in the Himalaya, temporarily increasing summer meltwater run-off but continuously reducing the ice-storage volume. In this Review, we discuss how and why glaciers and meltwater supplies have changed, how they will likely evolve in the future and how these changes impact water resources and water-related hazards. Heterogeneous glacier retreat is changing streamflow patterns, in turn, affecting the incidence of glacial-lake outburst floods and exacerbating the risk of flooding and water shortages associated with future climate change. These changes could negatively impact downstream populations and infrastructure, including the thriving hydropower sector and some of the world's largest irrigated agriculture systems, by making water flow more extreme and unpredictable. An improved in situ monitoring network for weather, hydrology and glacier change is a crucial requirement for predicting the future of this resource and associated hazards, and their impact on regional water, energy and food security.

（来源：Nature Reviews Earth & Environment 卷:11 页: 91-106 出版年: 2021, **DOI:** 10.1038/s43017-020-00124-w）

摘要精选

Quantitative estimates of Holocene glacier meltwater variations on the Western Tibetan Plateau

Li, Can-Ge; Wang, Mingda; Liu, Weiguo; 等

Knowledge of the alpine glacier meltwater variations is fundamental prerequisite for understanding glacier dynamics and assessing the availability of freshwater resources. Glaciers on the Tibetan Plateau (TP) are sources of water for most major Asian rivers, but their melting history remains unclear, preventing in-depth understanding of their mechanisms. Here, we propose the authigenic carbonate delta O-18 from glacial lakes as a quantitative proxy to estimate variations of glacier meltwater. In the Western Kunlun Mountain, 6 18 0 record at Guozha Co indicates that maximum glacier meltwater (-28.62 +/- 25.76 Gt) occurred at 9.5-8.5 ka BP, and minimum glacier meltwater (24.53 +/- 25.02 Gt) at 1.3-0.5 ka BP. Nearly 20% of regional glaciers melted from the Early to Late Holocene, likely controlled by the summer temperature and accumulation of melting potential estimated by positive degree-day. Based on the projected temperature, this study suggests the TP glaciers likely face severe threats at the current rates of global warming.

（来源：EARTH AND PLANETARY SCIENCE LETTERS 卷: 558 出版年: 2021, **DOI:** 10.1016/j.epsl.2021.116766）

Formation of the Three Gorges (Yangtze River) no earlier than 10 Ma

Zhang, Zengjie; Daly, Stephen J.; Li, Chang'an; 等.

The timing of formation of the Three Gorges, a critical capture point on the Yangtze River, has been debated for more than a century. In this paper, we review the existing evidence and apply two sedimentary provenance proxies (Pb isotopic compositions of detrital K-feldspar and detrital zircon U?Pb ages) to date its incision based on samples from the early Cretaceous to Quaternary western Jianghan Basin and from the Neogene Yangtze Gravel, both located downstream of the Three Gorges. We show that from the early Cretaceous to the late Eocene, the western Jianghan Basin was mainly fed by the proximal sources, including the Qinling orogen and the Huangling dome. Similarly, from the latest Oligocene to the Miocene, local paleo-rivers supplied the Yangtze Gravel, mainly from the nearby Tongbai-Dabieshan. By the late Pliocene, the Jianghan Basin was fed by a river delivering sands with a Pb isotopic character indistinguishable from that of the modern Yangtze River. These provenance indicators suggest that the Three Gorges was cut through after the late Miocene (-10 Ma) but prior to the late Pliocene (-3.4 Ma). Cretaceous-Cenozoic deposits from the Jianghan Basin and the Yangtze Gravel have a detrital zircon U?Pb geochronology signature indistinguishable from that of the modern Yangtze River. It is inferred from this that the detrital zircon provenance signal has effectively been homogenized by complex transportation/recycling processes in the Yangtze Craton.

（来源：EARTH-SCIENCE REVIEWS 卷: 216 出版年: 2021, **DOI:** 10.1016/j.earscirev.2021.103601）

Water quality variation in tributaries of the Three Gorges Reservoir from 2000 to 2015

Xiang, Rong; Wang, Lijing; Li, Hong; 等.

The Three Gorges Reservoir (TGR) underwent staged impoundment during 2003-2010. Periodic water impoundment included drainage (March to early June), low water level (June to August), impoundment (September to October), and high water level (November to February) periods. However, the impacts of the Three Gorges Dam (TGD) and impoundment on water quality of TGR tributaries remain poorly understood, especially in the long term and across the entire TGR drainage basin. Herein, water quality and hydrological indices of 27 tributaries, eutrophication of 38 tributaries, and pollution load of the TGR were determined during 2000-2015 to explore spatiotemporal variations in water quality. The results revealed slower flow velocity in tributaries and an extended residence time with the water level rising, and the water quality of tributaries was mainly affected by the mainstream backwater movement. Water quality was good in more than 60% of tested sites, had the best condition in the impoundment period, and it increased over time. Spatially, water quality in tributary upstream was better than in the backwater area, and worst in the tributary estuary. Among water quality indices, total nitrogen (TN) and total phosphorus (TP) were the key pollution indices, with median range of 1.619- 2.739 and 0.088-0.277 mg/L, respectively. Additionally, water quality indices of TGR tributaries displayed temporal and spatial heterogeneity due to different hydrodynamic and pollution load conditions. A total of 38 tributaries displayed eutrophication, the frequency of blooms concentrated in spring and increased from the upper tributaries to the downstream area. These results expanded the theory of hydrodynamic variation and the associated evolution of the water environment after impoundment, could provide theoretical references for water quality management in river-type reservoir.

（来源：WATER RESEARCH 卷: 195 出版年: 2021, **DOI:** 10.1016/j.watres.2021.116993）

Effects of phytoplankton blooms on fluxes and emissions of greenhouse gases in a eutrophic lake

Bartosiewicz, Maciej; Maranger, Roxane; Przytulska, Anna; 等.

Lakes are important sources of greenhouse gases (GHGs) to the atmosphere. Factors controlling CO2, CH4 and N2O fluxes include eutrophication and warming, but the integrated influence of climate-warming driven stratification, oxygen loss and resultant changes in bloom characteristics on GHGs are not well understood. Here we assessed the influence of contrasting meteorological conditions on stratification and phytoplankton bloom composition in a eutrophic lake, and tested for associated changes in GHGs inventories in both the shallow and deep waters, over three seasons (2010-2012). Atmospheric heatwaves had one of the most dramatic effects on GHGs. Indeed, cyanobacterial blooms that developed in response to heatwave events in 2012 enhanced both sedimentary CH4 concentrations (reaching up to 1mM) and emissions to the atmosphere (up to 8 mmol m & minus;2 d & minus;1). That summer, CH4 contributed 52% of the integrated warming potential of GHGs produced in the lake (in CO2 equivalents) as compared to between 34 and 39% in years without cyanobacterial blooms. High CH4 accumulation and subsequent emission in 2012 were preceded by CO2 and N2O consumption and under-saturation at the lake surface (uptakes at 30 mmol m(-2) d(-1) and -1.6 mu mol m(-2) d(-1), respectively). Fall overturn presented a large efflux of N2O and CH4, particularly from the littoral zone after the cyanobacterial bloom. We provide evidence that, despite cooling observed at depth during hot summers, CH4 emissions increased via stronger stratification and surface warming, resulting in enhanced cyanobacterial biomass deposition and intensified bottom water anoxia. Our results, supported by recent literature reports, suggests a novel interplay between climate change effects on lake hydrodynamics that impacts both bloom characteristics and GHGs production in shallow eutrophic lakes. Given global trends of warming and enrichment, these interactive effects should be considered to more accurately predict the future global role of lakes in GHG emissions.

（来源：WATER RESEARCH 卷: 196 出版年: 2021, **DOI:** 10.1016/j.watres.2021.116985）

Spatiotemporal dynamics of coupled dissolved silica and bicarbonate in a dam-induced urban lake system in the Three Gorges Reservoir Area

Li, Tianyang; He, Binghui; Zhang, Yuqi; 等.

Dissolved silica (DSi) and bicarbonate (HCO3-) stoichiometric coupling is collectively regulated by chemical weathering and algal activity, and potentially indicates the aquatic silicon retention and carbon emission in aquatic systems. Damming markedly remodels the hydrological conditions and aquatic biological activity, however, its effects on the spatiotemporal dynamics of coupled DSi and HCO3- remain poorly understood. Here we deciphered a 2-year hydrological and water quality dataset collected at multiple sites within an urban lake, namely Hanfeng Lake, the largest pre-dam of the Three Gorges Reservoir, to unravel the spatiotemporal dynamics of DSi and HCO3- and selected hydrological and water quality variables using cluster analysis, and to explore the best predictors for DSi:HCO3- using partial least squares regression. The changes of DSi, HCO3- and selected water variables could be characterized by spatial east and west zones, and further by temporal periods 1, 2 and 3 corresponding respectively to fluctuation stage, fluvial stage and lacustrine stage in each zone based on the hydrographic features of Hanfeng Lake. Wet season presented higher flow velocity, permanganate index, concentrations of DSi, HCO3-, nitrate-nitrogen and total suspended solids, and lower water level, secchi

depth and chlorophyll-a, but equal DSi:HCO3- relative to dry season. DSi was overall negatively correlated with HCO3-, highlighting the dominant role of chemical weathering rather algal activity. DSi:HCO3- exhibited significant relationships with various variables, but was the best predictable using water level, permanganate index and nitrogen-based variables, suggesting the strong effects of water level fluctuation and pollution discharge on the coupling of silicon and carbon. Our results have great significance for understanding and modeling the biogeochemical cycles of silicon and carbon in the dam-induced lake ecosystems worldwide.

（来源：JOURNAL OF HYDROLOGY 卷: 597 出版年: 2021, **DOI:** 10.1016/j.jhydrol.2021.126181）

Whole-lake methane emissions from two temperate shallow lakes with fluctuating water levels: Relevance of spatiotemporal patterns

Schmiedeskamp, Marcel; Praetzel, Leandra Stephanie Emilia; Bastviken, David; 等

Water clarity (expressed as Secchi disk depth (SDD)) reflects light transmission capacity of a water body and influences growth of aquatic plants, aquatic organisms, and primary productivity. Here, we calibrated and validated a general model based on Landsat series data for deriving SDD of various inland waters across China. The quality of remotely sensed reflectance products from different Landsat series images was assessed using in situ reflectance measurements. The results indicated that the products in the visible bands are the most robust and stable to estimate SDD for inland waters. Subsequently, a simple power function model based on red band was built using 887 pairs of in situ SDD measurements and concurrent Landsat images. The model was validated with an independent dataset of 246 SDD measurements, and the results showed that the mean relative error and normalized root mean square error were 34.2% and 55.4%, respectively. Finally, the model was applied to Landsat images acquired between 2016 and 2018 to investigate the SDD spatial distribution of all lakes with water area ≥ 10 km2 (total 641 lakes) in China. The estimation results demonstrated that the Eastern Plain Lake Zone and Northeast Plain Lake zone have relatively low SDD, with multiyear average SDD of 0.56±0.17m and 0.47±0.29m, respectively. The Yunnan-Guizhou Plateau Lake Zone and Tibetan Plateau Lake Zone have relatively high SDD, with multiyear average SDD of 1.48±0.86m and 1.30±0.83m, respectively. The results indicated that the proposed model exhibits strong ability to accurately construct SDD coverage for various lakes.

（来源: LIMNOLOGY AND OCEANOGRAPHY 卷: 66 期:6 页:2455-2469 出版年: 2021, **DOI:** 10.1002/lno.11764）

Unraveling the effect of inter-basin water transfer on reducing water scarcity and its inequality in China

Sun, Siao; Zhou, Xian; Liu, Haixing;等

Securing water supply in the face of increasing water scarcity is one important challenge faced by humanity in sustainable development. Inter-basin water transfer is widely applied to provide water supply security in regions where water demand exceeds water availability. However, the effect of inter-basin water transfer on alleviating water scarcity and its inequality is poorly understood especially at the national scale. Based on a newly compiled database of inter-basin water transfer projects in China, here we report a first national assessment of their effect on securing water supply in different basins. We developed a number of indices to facilitate quantifying the effect of water transfer on water scarcity and its inequality. The capacity of inter-basin transfer projects has been steadily increased, which achieved similar to 48.5 billion m(3) yr(-1) by 2016 (equivalent to similar to 8% of the national water use). The

results indicate that water transfer has impacted water supply of 43 sub-basins out of a total of 76 sub-basins, but it hardly changes a basin's water scarcity level (e.g., from water scarcity to low water scarcity). Approximately three quarters of people in China are affected by water transfer. More than a half of the national population (705 million) benefit from alleviated water scarcity, leading to the inequality coefficient reduced from 0.64 under natural water availability condition to 0.59 considering water transfer in 2016. However, 357 million people in water transfer source basins are subject to increased water scarcity, in which similar to 21% are from water stressed sub-basins. This study reveals for the first time water transfer induced water scarcity and inequality change across sub-basins in China, and highlights the challenges to secure water supply across basins.

（来源：WATER RESEARCH 卷: 194 出版年: 2021, **DOI:** 10.1016/j.watres.2021.116931）

Correcting a major error in assessing organic carbon pollution in natural waters

Jiao, Nianzhi; Liu, Jihua; Edwards, Bethanie; 等

Microbial degradation of dissolved organic carbon (DOC) in aquatic environments can cause oxygen depletion, water acidification, and CO2 emissions. These problems are caused by labile DOC (LDOC) and not refractory DOC (RDOC) that resists degradation and is thus a carbon sink. For nearly a century, chemical oxygen demand (COD) has been widely used for assessment of organic pollution in aquatic systems. Here, we show through a multicountry survey and experimental studies that COD is not an appropriate proxy of microbial degradability of organic matter because it oxidizes both LDOC and RDOC, and the latter contributes up to 90% of DOC in high-latitude forested areas. Hence, COD measurements do not provide appropriate scientific information on organic pollution in natural waters and can mislead environmental policies. We propose the replacement of the COD method with an optode-based biological oxygen demand method to accurately and efficiently assess organic pollution in natural aquatic environments.

（来源：SCIENCE ADVANCES 卷: 7 期:6 出版年: 2021, **DOI:** 10.1126/sciadv.abc7318）

The role of freshwater eutrophication in greenhouse gas emissions: A review

Li, Yi; Shang, Jiahui; Zhang, Chi; 等.

Greenhouse gases (GHGs) have long received public attention because they affect the Earth's climate by producing the greenhouse effect. Freshwaters are an important source of GHGs, and the enhancement in their eutrophic status affects GHG emissions. Along with the increasing eutrophication of water bodies, the relevant quantitative and qualitative studies of the effects of freshwater eutrophication on GHG emissions have made substantial progress, particularly in the past 5 years. However, to our knowledge, this is the first critical review to focus on the role of freshwater eutrophication in GHG emissions. In this review, the emissions of common GHGs from freshwater are quantitatively described. Importantly, direct (i.e., dissolved oxygen, organic carbon, and nutrients) and indirect factors (i.e., dominant primary producer and algal blooms) affecting GHG emissions from eutrophic freshwater are systematically analyzed. In particular, the existence and significance of feedback loops between freshwater eutrophication and GHG emissions are emphasized considering the difficulties managing freshwater ecosystems and the Earth's climate. Finally, several future research directions as well as

mitigation measures are described to provide useful insight into the dynamics and control of GHG emissions.

(来源：SCIENCE OF THE TOTAL ENVIRONMENT 卷: 768 出版年:2021, **DOI:** 10.1016/j.scitotenv.2020.144582)

Eco-environmental impacts of dams in the Yangtze River Basin, China

Li, Boyan; Chen, Nengcheng; Wang, Wei; 等.

Nearly half large dams of China have been built in the Yangtze River Basin (YRB) and the eco-environmental impacts of existing dams remain elusive. Here we present a spatio-temporal approach to measuring the ecoenvironmental impacts of dams and its long-term changes. We also develop a new metric, the dam ecoenvironmental effect index (DEEI), that quickly identifies the eco-environmental impacts on dams over 36 years. Underlying the analysis are the revised universal soil loss equation (RUSLE), the generalized boosted regression modeling (GBM), the generalized linear model (GLM), stepwise multiple regression, trend analysis, soil erosion and sediment yield balance equation, and sample entropy used to identify the eco-environmental impacts of dams on yearly timescales. We find that the accumulated negative environmental effects of constructed dams have increased significantly and has led to large-scale hydrophysical and human health risk affecting the Yangtze River Basins downstream (i.e. Jianghan-Lushui-Northeastern Hubei, Dongting Lake District, Yichang-Jianli, and Qingjiang) and reservoir areas (i.e. Wanxian-Miaohe, Miaohe-Huanglingmiao, and Huanglingmiao-Yichang). We also provide observational evidence that dam construction has reduced the complexity of short-term (1-12 months) in runoff and sediment loads. This spatial pattern seems to reflect a filtering effect of the dams on the temporal and spatial patterns of runoff and sediment. Three Gorges Dam (TGD) has a significant impact on the complexity of the runoff and sediment loads in the mainstream of the Yangtze River. This enhanced impact is attributed to the high trapping efficiency of the dam and its associated large reservoir. This assessment may underestimate the cumulative effect of the dam because it does not consider the future effects of the planned dam. Our study provides a quantitative methodology for finding the relative change rate of eco-environmental impact on dams, which is the first step towards addressing the extent, process, and magnitude of the dam-induced effects.

(来源：SCIENCE OF THE TOTAL ENVIRONMENT 卷: 774 出版年:2021, **DOI:** 10.1016/j.scitotenv.2021.145743)

Effect of water-level fluctuations on methane and carbon dioxide dynamics in a shallow lake of Northern China: Implications for wetland restoration

Yuan, Xiaomin; Liu, Qiang; Cui, Baoshan; 等.

Shallow lakes are characterized by strong hydrological fluctuations, affecting their biochemistry and carbon (C) balance. This study explored carbon dioxide (CO2) and methane (CH4) flux under strong water-level fluctuations in a shallow lake while also addressing its implications regarding wetland restoration. The DeNitrification-DeComposition (DNDC) model, a process-based biogeochemical model, was used to simulate CO2 and CH4 flux under intensive water-level fluctuations in Lake Baiyangdian (BYD), Northern China. Results showed that: (i) the DNDC model was able to reasonably capture CO2 and CH4 dynamics, which were determined to be extremely sensitive to water-depth fluctuations at a -10 cm to 10 cm range; (ii) the lowest CO2 flux was observed at a 40-day duration, while the trend in annual CH4 flux was to increase as inundation time increased, changing from -2.27 kg C/ha/y to 1.57 kg C/ha/y; and (iii) CO2 and CH4 flux increased under higher fluctuation frequencies, wherein CO2 flux was lowest

in January and February and CH4 flux increased from December to March under certain frequencies. Our results indicate that water-level fluctuations (e.g., water depth, duration, frequency, and timing) affected both CO2 and CH4 flux. As it pertains to water diversion projects used for shallow lake restoration initiatives, the optimum approach, pertinent to water yields, diversion time, and duration, should first be considered carefully. Results from this study provide useful information for assisting policymakers with respect to reducing gaseous C emissions during ecological water transfer project regulations in shallow lakes.

（来源：JOURNAL OF HYDROLOGY 卷: 597 出版年: 2021 , **DOI:** 10.1016/j.jhydrol.2021.126169）

Human impacts on the cladoceran community of Jili Lake, arid NW China, over the past century

Hu, Ling; Li, Yuan; Leppanen, Jaakko Johannes; 等.

Deterioration of aquatic ecosystems, as a consequence of human-induced disturbances, is a critical global concern. To fully understand the responses of aquatic systems to anthropogenic impacts, it is crucial to assess long-term changes in lakes. The water quality of Jili Lake, a large water body in northwest China, has deteriorated recently, owing to the growing impacts of regional warming and human activities. Thus, Jili Lake was a prime candidate for evaluation of historical multi-stressor impacts. Meteorological data, historical documents, and assemblages of cladoceran microfossils in the sediments of Jili Lake were employed to investigate changes in the cladoceran community over the past century, and to evaluate the response of that aquatic community to human activities. From the 1920s to the 1950s, species richness of the cladoceran community was high, which reflected conditions of relatively low human impact. From the 1960s to 1970s, a sharp decrease in Bosmina longirostris, a planktonic cladoceran species, suggested a decrease in water level as a result of dam construction and intensified water exploitation. Since the 1980s, the water level in the lake has been restored, but increased fish farming and construction of a water storage facility caused salinisation and eutrophication of Jili Lake. Accordingly, the cladoceran community displayed distinct signs of a regime shift, with a gradual transition to dominance of B. longirostris and a sharp decrease in littoral species (e.g. Leydigia leydigi, L. acanthocercoides, Alona quadrangularis, Alona affinis). Our results suggest that human-induced disturbances were the main factor that drove changes in the cladoceran community since about the mid-20th century.

（来源：JOURNAL OF PALEOLIMNOLOGY 出版年: 2021, **DOI:** 10.1007/s10933-021-00186-w）

The pattern of sedimentary bacterial communities varies with latitude within a large eutrophic lake

Sun, Xiaojian; Cao, Xinyi; Zhao, Dayong; 等.

We investigated the diversity, composition, and assembly processes of sedimentary bacterial communities across Lake Taihu, China, a large, shallow, and eutrophic water body. Amplicon-based 16S rRNA gene high-throughput sequencing identified the composition and phylogenetic structure of the bacterial communities within the 28 collected samples. Diversity analysis revealed that sedimentary bacterial communities demonstrated significant trends with nutrient loading and habitat along latitude. We used network analysis to disentangle the role of keystone taxa in bacterial communities. Most identified keystone species were from the genus Nitrospira (affil-iated with Nitrospirae), subphylum Deltaproteobacteria (affiliated with Proteobacteria), subphylum Gammapro-teobacteria (affiliated with Proteobacteria), family Rhodocyclaceae (affiliated with Betaproteobacteria), phylum Bacteroidetes,

genus Bacillus (affiliated with Firmicutes), and family Anaerolineaceae (affiliated with Chloroflexi) in order of abundance. These keystone taxa play fundamental roles in carbon and nitrogen cycling within Lake Taihu. Phylogenetic structure analysis indicated that the bacterial communities were more phylogenetically clustered than expected by chance and that deterministic processes dominated the assembly of bacterial com-munities across Lake Taihu. Niche selection was the crucial factor driving the assembly of bacterial communities. This study enhances the understanding of the distribution of sedimentary bacterial communities and their as-sembly mechanisms across Lake Taihu.

（来源：LIMNOLOGICA 卷: 87 出版年: 2021, **DOI:** 10.1016/j.limno.2021.125860）

Anthropogenic-Driven Alterations in Black Carbon Sequestration and the Structure in a Deep Plateau Lake

Huang, Changchun; Lu, Lingfeng; Li, Yi; 等.

The continuous flux of organic carbon (OC) from terrestrial ecosystems into inland water is an important component of the global carbon cycle. The buried OC pool in inland water sediments is considerable, and black carbon (BC) is a significant contributor to this OC pool because of the continuous growth in BC emissions. Therefore, determining the effect of BC on total OC burial and variations in the structure of BC during the burial process will contribute significantly to our understanding of lacustrine carbon cycling. This study investigated BC burial and its structural variations in response to anthropogenic drivers using four dated sedimentary cores from a deep plateau lake in China. The BC burial rate rose from 0.96 +/- 0.64 g.m(-2).y(-1) (mean of sedimentary cores pre-1960s) to 4.83 +/- 1.25 g.m(-2).y(-1) (after 2000), which is a 5.48 +/- 2.12-fold rise. The increase of char was similar to those of BC. The growth rate of soot was 7.20 +/- 4.30 times, which is higher than that of BC and char, increasing from 0.12 +/- 0.08 to 0.64 +/- 0.23 g.m(-2).y(-1). There was a decreasing trend in the ratio of char and soot at a mean rate of 62.8 +/- 6.46% (excluding core 3) in relation to increased fossil fuel consumption. The contribution of BC to OC burial showed a significant increasing trend from the past to the present, particularly in cores 3 and 4, and the mean contribution of the four cores was 11.78 +/- 2.84%. Source tracer results from positive matrix factorization confirmed that the substantial use of fossil fuels has promoted BC burial and altered the BC structure. This has resulted in BC with a higher aromatic content in the lake sediment, which exhibits reduced reactivity and increased stability. The strong correlation between BC and allochthonous total OC indicates that the input pathways of the buried BC in this plateau lake sediment were terrestrial surface processes and not atmospheric deposition.

（来源：ENVIRONMENTAL SCIENCE & TECHNOLOGY，2021, 55(9):6467-6475, **DOI:** 10.1021/acs.est.1c00106）

Water quality drives the regional patterns of an algal metacommunity in interconnected lakes

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The metacommunity approach provides insights into how the biological communities are assembled along the environmental variations. The current study presents the importance of water quality on the metacommunity structure of algal communities in six river-connected lakes using long-term (8years) monitoring datasets. Elements of metacommunity structure were analyzed to evaluate whether water quality structured the metacommunity across biogeographic regions in the riverine ecosystem. The algal community in all lakes was found to exhibit Clementsian or quasi-Clementsian structure properties such as significant turnover, grouped and species sorting indicating that the communities responded to the

environmental gradient. Reciprocal averaging clearly classified the lakes into three clusters according to the geographical region in river flow (upstream, midstream, and downstream). The dispersal patterns of algal genera, including Aulacoseira, Cyclotella, Stephanodiscus, and Chlamydomonas across the regions also supported the spatial-based classification results. Although conductivity, chemical oxygen demand, and biological oxygen demand were found to be important variables (loading>|0.5|) of the entire algal community assembly, water temperature was a critical factor in water quality associated with community assembly in each geographical area. These results support the notion that the structure of algal communities is strongly associated with water quality, but the relative importance of variables in structuring algal communities differed by geological regions.

(来源：Scientific reports,2021, 11(1):13601, **DOI:** 10.1038/s41598-021-93178-9)

1961~2016 年全球变暖背景下冰川物质亏损加速度研究

李耀军，丁永建，上官冬辉等

过去几十年间，全球冰川物质亏损的加速趋势日益显著，而这种加速趋势将对全球海平面上升、流域水资源以及冰冻圈灾害等方面产生深远的影响. 针对目前关于冰川物质亏损加速度的研究仍然比较贫乏的问题，本研究利用实测冰川物质平衡记录和最新的融合实测资料与大地测量法表面高程变化的冰川物质变化数据，对全球冰川物质亏损加速度进行研究. 结果表明，1961~2016 年全球冰川物质亏损经历了显著的加速过程. 在全球尺度上，冰川物质亏损加速度分别为(5.76±1.35)Gt a−2 (冰量损失加速度)和(0.0074±0.0016)m w.e.a−2 (单位面积冰量损失加速度). 在区域尺度上，冰川主要分布区(除南极冰盖边缘地区)的冰量损失加速度大于冰川储量较小的区域，其中阿拉斯加地区的冰量损失加速度最大((1.33±0.47)Gt a−2). 对单位面积冰量变化而言，冰川分布面积较小的区域和几个主要冰川分布区都呈现出较大的冰川消融加速度，其中欧洲中部的冰川单位面积物质亏损的加速度最大((0.024±0.0088)m w.e.a−2). 全球气候变暖是冰川物质亏损加速的主要驱动力. 通过对比研究，发现格陵兰冰盖和南极冰盖对全球海平面上升贡献的加速度均大于冰川. 本研究将有助于提升对冰川变化机理的认识，为应对冰川变化的影响提供科学依据。

（来源：中国科学: 地球科学, 2021,51(3): 453-464）

河口最大浑浊带研究的回顾与展望

王重洋，周成虎，陈水森等

最大浑浊带是河口近岸泥沙含量显著高于上下游，并在一定范围内有规律迁移的浑浊水体，是河流入海泥沙输移过程中的特有现象. 它显著体现了河流、海洋及物质能量的耦合作用，其发展动态、研究进展备受关注. 本文通过回顾国内外河口最大浑浊带 80 多年来的研究现状和历程，总结经验、展望未来. 既有研究已对河口最大浑浊带的泥沙含量、物质来源及组成等基本特征进行了较为全面的总结，认识到不同类型河口最大浑浊带的形成发育存在不同的主导动力过程和主控影响因素；此外，河口最大浑浊带在中短尺度上的时空变化也

得到了比较充分的分析和讨论. 相关研究在多方面都取得了瞩目的成果和进展, 具有重要的科学价值与现实意义. 但是, 分析认为仍亟待继续开展并进一步加强最大浑浊带的精准定量识别方法研究、空间立体分布整体特性研究, 特别是人类活动加剧和全球自然环境显著变化影响下的长期时空动态特征研究, 以促进对河口最大浑浊带现象及其时空演变规律和趋势更加全面、更加深刻的认识和理解, 助力社会经济和自然环境健康可持续发展。

（来源：科学通报,2021,66(18): 2328-2342）

流域科学: 连接水文学与流域可持续管理的枢纽

贺缠生，Allan JAMES L.

近几十年来, 为了更好地认识和管理不同时空尺度的水循环, 许多水科学和管理项目相继问世, 如生态水文学、全球水文学、社会水文学、供水管理、需水管理和水资源综合管理(Integrated Water Resources Management, IWRM)等. 与此同时, 示踪、制图、遥感、机器学习和模拟等先进技术也广泛应用于水文过程和水资源研究中. 尽管如此, 全球水危机仍日益加剧. 究其原因在于水文水资源研究和管理之间未能在不同时空尺度建立有效的链接和交流来实现联合国可持续发展目标. 流域是水资源管理的基本单元, 流域科学有望搭建水文水资源研究与管理之间的桥梁. 本文首先回顾水文研究和水资源管理的进展, 进而讨论了全球水资源界面临的问题和挑战. 在此基础上, 提出了流域科学的四个核心组成部分: (1) 水文分析; (2) 水资源政策; (3) 综合治理; (4) 管理与反馈. 该构架综合考虑水资源拥有量和用水量及水质, 量化水循环的储存、通量和质量, 基于地球环境边界条件理论确定当地水资源阈值; 提出水资源管理的具体可行措施. 流域科学为应对当前全球水危机和实现联合国可持续发展目标提供了互补性水资源管理途径。

（来源：中国科学: 地球科学, 2021,51(5): 666-679）

Timescale of reduction of long-term phosphorus release from sediment in lakes

Rippey, Brian; Campbell, Julie; McElarney, Yvonne; 等.

It is important for lake management and policy to estimate the timescale of recovery from long-term P release from sediment after a reduction in the external load. To provide a scientific basis for this, a condensed model was elaborated, applied and evaluated in four lakes. The model is based on first order kinetics, with an overall rate constant composed of the rate of diagenesis of labile P (kd,2) and rate of burial of P (kb) below an active sediment layer. Using the variation of P fractions in dated sediment cores, kd,2 varied from 0.0155 to 0.383 yr-1, kb from 0.0184 to 0.073 yr-1 and the overall rate constant from 0.0230 to 0.446 yr-1. The active layer depths, 8 to 29 cm, and kd,2 values are within the ranges found by others. The time for a 75% reduction (t75) of labile P in the active layer is 60 years in Lough Melvin, 3 in Ramor, 33 in Sheelin and 41 in Neagh, although P release is only important in Ramor and Neagh. Combining the kd,2 values with other estimates (mean 0.0981 yr-1, median 0.0426; n=14) produces a t75 value of less than 14 and 33 years. A review of other models indicates a timescale of one to two decades and from lake monitoring also of one to two decades. It is desirable to estimate the timescale directly in all lakes if sediment P release is important, but, generally, it should take between one and three

decades.

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不恰当的植被恢复导致水资源减少

周国逸，夏军，周平等

本文从“森林与水”的科学争论和生态水文学的分析出发，通过傅抱璞“自上而下”理论框架(傅抱璞, 1981)及其派生理论(Zhou 等, 2015)阐述了植被与水资源的关系，并通过大量观测数据和大型植被工程效果进行验证．本研究还考察了植物自然入侵和生长过程对水资源的影响，并试图解释为什么人们不关心自然起源的植物群落生长和波动对产水量的影响，由此得出观点——减少水资源的不是植被本身，而是人类盲目地滥用植被恢复．最后，我们提出人工恢复植被的原则．

这一结论还需要通过各种研究加以验证．在这些研究中，最有必要建立一个完整的理论框架，用以量化植被变化对水资源的影响．如上所述，完整的理论框架应包括五个相互关联的模块．在我们的分析中，虽然模块 1 是可靠的，模块 2 也可以根据地球表面系统的已知规律进行综合，但模块 3~5 实际上并不存在，这降低了我们结论的可靠性和对重大科学争议澄清的能力．基于高度不一致和不可理解的观测结果，以及大数据时代的“两难境地”，我们还提出，在探索“森林与水”的机制时，更需要“自上而下”的方法，或者至少需要更多的“自上而下”分析指导的全球观测和实验。

（来源：中国科学: 地球科学, 2021,51(2): 175-182）

参数区域化在全球水文模型 FLEX-Global 中的应用

王璟京，高红凯，刘敏，等

全球水文模型是从全球视角解决全球变化相关水资源问题的重要工具，但模型精度不高是长期困扰全球水文模型发展的瓶颈问题．为了提升全球水文模型径流量模拟的精度，本文基于水文模型参数区域化开发了全球水文模型 FLEX-Global. FLEX-Global 主要是以 FLEX 水文模型为框架，并耦合 HSC 产流模块进行净雨量计算，并用全球汇流模型 CaMa-Flood 进行河网汇流计算．该模型以 0.5°×0.5°的空间分辨率模拟日时间步长的全球范围流域径流. 为检验模型精度, FLEX-Global 首先与全球径流数据集 GRDC 中 26 个主要河流实测径流量进行比较，并与现有的 7 个全球水文模型进行比较和验证，进而分析了各模型精度在不同气候区的性能．多指标评估结果表明，采用参数区域化的 FLEX-Global 模型可以提高径流模拟精度，尤其是在赤道气候带和干燥气候带提高效果显著．基于参数区域化的该全球水文模型，可为气候变化影响评估、全球水资源优化配置、多圈层耦合模拟、跨部门影响模型比较等提供科学支撑。

（来源：中国科学: 地球科学, 2021,51(5): 805-823）

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 Niño 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 年 06 月 23 日, https://doi.org/10.1360/N072020-0412）

Water-level fluctuations regulate the availability and diffusion kinetics process of phosphorus at lake water-sediment interface

Yuan, Hezhong; Wang, Haixiang; Zhou, Yanwen; 等.

Sequential extraction and in-situ diffusive gradients in thin films (DGT) techniques were used to determine phosphorus (P) fractions and high-resolution 2D fluxes of labile PDGT, Fe2+DGT, and S2-DGT in sediment systems. The diffusion fluxes were subsequently calculated for different scenarios. Dynamic diffusion parameters between solid sediment and solution were also fitted using the DIFS (DGT-induced fluxes in sediments) model. The results suggested that Fe-bound P (Fe-P) was the dominant pool which contributed to the resupply potential of P in the water-sediment continuum. Significant upward decreases of labile PDGT, Fe2+DGT, and S2-DGT fluxes were detected in pristine and incubated microcosms. This dominance indicated the more obvious immobilization of labile P via oxidation of both Fe2+ and S2- in oxidic conditions. Additionally, these labile analytes in the microcosms obviously decreased after a 30-day incubation period, indicating that water-level fluctuations can significantly regulate adsorption-desorption processes of the P bound to Fe-containing minerals within a short time. Higher concentrations of labile PDGT, Fe2+DGT, and S2-DGT were measured at the shallow lake region where more drastic water-level variation occurred. This demonstrates that frequent adsorption-desorption of phosphate from the sediment particles to the aqueous solution can result in looser binding on the solid sediment surface and easier desorption in aerobic conditions via the regulation of water levels. Higher R values fitted with DIFS model suggested that more significant desorption and replenishment effect of labile P to the aqueous solution would occur in lake regions with more dramatic water-level variations. Finally, a significant positive correlation between S2-DGT and Fe2+DGT in the sediment indicated that the S2- oxidization under the conditions of low water-level can trigger the reduction of Fe(III) and subsequent release of active P. In general, speaking, frequent water-level fluctuations in the lake over time facilitated the formation and retention of the Fe(II) phase in the sediment, and desorption of Fe coupled P into the aqueous solution when the water level was high.

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Under-Ice Dissolved Oxygen and Metabolism Dynamics in a Shallow Lake: The Critical Role of Ice and Snow

Huang, Wenfeng; Zhang, Zheng; Li, Zhijun; 等.

Interaction of under-ice physical, chemical, and biological processes with lake ice/snow cover is examined to better understand how changing winter climate may affect lake ecosystems. We derived under-ice dissolved oxygen (DO) dynamics from high-frequency observations and modified a widely used lake metabolism model by including the effect of freezing and thawing on DO concentration. Estimates were produced for the production and respiration in a shallow lake on the Mongolian Plateau in three winters. Diel, synoptic, and seasonal variations in DO concentration were detected as responses to solar radiation, episodic snowfall events, and occasional convective mixing. Based on the observations and a radiative transfer model, incident solar radiation was partitioned into reflectance, absorbance, and transmittance by the snow and ice cover. For bare ice, the contributions of these three parts were 35%, 39%, and 26%, respectively, while under a new 4.5 cm thick snow cover, the corresponding values were 79%, 17%, and 3%. This points out the critical role of snow and ice on under-ice light conditions, which is the primary forcing for the temperature and the rate of photosynthesis under ice. The results showed three principal factors, which influenced under-ice DO and metabolism: (1) thickness and optical properties of ice and snow, which affected the light transfer and depth of the euphotic zone, (2) mediated radiation and ice-water heat transfer which controlled water temperature, and (3) DO exclusion during freezing and dilution by melt water. This study highlights the ecosystem characteristics in shallow ice-covered lakes in arid temperate regions and promotes our understanding of the response of the cold aquatic environment to climate change.

（来源：WATER RESOURCES RESEARCH 卷:57 期: 5 出版年: 2021 , **DOI:** 10.1029/2020WR027990）

A 25-year retrospective analysis of factors influencing success of aluminum treatment for lake restoration

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For more than 50 years, aluminum (Al)-salts have been used with varying degrees of success to inactivate excess mobile phosphorus (P) in lake sediments and restore lake water quality. Here, we analyzed the factors influencing effectiveness and longevity of Al-treatments performed in six Swedish lakes over the past 25 years. Trends in post-treatment measurements of total phosphorus (TP), Chlorophyll a (Chl_a), Secchi disk depth (SD) and internal P loading rates (Li) were analyzed and compared to pre-treatment conditions. All measured water quality parameters improved significantly during at least the first 4 years post-treatment and determination of direct effects of Al-treatment on sediment P release (Li) was possible for three lakes. Improvements in TP (-29 to -80%), Chl_a (-50 to -78%), SD (7 to 121%) and Li (-68 to -94%) were observed. Treatment longevity, determined via decreases in surface water TP after treatment, varied from 7 to >47 years. Lake type, Al dose, and relative watershed area were related to longevity. In addition, greater binding efficiency between Al and P was positively related to treatment longevity, which has not previously been shown. Our findings also demonstrate that adequate, long-term monitoring programs, including proper determination of external loads, are crucial to document the effect of Al-treatment on sediment P release and lake water quality.

（来源：Water research 卷:200 页: 117267 出版年: 2021, **DOI:** 10.1016/j.watres.2021.117267）

Forecasting water temperature in lakes and reservoirs using seasonal climate prediction

Mercado-Bettin, Daniel; Clayer, Francois; Shikhani, Muhammed; 等.

Seasonal climate forecasts produce probabilistic predictions of meteorological variables for subsequent months. This provides a potential resource to predict the influence of seasonal climate anomalies on surface water balance in catchments and hydro-thermodynamics in related water bodies (e.g., lakes or reservoirs). Obtaining seasonal forecasts for impact variables (e.g., discharge and water temperature) requires a link between seasonal climate forecasts and impact models simulating hydrology and lake hydrodynamics and thermal regimes. However, this link remains challenging for stakeholders and the water scientific community, mainly due to the probabilistic nature of these predictions. In this paper, we introduce a feasible, robust, and open-source workflow integrating seasonal climate forecasts with hydrologic and lake models to generate seasonal forecasts of discharge and water temperature profiles. The workflow has been designed to be applicable to any catchment and associated lake or reservoir, and is optimized in this study for four catchment-lake systems to help in their proactive management. We assessed the performance of the resulting seasonal forecasts of discharge and water temperature by comparing them with hydrologic and lake (pseudo)observations (reanalysis). Precisely, we analysed the historical performance using a data sample of past forecasts and reanalysis to obtain information about the skill (performance or quality) of the seasonal forecast system to predict particular events. We used the current seasonal climate forecast system (SEAS5) and reanalysis (ERA5) of the European Centre for Medium Range Weather Forecasts (ECMWF). We found that due to the limited predictability at seasonal time-scales over the locations of the four case studies (Europe and South of Australia), seasonal forecasts exhibited none to low performance (skill) for the atmospheric variables considered. Nevertheless, seasonal forecasts for discharge present some skill in all but one case study. Moreover, seasonal forecasts for water temperature had higher performance in natural lakes than in reservoirs, which means human water control is a relevant factor affecting predictability, and the performance increases with water depth in all four case studies. Further investigation into the skillful water temperature predictions should aim to identify the extent to which performance is a consequence of thermal inertia (i.e., lead-in conditions).

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Hydrodynamics, Sediment Transport and Morphological Features at the Confluence Between the Yangtze River and the Poyang Lake

Yuan, Saiyu; Tang, Hongwu; Li, Kun; 等.

Confluences act as critical nodes in a river network as they affect flow, sediment transport, water quality, and ecological patterns. A complete knowledge about hydro-morpho-sedimentary processes at river confluences is still incompleted and it has been usually accepted that secondary flows are weak because of the significant role of form roughness in large rivers. In this study, two field surveys were conducted on the flow structure, suspended sediment transport and morphology of the confluence between the Yangtze River (the largest river in China) and the Poyang Lake (the largest freshwater lake in China). Dual counter-rotating cells were observed during high flow conditions and a single secondary cell appeared in low flow conditions. These helical cells restricted the core size of high sediment concentration and downwelling flows acted as a barrier hindering the exchange of sediment between the two rivers. Furthermore, the observed large scour hole was likely related to the downwelling and

upwelling flows caused by helical motions. In low flow conditions, the scour hole looked like a deep channel, which was likely related to a long-surviving helical cell. The scour hole disappeared further downstream, when either the helical motion got weak during low flow conditions, or when a reverse helical cell occurred during high flow conditions. Hydrodynamics, suspended sediment transport and morphological features observed at such a large confluence demonstrated that river planform geometry and discharge ratio affected the flow structure, especially the helical motion. This in turn affected sediment transport as well as the local bed morphology.

（来源：WATER RESOURCES RESEARCH 卷:5 期:3 出版年: 2021, **DOI:** 10.1029/2020WR028284）

Optimal water resources operation for rivers-connected lake under uncertainty

Liu, Bojun; Wang, Yu; Xia, Jun; 等.

Due to the complex water system and diversified management requirements, the optimal water resources operation of the rivers-connected lake has always been a difficulty in current researches. Based on the discussion of characteristics of the rivers-connected lake, this paper quantified the forecasting uncertainty in the operation process, and set the quantified uncertainty as the objective function to establish the water resources optimal operation model of rivers-connected lake. The human factors were coupled to the optimal water resources operation in the model, in order to obtain the optimal plan of lake water resources operation with human adaptability. Hongze Lake was taken as an example for the analysis of water resources optimization operation plan of rivers-connected lake. Also, an integrated algorithm including the normal boundary crossing method, the primal-dual interior-point method, and the Non-dominated Sorting Genetic Algorithm-II (NSGA-II) was proposed to solve the lake operation model. The results proved that the optimization calculation of multi-objective operation under the uncertainty conditions of Hongze Lake can be obtained by the proposed model and algorithm. Uncertainties related to forecasts of lake operation can be effectively reduced by the proposed model, which, thus, implied the obtained operation plan in this paper is more adaptive to changing environment than the existing other plans. The research results can provide technical methods for the lake water resources operation with plentiful and diverse objectives of China and other countries.

(来源：JOURNAL OF HYDROLOGY 卷:595 出版年: 2021, **DOI:** 10.1016/j.jhydrol.2020.125863)

A multi-proxy record of climate variations over the last millennium from Kulun-nuur Lake sediments, Inner Mongolia, north-central China

Mao, Xin; Wan, Dejun; Song, Lei; 等.

Reconstructing climate change over the last millennium is important for understanding natural climate variability and improving global climatic prediction. Precipitation variations from different records in north-central China, especially in the EASM margin area, are controversial. Here, we present a multi-proxy (grain size, pollen, TOC and TOC/TN ratio) record from Kulun-nuur Lake in east-central Inner Mongolia as an archive of moisture variations over the last millennium. Our record reveals that the Kulun-nuur Lake area is characterized by a wet Medieval Warm Period (MWP; 900-1300 AD), a dry Little Ice Age (LIA; 1300-1820 AD) and a relatively wet Current Warm Period (CWP; 1820 AD to present). In addition, within the context of an overall wet climate during the MWP, a short-term relatively dry episode occurred from 1000 to 1070 AD. The climate patterns reconstructed from Kulun-nuur Lake display good consistency with other records and models, suggesting that warm-wet/cold-dry are the main climate

patterns in north-central China during the last millennium. These patterns of regional hydrological changes on multi-decadal to centennial scales may be related to solar activity and the Atlantic Multidecadal Oscillation.

（来源：JOURNAL OF PALEOLIMNOLOGY 出版年: 2021, **DOI:** 10.1007/s10933-021-00189-7）

The effects of flood pulse on multiple aquatic organisms in a seasonal shallow lake

Liu, Yang; Zhang, Min; Peng, Wenqi; 等.

Different aquatic organisms have different reactions to environmental variations due to their different ways of reaction traits. Understanding the effect of hydrological disturbance on lake from the perspective of multiple aquatic organisms is important for lake management. Poyang Lake (PYL) experiences severe hydrological disturbance under the effects of flood pulse during the rainy season. In this study, we analyzed the responses of phytoplankton, zooplankton, and macroinvertebrates to hydrological disturbance during the rainy season in PYL. Flood pulse determined the spatial variation in turbidity (Turb), transparency (Trans), dissolved oxygen (DO), total phosphorus (TP), and soluble reactive phosphorus. Physical factors (Turb, Trans, conductivity) explained phytoplankton (9.6%) and zooplankton (15%) community variation, and the combination of physical and nutrient factors explained macroinvertebrate (3.8%) community variation. Cyclotella sp., Attheya zachariasi, and Melosira ambigua were the keystone taxa of phytoplankton, and these taxa were driven by Turb and Trans. Brachionus angularia, Polyarthra vulgaris, Filinia longiseta, and Diffugia globulosa were the keystone taxa of zooplankton and entire aquatic organisms, which contributed a lot to maintain the biological community stability possibly through the food web. These keystone taxa were stimulated by high Trans, DO, dissolved organic carbon (DOC) and nitrate (NO3-). We found habitat conditions (Turb, Trans and DO) were the prominent factors influencing the aquatic organism structure in strong hydrological disturbance environment. For the keystone taxa, both habitat conditions (i.e., DO) and exogenous nutrient inputs (i.e., DOC and NO3-) caused significant effect. This study provides new insights into the holistic response of multiple aquatic communities to flood pulse as well as the role of keystone species in maintaining community stability, which could guide the conservation and management of seasonal lake ecosystems.

（来源：AQUATIC ECOLOGY, 2021,55(2):379-399, **DOI:** 10.1007/s10452-020-09829-y）

Establishment of a Target, Suspect, and Functional Group-Dependent Screening Strategy for Organophosphate Esters (OPEs): "Into the Unknown" of OPEs in the Sediment of Taihu Lake, China

Ye, Langjie; Meng, Weikun; Huang, Jianan; 等.

Current environmental monitoring studies are generally confined to several target organophosphate esters (OPEs), and there is a lack of strategies for comprehensively screening all potential OPEs in environmental samples. Here, an effective and accurate strategy was developed for the target, suspect, and functional group-dependent screening of OPEs by the use of ultrahigh-performance liquid chromatography-Q Exactive hybrid quadrupole-Orbitrap high-resolution mass spectrometry (UHPLC-Q-Orbitrap HRMS), and this strategy was applied for the analysis of n = 74 sediment samples (including 23 surface sediment samples and 51 sediment core samples) collected from Taihu Lake (eastern China) in 2019. In these analyzed samples, we successfully identified n = 35 OPEs, and 23 of them were reported in this region for the first time.

In addition, this strategy also presented other interesting findings, i.e., (1) OPE concentrations decreased with increasing distance from the coast of the lake; (2) the newly identified 3-hydroxyphenyl diphenyl phosphate (meta-OH-TPHP) was not statistically significantly correlated with triphenyl phosphate (TPHP; r = 0.02494, p = 0.9101) but with resorcinol bis(diphenyl phosphate) (RDP) (r = 0.9271, p < 0.0001) and three other OPEs; and (3) the summed concentrations of aryl OPEs (Sigma arylOPEs) in sediment core samples exhibited significantly increasing trends as the depth decreased. Collectively, this study provided an effective strategy that was successfully applied for comprehensive screening of OPEs in the sediments of Taihu Lake, and this strategy could have promising potential to be extended to other environmental matrices or samples.

(来源：Environmental science & technology,2021,55(9): 5836-5847, **DOI:** 10.1021/acs.est.0c07825)

Optimized remote sensing estimation of the lake algal biomass by considering the vertically heterogeneous chlorophyll distribution: Study case in Lake Chaohu of China

Hu, Minqi; Zhang, Yuchao; Ma, Ronghua; 等.

Due to the difference of vertical distribution of algae in lakes, it is necessary to carry out remote sensing estimation of algal biomass based on the vertically heterogeneous distribution of chlorophyll in order to improve the accuracy of biomass inversion. A new algorithm is proposed and validated to measure algal biomass in Lake Chaohu based on the Moderate Resolution Imaging Spectrometer (MODIS) images. The algal biomass index (ABI) is defined as the difference in remote-sensing reflectance (R-rs, sr(-1)) at 555 nm normalized against two baselines with one formed linearly between R-rs(859) and R-rs(469) and another formed linearly between R-rs(645) and R-rs(469). Both theory and model simulations show that ABI has a good relation with the algal biomass in the euphotic zone (R-2 = 0.88, p < 0.01, N = 50). Field data were further used to estimate the biomass outside the euphotic layer through an empirical algorithm. The ABI algorithm was applied to MODIS Rayleigh-corrected reflectance (R-rc) data after testing the sensitivity to sun glint and thickness of aerosols, which showed an acceptable precision (root mean square error < 21.31 mg and mean relative error < 16.08%). Spectral analyses showed that ABI algorithm was immune to concentration of colored dissolved organic matter (CDOM) but relatively sensitive to suspended particulate inorganic matter (SPIM), which can be solved by using Turbid Water Index (TWI) though in such a challenging environment. A long-term (2012-2017) estimation of algal biomass was further calculated based on the robust algorithm, which shows both seasonal and spatial variations in Lake Chaohu. Tests of ABI algorithm on Sentinel-3 OLCI demonstrates the potential for application in other remote sensors, which meets the need of observation using multi-sensor remote sensing in the future.

（来源：SCIENCE OF THE TOTAL ENVIRONMENT 卷:595 出版年: 2021, **DOI:** 10.1016/j.scitotenv.2020.144811）

The changing characteristics of phytoplankton community and biomass in subtropical shallow lakes: Coupling effects of land use patterns and lake morphology

Peng, Xue; Zhang, Lu; Li, Yuan; 等.

The community composition and biomass of phytoplankton in shallow lakes are impacted by many environmental factors including water quality physicochemical parameters, land use in the watershed,

and lake morphology. However, few studies have simultaneously evaluated the relative importance of these factors on the effect of community composition and biomass of phytoplankton. The relative importance of the water quality physicochemical parameters (water temperature [WT], total nitrogen [TN], total phosphorus [TP], pH, dissolved oxygen [DO], electrical conductivity [EC], turbidity and Secchi depth [SD]), land use (built-up land, farmland, waters, forest, grassland, and unused land) in the watershed, and lake morphology (area and depth) on the composition and biomass of phytoplankton communities were assessed in 29 subtropical shallow lakes in Wuhan, China, during different seasons from December 2017 to November 2018. The results showed that phytoplankton in all 29 lakes was mainly composed of Cyanophyta, Chlorophyta, and Bacillariophyta. Phytoplankton abundance was highest in summer and lowest in winter. We analyzed the relative importance of the three groups of variables to the community composition of the phytoplankton by variance decomposition. The results showed that the three groups of environmental variables had the highest explanation rate (> 80%) for the composition of the phytoplankton community in summer and autumn, and the explanation rates in spring and winter were 42.1% and 39.8%, respectively. The water quality physicochemical parameters were the most important variables affecting the composition of phytoplankton communities, followed by land use in the watershed. Through generalized additive model and structural equation model analysis, we found that the land use and lake morphology had minimal direct impact on the Chl-a and cell density of phytoplankton, mainly by altering the TN, TP, turbidity, SD, DO, and EC, which indirectly affected phytoplankton. WT and nutrients were still the main predictors of phytoplankton abundance. Built-up land was the main source of nitrogen and phosphorus in lakes. Correlation analysis found that forest and grassland had positive impacts on reducing lake nitrogen and phosphorus contents. This showed that increasing grassland and forest in the watershed could reduce the pollutants entering the lake. Our findings will contribute to water quality management and pollution control for subtropical shallow lakes.

（来源：Water research 卷:200 页: 117235 出版年: 2021, **DOI:** 10.1016/j.watres.2021.117235）

Habitats and seasons differentiate the assembly of bacterial communities along a trophic gradient of freshwater lakes

Jiao, Congcong; Zhao, Dayong; Huang, Rui; 等.

Freshwater lakes are subject to variable degrees of eutrophication. Within lakes, the planktonic bacterial community (PBC) and sediment bacterial community (SBC) are both significant participants in biogeochemical processes of lake ecosystems. However, how the assembly patterns of bacterial communities vary seasonally along a trophic gradient in freshwater lakes is poorly understood.

Here, we collected and analysed water and sediment samples from 13 shallow lakes located in an urban region of China during summer and winter, the trophic states of which ranged from mesotrophic to middle eutrophic in summer and oligo-mesotrophic to light eutrophic in winter. High-throughput sequencing of 16S ribosomal RNA genes was used to determine the diversity and composition of bacterial communities.

Our results indicated that bacterial communities derived from different habitats and seasons did not exhibit a uniform response to lake trophic states. Linear and nonlinear mixed effect models suggested that the alpha-diversity of PBC and SBC, respectively, showed a unimodal and monotonically decreasing trend with increasing eutrophication in summer, whereas that of PBC and SBC, respectively, exhibited no obvious trend or an increased pattern along the trophic gradient in winter. In addition, the taxonomic

compositional dissimilarity of the PBC was most significantly related to lake trophic differences in summer. Phylogenetic structure analysis revealed that mostly environmental selection regulated the SBC and PBC in both seasons. Moreover, dispersal limitation and homogenising dispersal contributed more to the assembly of SBC and PBC in both seasons, respectively. Water temperature, associated with seasonal variability, was the most important variable driving the PBC assembly, while sediment pH overwhelmed nutrients in regulating the seasonal patterns of SBC assemblages.

Overall, we highlighted that the water and sediments, as well as the seasons, differentiated the diversity patterns and assembly processes of bacterial communities along a trophic gradient of freshwater lakes. Our findings provide novel information for understanding the ecological responses of lacustrine bacterial communities to trophic gradients and seasonal variations. This study also contributes an important reference for predicting the changes of microbial community biodiversity under future scenarios of eutrophication.

（来源：FRESHWATER BIOLOGY 出版年: MAY 2021, **DOI:** 10.1111/fwb.13735）

Eutrophication decreased CO_2 but increased CH_4 emissions from lake: A case study of a shallow Lake Ulansuhai

Sun, Heyang; Lu, Xixi; Yu, Ruihong; 等.

Eutrophic lakes, especially shallow eutrophic lakes, disproportionately contribute to greenhouse gas (GHG) emissions. To investigate the effects of eutrophication on GHG dynamics, we conducted field measurements every three months from January 2019 to October 2019 in Lake Ulansuhai, a shallow eutrophic lake (mean depth of 0.7m) located in a semi-arid region in Northern China. We found that Lake Ulansuhai was a predominantly source of atmospheric carbon dioxide (CO_2); however, it converted to a CO_2 sink in July due to eutrophication. It was also a strong source of methane (CH_4) with a mean CO_2 emission of 35.7±12.1mmol m-2 d-1 and CH_4 emission of 5.9±2.9mmol m-2 d-1. The CO_2 concentrations in most sites and CH_4 concentrations in all sites were supersaturated, with the average partial pressure of CO_2 (p CO_2) being 654±34 muatm and the partial pressure of CH_4 (p CH_4) being 157±37 muatm. The partial pressures and emissions of the greenhouse gases exhibited substantial seasonal and spatial variations. The correlation analysis between the trophic level index and the partial pressure of the greenhouse gases indicated that eutrophication could significantly decrease the CO_2 emissions but increase the CH_4 emissions from the lake, resulting in a CH_4 and CO_2 emission ratio of approximately 2 in terms of global warming potential. Eutrophication decreased the p CO_2 in the lake and subsequently increased the p CH_4 due to nutrient input, thereby enhancing primary production. The results indicated that shallow eutrophic lakes in arid regions are strong sources of CH_4 and that eutrophication could alter the greenhouse gas emission patterns.

(来源：Water research 卷:201 页: 117363 出版年: 2021, **DOI:** 10.1016/j.watres.2021.117363)

Inland water level measurement from spaceborne laser altimetry: Validation and comparison of three missions over the Great Lakes and lower Mississippi River

Xiang, Jin; Li, Hui; Zhao, Jiayang; 等.

Satellite laser altimetry offers an opportunity to accurately measure inland water levels over the Earth's surface. This paper described the validation and comparison of three spaceborne missions for inland

water level retrievals, including the Geoscience Laser Altimeter System (GLAS) onboard the Ice, Cloud and Land Elevation Satellite-1 (ICESat-1), as well as the newly launched Advanced Topographic Laser Altimeter System (ATLAS) onboard ICESat-2 and the Global Ecosystem Dynamics Investigation (GEDI) lidar on the International Space Station. This study was conducted over the Great Lakes and lower Mississippi River using in-situ data from 22 gauging stations, where the potential for monitoring inland water dynamics was explored. The results showed that ICESat-2 provided lake water level retrievals with an unprecedented accuracy (RMSE = 0.06 m, biases = -0.01 +/- 0.05 m), followed by ICESat-1 (RMSE = 0.10 m, biases = -0.04 +/- 0.10 m), and then by GEDI (RMSE = 0.28 m, biases = -0.10 +/- 0.23 m). ICESat-2 also offered more accurate river water level measurements (RMSE = 0.12 m, biases = -0.08 +/- 0.07 m) than those of ICESat-1 (RMSE = 0.25 m, biases = -0.18 +/- 0.16 m) and GEDI (RMSE = 0.40 m, biases = 0.24 +/- 0.24 m). The analysis suggested that for all the altimeters, the strong beam achieved higher water level accuracies than those of the weak, and the nighttime acquisitions were slightly more accurate than those of the daytime. However, our result indicated no considerable differences between measurement accuracy and river width. Furthermore, the analysis demonstrated their great potential in monitoring inland water dynamics, especially with the combination of ICESat-2 and GEDI platforms. This study provided a comprehensive understanding of measurement accuracies of three recent missions and recommended that end users should employ the strong beam data acquired during the nighttime for accurate water level retrievals.

（来源：JOURNAL OF HYDROLOGY 卷:597 出版年: 2021, **DOI:** 10.1016/j.jhydrol.2021.126312）

Intraguild predation dampens trophic cascades in shallow aquatic mesocosms in the subtropics: Implications for lake restoration by biomanipulation

He, Hu; Ning, Xiaoyu; Chen, Kunquan; 等.

Intraguild predation (IGP), defined as killing and eating among potential competitors, is commonly observed in shallow lakes and is predicted to dampen trophic cascades and affect ecosystem properties (e.g. phytoplankton biomass or primary production). We tested this hypothesis by manipulating the density of two common lake predators, the small-sized fish Pelteobagrus fulvidraco (the intraguild predator) and the shrimp Exopalaemon modestus (the intraguild prey), in outdoor mesocosms containing natural phytoplankton and zooplankton communities.

In single predator treatments, both predators induced a strong trophic cascade, as evidenced by extinction of the key herbivore, Daphnia pulex, and increasing phytoplankton biomass and chlorophyll a concentration.

When the two predators were added together, however, the strength of collective predator effects on zooplankton and the cascading effects on phytoplankton growth were weaker than the sum of the individual predator effects. We attributed this antagonism among predators to intraguild predation as demonstrated by the lower shrimp catch per unit effort in the presence of fish.

Our study suggests that common predators in subtropical shallow lakes may act antagonistically and thereby dampen trophic cascades in food webs. Thus, when implementing biomanipulation efforts to

suppress algal growth via enhancing zooplankton herbivory, both the quantity and diversity of lake predator assemblies should be considered.

(来源：FRESHWATER BIOLOGY, 2021, **DOI:** 10.1111/fwb.13739)

Variation of lake-river-aquifer interactions induced by human activity and climatic condition in Poyang Lake Basin, China

Wang, Zhenchen; Yang, Yun; Chen, Gan; 等.

In low-lying fluvial-lacustrine plain, anthropogenic activities and climatic variation could have a comprehensive influence on the interactions between surface water and groundwater (SW-GW) involving lake-river-aquifer. Quantification of the changes in SW-GW interaction in spatial and temporal scale causing by the two driving sources could help to the understanding of the regional water cycle mechanism and the adjustment of the decision making. However, it is usually difficult to distinguish the impact of anthropogenic activities from the climatic variation on a regional scale. Here, by using a regional three-dimensional groundwater numerical model with long term monitoring of the hydrological dynamic in Poyang Lake Basin (PLB), China, we found that groundwater storage variation in the bank storage districts can be used as an indicator to quantify each source and sink in the process of SW-GW interactions. And surface water infiltration plays a more dominant role in constructing bank storage which is meant to preserve groundwater storage. Our research in PLB demonstrates that the hydrological change caused by the operation of the Three Gorges Dam (TGD) since 2003 is mainly responsible for the autumn drought in PLB. The surface water recession due to the impoundment in TGD from September to October has an impact about 7 times stronger than the rainfall reduction. Moreover, the groundwater storage deficit caused by the insufficient recharge from the surface water infiltration would maintain the whole year, unlike the surface water system which would easily recover at the end of the year. The results demonstrate the chain interactions among lake-river-aquifer. Failing to distinguish the magnitude of each influence factor may lead to underestimating the impact on the whole water system. The results also highlight the function and the vulnerability of the groundwater system which might be vital to the riparian and estuarinewetl and ecosystem.

（来源：JOURNAL OF HYDROLOGY 卷:595 出版年: 2021, **DOI:** 10.1016/j.jhydrol.2021.126058）

Spatial-temporal trends of hydrological transitions in thermokarst lakes on Northeast Qinghai-Tibet Plateau based on stable isotopes

Yang, Yuzhong; Wu, Qingbai; Liu, Fengjing; 等.

Regarded as the water towers of numerous large rivers in Asia, the Source Area of Yellow River (SAYR) on Northeast Qinghai-Tibet Plateau (QTP) contains substantial thermokarst lakes, which have exerted significant roles on the regional hydrology and water resources under permafrost degradation. To address the potential impact of climate- and permafrost-induced changes in surface hydrological processes in the SAYR, the hydrological transitions and water balance of thermokarst lakes were characterized on large scales during three years using stable isotope method. Spatial and seasonal deviations in hydrological processes of thermokarst lakes were remarkable. Calculations of evaporation-to-inflow (E/I) ratios based on an isotope-mass balance model revealed substantial evaporation for all thermokarst lakes during June due to the control of climate conditions and limited input water. Substantial feeds from summer/fall rain and permafrost meltwater resulted in lower evaporation and positive water balance of lakes during July, August, September, and October. Based on the

relationship between lake-specific input water isotope compositions (delta(I)) and annual average isotope value of precipitation (delta(P)), the recharge patterns of thermokarst lakes in the SAYR were classified: supra-permafrost water/rainfall-dominated lakes were mainly concentrated during June and October regardless of spatial divergences, and summer precipitation/permafrost thaw-dominated lakes are popular during July and August. Qualitatively, seasonal diversities in the water balance of thermokarst lakes are combinatively controlled by air temperature, precipitation regimes, permafrost degradation in the SAYR. Lastly, the future hydrological trajectories of thermokarst lakes are expected under climatic warming and permafrost degradation. This study serves as an important contribution for understanding future hydrological changes and allocation of water resources on the QTP, as well as an indication of permafrost degradation under climate warming.

(来源：JOURNAL OF HYDROLOGY 卷:597 出版年: 2021, **DOI:** 10.1016/j.jhydrol.2021.126314)

The Investigation of the Connections Among Hydrogeological Factors and the Emissions of Two Greenhouse Gases in Lake Sediment

Lu, Xiang; Zhou, Xiaotian; Xu, Yaofei; 等.

Wet ecosystems are important in terms of global greenhouse gas emissions, where a high soil water content is one of the most typical features. However, the roles of hydrogeological properties in sediment during the emission process of methane and carbon dioxide remain to be researched, especially in lake ecosystems. In this study, through investigating the layered sediment in Chaohu Lake, we discovered that strong correlations exist between the water content and microbial gas emissions (methane and carbon dioxide). To further examine these correlations, a systematic analysis of the hydrogeological properties in sediment, gas emission features, methane bubble emission theories and microbiomics was conducted. The results revealed that microbial methane emissions can influence sediment structure and the interstitial water content. Differently, the similar distributions in different layers probably lead to the correlations between microbial carbon dioxide emission and the water content. This research also discusses the connections with other hydrogeological parameters (particle features, interstitial space, etc.) during the emission process. In addition, this study addresses the significance of methane emissions for the material exchange between overlying water and sediment. The effect of microbial gas emissions on sediment physical-chemical properties also provides meaningful information for researching the relationships among environmental factors and microbial ecology.

(来源：WATER RESOURCES RESEARCH, 2021,57(5), **DOI:** 10.1029/2020WR029375)

The biotransformation of soil phosphorus in the water level fluctuation zone could increase eutrophication in reservoirs

Chen, Zhongli; Fang, Fang; Shao, Ying; 等

The massive amounts of phosphorus (P) entering into rivers and reservoirs may induce eutrophication. However, the link between the transport and transformation of soil P and the dynamics of P availability in reservoir regions are not well demonstrated. The present study selected the Pengxi River suffering the anti-seasonal water level fluctuation of the Three Gorgers Reservoir as the study area. Soil nutrients along the longitudinal and lateral gradients of the Pengxi River were investigated to illustrate the spatial distribution patterns, analyzed by the Hedley extraction schemes. The effects of biotic and abiotic factors on soil P transformation and the dynamics of bioavailable P were evaluated via determinations of enzymatic hydrolysis phosphorus (EHP) with and without ultraviolet (UV) irradiation. The results

indicated that soil nutrients varied significantly between the water level fluctuation zone (WLFZ) and upland along the river longitudinal gradients, where the trends of the extracted OP were the same in H2O, NaHCO3 and NaOH extractions. The EHP accounted for 33.67 +/- 15.87% of the total extracted OP, of which Monoester P, Phytate-like P and NHOP were determined at all extracts but Diester P was mainly found at H2O and NaOH extracts. UV irradiation significantly increased P bioavailability up to 24.44%. These results could demonstrate the mechanism of soil P transformation via UV irradiation and enzymatic hydrolysis. Therefore, the bioavailable P enters the water body during the submergence period may lead to eutrophication in the Pengxi River, which could pose a risk to the reservoir ecosystem.

(来源：SCIENCE OF THE TOTAL ENVIRONMENT 卷:763 出版年: 2021, **DOI:** 10.1016/j.scitotenv.2020.142976)

Micropollutant biotransformation and bioaccumulation in natural stream biofilms

Desiante, Werner L.; Minas, Nora S.; Fenner, Kathrin

Micropollutants are ubiquitously found in natural surface waters and pose a potential risk to aquatic organisms. Stream biofilms, consisting of bacteria, algae and other microorganisms potentially contribute to bioremediating aquatic environments by biotransforming xenobiotic substances. When investigating the potential of stream biofilms to remove micropollutants from the water column, it is important to distinguish between different fate processes, such as biotransformation, passive sorption and active bioaccumulation. However, due to the complex nature of the biofilm community and its extracellular matrix, this task is often difficult. In this study, we combined biotransformation experiments involving natural stream biofilms collected upand downstream of wastewater treatment plant outfalls with the QuEChERS extraction method to distinguish between the different fate processes. The QuEChERS extraction proved to be a suitable method for a broad range of micropollutants (> 80% of the investigated compounds). We found that 31 out of 63 compounds were biotransformed by the biofilms, with the majority being substitution-type biotransformations, and that downstream biofilms have an increased biotransformation potential towards specific wastewater-relevant micropollutants. Overall, using the experimental and analytical strategy developed, stream biofilms were demonstrated to have a broad inherent micropollutant biotransformation potential, and to thus contribute to bioremediation and improving ecosystem health.

(来源：WATER RESEARCH 卷:193 出版年: 2021, **DOI:** 10.1016/j.watres.2021.116846)

Morphological consequences of upstream water and sediment changes and estuarine engineering activities in Pearl River Estuary channels over the last 50 years

Wang Yong-Hong; Cai Si-Long; Yang Yuan-Dong; 等

The relative contributions of decreased upstream sediment loads and local estuarine engineering activities to the estuarine channel geometry are poorly understood. In this study, we analyze the hydrological changes and identify the location, duration and intensity of the estuarine engineering activities based on the channel morphologic changes from 1965 to 2017 at the five stations in the Pearl River Estuary. Thereafter, the Mann-Kendall (M-K) statistical test, empirical orthogonal function (EOF) tests, and channel geometry reconstruction based on the hydrological coefficient were performed to quantitatively estimate the relative contributions from upstream dam construction and estuarine engineering activities. The results show that the geometric changes in the five transects over the last 50

years could be divided into three stages. Stage I extends over approximately 23-33 years at the different channel transects, during which the channel geometries were mainly influenced by natural factors, with a balance between erosion and deposition. Stage II occurred during the next 11-20 years and the changes in the cumulated water depth in comparison to the values in the previous adjacent years at this stage are approximately 5-25 times the values in stage I. The human activities (e.g., sand excavation) contribute to >70-90% of the extreme geometric changes. Stage III lasted for <3-11 years in the different transects with a slight depositional trend, and policies regulating sand excavation were implemented during this stage. The rapid increase in the channel area and water depth caused by sand excavation can cause the downcutting of the riverbed, a decrease in the water level, and redistribution of the water and sediment discharge. Therefore, the monitoring, simulation and analysis of the variation in the typical channel geometry over the long term provide important means to understand the human activities occurring and insights for future sustainable estuarine management.

(来源：SCIENCE OF THE TOTAL ENVIRONMENT 卷:765 出版年: 2021,**DOI:** 10.1016/j.scitotenv.2020.144172)

Emergent spatial patterns of competing benthic and pelagic algae in a river network: A parsimonious basin-scale modeling analysis

Yang, Soohyun; Bertuzzo, Enrico; Buttner, Olaf; 等

Algae, as primary producers in riverine ecosystems, are found in two distinct habitats: benthic and pelagic algae typically prevalent in shallow/small and deep/large streams, respectively. Over an entire river continuum, spatiotemporal patterns of the two algal communities reflect specificity in habitat preference determined by geomorphic structure, hydroclimatic controls, and spatiotemporal heterogeneity in nutrient loads from point- and diffuse-sources. By representing these complex interactions between geomorphic, hydrologic, geochemical, and ecological processes, we present here a new river-network-scale dynamic model (C(n)ANDY) for pelagic (A) and benthic (B) algae competing for energy and one limiting nutrient (phosphorus, P). We used the urbanized Weser River Basin in Germany (7th-order; similar to 8.4 million population; similar to 46 K km(2)) as a case study and analyzed simulations for equilibrium mass and concentrations under steady median river discharge. We also examined P, A, and B spatial patterns in four sub-basins. We found an emerging pattern characterized by scaling of P and A concentrations over stream-order whereas B concentration was described by three distinct phases. Furthermore, an abrupt algal regime shift occurred in intermediate streams from B dominance in omega <= 3 to exclusive A presence in omega >= 6. Modeled and long-term basin-scale monitored dissolved P concentrations matched well for omega<4, and with overlapping ranges in omega<3. Power-spectral analyses for the equilibrium P, A, and B mass distributions along hydrological flow paths showed stronger clustering compared to geomorphological attributes, and longer spatial autocorrelation distance for A compared to B. We discuss the implications of our findings for advancing hydro-ecological concepts, guiding monitoring, informing management of water quality, restoring aquatic habitat, and extending CANDY model to other river basins.

(来源：WATER RESEARCH 卷:193 出版年: 2021, **DOI:** 10.1016/j.watres.2021.116887)

Decline in terrestrial water recharge with increasing global temperatures

Banerjee, Chandan; Sharma, Ashish; Kumar, Nagesh D.

Since 1901, global temperatures have risen by 0.89 degrees C, seriously impacting precipitation patterns

and flow peaks. However, few assessments of changes in global water balance have been conducted. Here we investigate the effect of rising temperatures on water recharge for 31 major river basins across the world using satellite derived terrestrial water storage. We find reductions in Relative Recharge (indicative of the Terrestrial Water Recharge (TWR)) with increasing temperature in 23 of the 31 basins, with 12 basins showing significant reductions (at 90% confidence level). The possible explanation is that increase in temperature reduces the relative recharge due to increased evapotranspiration and reduced snow accumulation. Thus, in a future wanner climate, even an unchanged precipitation would lead to diminished recharge than expected, with reductions in precipitation expected to exacerbate it further. Large-scale changes in recharge would subsequently influence vegetation growth. Reduction in TWR showed clear association with diminished vegetation growth in majority of the river basins analyzed, adding further confirmation to the hypothesis being assessed.

(来源：SCIENCE OF THE TOTAL ENVIRONMENT 卷:764 出版年: 2021,**DOI:** 10.1016/j.scitotenv.2020.142913)

Increasingly severe cyanobacterial blooms and deep water hypoxia coincide with warming water temperatures in reservoirs

Smucker, Nathan J.; Beaulieu, Jake J.; Nietch, Christopher T.; 等

Cyanobacterial blooms are expected to intensify and become more widespread with climate change and sustained nutrient pollution, subsequently increasing threats to lentic ecosystems, water quality, and human health. However, little is known about their rates of change because long-term monitoring data are rare, except for some well-studied individual lakes, which typically are large and broadly dispersed geographically. Using monitoring data spanning 1987-2018 for 20 temperate reservoirs located in the USA, we found that cyanobacteria cell densities mostly posed low-to-moderate human health risks until 2003-2005, after which cell densities rapidly increased. Increases were greatest in reservoirs with extensive agriculture in their watersheds, but even those with mostly forested watersheds experienced increases. Since 2009, cell densities posing high human health risks have become frequent with 75% of yearly observations exceeding 100,000 cells ml(-1), including 53% of observations from reservoirs with mostly forested watersheds. These increases coincided with progressively earlier and longer summer warming of surface waters, evidence of earlier onset of stratification, lengthening durations of deep-water hypoxia, and warming deep waters in non-stratifying reservoirs. Among years, higher cell densities in stratifying reservoirs were associated with greater summer precipitation, warmer June surface water temperatures, and higher total Kjeldahl nitrogen concentrations. These trends are evidence that expected increases in cyanobacterial blooms already are occurring as changing climate conditions in some regions increasingly favor their proliferation. Consequently, their negative effects on ecosystems, human health, and socioeconomic wellbeing could increase and expand if warming trends and nutrient pollution continue.

（来源：GLOBAL CHANGE BIOLOGY 卷:27 期:11 出版年: 2021, **DOI:** 10.1111/gcb.15618）

Viability of SARS-CoV-2 in river water and wastewater at different temperatures and solids content

de Oliveira, Leonardo Camilo; Torres-Franco, Andres Felipe; Lopes, Bruna Coelho; 等.

COVID-19 patients can excrete viable SARS-CoV-2 virus via urine and faeces, which has raised concerns over the possibility of COVID-19 transmission via aerosolized contaminated water or via the faecal-oral route. These concerns are especially exacerbated in many low-and middle-income countries,

where untreated sewage is frequently discharged to surface waters. SARS-CoV-2 RNA has been detected in river water (RW) and raw wastewater (WW) samples. However, little is known about SARS-CoV-2 viability in these environmental matrices. Determining the persistence of SARS-CoV-2 in water under different environmental conditions is of great importance for basic assumptions in quantitative microbial risk assessment (QMRA). In this study, the persistence of SARS-CoV-2 was assessed using plaque assays following spiking of RW and WW samples with infectious SARS-CoV-2 that was previously isolated from a COVID19 patient. These assays were carried out on autoclaved RW and WW samples, filtered (0.22 mu m) and unfiltered, at 4 degrees C and 24 degrees C. Linear and nonlinear regression models were adjusted to the data. The Weibull regression model achieved the lowest root mean square error (RMSE) and was hence chosen to estimate T 90 and T 99 (time required for 1 log and 2 log reductions, respectively). SARS-CoV-2 remained viable longer in filtered compared with unfiltered samples. RW and WW showed T 90 values of 1.9 and 1.2 day and T 99 values of 6.4 and 4.0 days, respectively. When samples were filtered through 0.22 mu m pore size membranes, T 90 values increased to 3.3 and 1.5 days, and T 99 increased to 8.5 and 4.5 days, for RW and WW samples, respectively. Remarkable increases in SARS-CoV-2 persistence were observed in assays at 4 degrees C, which showed T 90 values of 7.7 and 5.5 days, and T 99 values of 18.7 and 17.5 days for RW and WW, respectively. These results highlight the variability of SARS-CoV-2 persistence in water and wastewater matrices and can be highly relevant to effort s aimed at quantifying water-related risks, which could be valuable for understanding and controlling the pandemic.

(来源：WATER RESEARCH 卷:195 出版年: 2021, **DOI:** 10.1016/j.watres.2021.117002)

Influence of the mightiest rivers worldwide on coastal sea surface temperature warming

Fernandez-Novoa, D; Costoya, X; DeCastro, M; Gomez-Gesteira, M. 等

Since 1901, global temperatures have risen by 0.89 degrees C, seriously impacting precipitation patterns and flow peaks. However, few assessments of changes in global water balance have been conducted. Here we investigate the effect of rising temperatures on water recharge for 31 major river basins across the world using satellite derived terrestrial water storage. We find reductions in Relative Recharge (indicative of the Terrestrial Water Recharge (TWR)) with increasing temperature in 23 of the 31 basins, with 12 basins showing significant reductions (at 90% confidence level). The possible explanation is that increase in temperature reduces the relative recharge due to increased evapotranspiration and reduced snow accumulation. Thus, in a future wanner climate, even an unchanged precipitation would lead to diminished recharge than expected, with reductions in precipitation expected to exacerbate it further. Large-scale changes in recharge would subsequently influence vegetation growth. Reduction in TWR showed clear association with diminished vegetation growth in majority of the river basins analyzed, adding further confirmation to the hypothesis being assessed.

(来源：SCIENCE OF THE TOTAL ENVIRONMENT 卷:768 出版年: 2021,**DOI:** 10.1016/j.scitotenv.2020.144915)

Integrating resilience with functional ecosystem measures: A novel paradigm for management decisions under multiple-stressor interplay in freshwater ecosystems

Jaiswal, Deepa; Pandey, Usha; Mishra, Vibha; 等.

Moving beyond monitoring the state of water quality to understanding how the sensitive ecosystems

respond to complex interplay of climatic and anthropogenic perturbations, and eventually the mechanisms that underpin alterations leading to transitional shifts is crucial for managing freshwater resources. The multiple disturbance dynamics-a single disturbance as opposed to multiple disturbances for recovery and other atrocities-alter aquatic ecosystem in multiple ways, yet the global models lack representation of key processes and feedbacks, impeding potential management decisions. Here, the procedure we have embarked for what is known about the biogeochemical and ecological functions in freshwaters in context of ecosystem resilience, feedbacks, stressors synergies, and compensatory dynamics, is highly relevant for process-based ecosystem models and for developing a novel paradigm toward potential management decisions. This review advocates the need for a more aggressive approach with improved understanding of changes in key ecosystem processes and mechanistic links thereof, regulating resilience and compensatory dynamics concordant with climate and anthropogenic perturbations across a wide range of spatio-temporal scales. This has relevance contexting climate change and anthropogenic pressures for developing proactive and adaptive management strategies for safeguarding freshwater resources and services they provide.

（来源：GLOBAL CHANGE BIOLOGY 出版年: 2021, **DOI:** 10.1111/gcb.15662）

Dams and Climate Interact to Alter River Flow Regimes Across the United States

Chalise, Dol Raj; Sankarasubramanian, A.; Ruhi, Albert

Storing and managing river flows through reservoirs could dampen or increase climate-induced fluctuations in streamflow, but interactions between the effects of dams and climate are poorly understood. Here, we examined how dam properties control different facets of flow alteration across the coterminous United States (CONUS), and compared alteration trends between dam-affected and reference stream gages. We quantified departures from the natural flow regime using 730 stations with long-term daily discharge data. Dam size and purpose explained high variation in flow alteration, and alteration was particularly severe in water-stressed regions. Importantly, regulation of river flows by dams often dampened climate-driven alteration (48% of the flow metrics), particularly in watersheds with positive flow trends; while worsening climatic impacts in other cases (44%), or even having dual effects (8%). Our results show that dam and climate impacts on streamflow need to be assessed jointly, and based on a diverse range of flow regime facets (e.g., event magnitude and duration, frequency, and timing) instead of mean annual flows only. By pairing the USGS streamflow records available from upstream and downstream of 209 dams across the CONUS, we advance the notion that dams amplify flow alteration, but also ameliorate some flow alteration metrics. Understanding such potential and limitations is important in light of climate non-stationarity and a new wave of damming in developing economies, and will be key to further advancing environmental flow science into the future.

（来源：EARTHS FUTURE 卷:9 期:4 出版年: 2021, **DOI:** 10.1029/2020EF001816）

Century-Scale Reconstruction of Water Storage Changes of the Largest Lake in the Inner Mongolia Plateau Using a Machine Learning Approach

Fan, Chenyu; Song, Chunqiao; Liu, Kai; 等.

Lake Hulun is the fifth-largest lake in China, playing a substantial role in maintaining the balance of the grassland ecosystem of the Mongolia Plateau, which is a crucial ecological barrier in North China. To better understand the changing characteristics of Lake Hulun and the driving mechanisms, it is

necessary to investigate the water storage changes of Lake Hulun on extended timescales. The main objective of this study is to reconstruct the water storage time series of Lake Hulun over the past century. We employed a machine learning approach termed the extreme gradient boosting tree (XGBoost) to reconstruct the water storage changes over a one-century timescale based on the generated bathymetry and satellite altimetry data and investigated the relationships with hydrological and climatic variables in long term. Results show that the water storage changes from 1961 to 2019 were featured by four fluctuation phases, with the highest water storage observed in 1991 (14.02 Gt) and the lowest point in 2012 (5.18 Gt). The century-scale reconstruction result reveals that the water storage of Lake Hulun reached the highest point in the 1960s within the period of 1910-2019. The lowest stage occurred in the sub-period of the 1930s-1940s, which was even lower than the alerted shrinkage stage in 2012. The predictive model results indicate the effective performance of the XGBoost model in reconstructing century-scale water storage variations, with the mean absolute error of 0.68, normalized root mean square error of 0.11, Nash-Sutcliffe efficiency of 0.97, and correlation coefficient of 0.94. The annual fluctuations of water storage were mostly affected by precipitation, followed by vapor pressure, temperature, potential evapotranspiration, and wet day frequency. The dominating characteristics of different variables vary evidently with different sub-periods. The atmospheric circulations of the Arctic Oscillation, El Nino Southern Oscillation, Pacific Decadal Oscillation, and North Atlantic Oscillation have tight associations with the water storage variations of Lake Hulun, which change with different study periods.

（来源：WATER RESOURCES RESEARCH 卷:57 期:2 出版年: 2021, **DOI:** 10.1029/2020WR028831）

Safety design for water-carrying Lake flood control based on copula function: A Case study of the Hongze Lake, China

Luo, Yun; Dong, Zengchuan; Liu, Yuhuan; 等.

Lakes are typical plain reservoirs, with many similar functions to valley reservoirs; however, their flood processes differ significantly due to their specific topography. Flooding of the dam site, the entire reservoir inflow, is considered during flood control analysis of valley reservoirs. Whereas, the flood inundation risk of flood detention areas in the lake basin should be considered for lakes. Therefore, more attention should be paid to the flood processes of each sub-region. Here, based on the flood processes characteristics of large water-carrying lakes, a complete framework for establishing design floods for sizeable rivers-connected lakes is introduced. First, multiple Copula-based joint distribution functions are constructed based on the water system structure of the lake. Then, several confidence intervals are obtained using a methodology that identifies the boundary for multivariate combinations. Finally, through these confidence intervals are used in conjunction with each other, the design flood processes for water-carrying lake system can be determined. The proposed methodology was applied to the Hongze Lake, China. The results indicate that this method not only effectively avoids the randomness of the traditional method but also balances the characteristics of the flood process in each sub-region with the features of the entire flood process. The proposed method has a strong statistical theoretical foundation and expands the applicability of multi-variable flood frequency analysis techniques to water conservancy projects.

(来源：JOURNAL OF HYDROLOGY 卷:597 出版年: 2021, **DOI:** 10.1016/j.jhydrol.2021.126188)

Hydro-sediment-morphodynamic processes of the baige landslide-induced barrier Lake, Jinsha River, China

Li, Ji; Cao, Zhixian; Cui, Yifei; 等.

Lakes A large landslide impacting a river may cause a multi-phase chain of hazards, comprising landslide-generated waves, inundation as a barrier lake develops upstream of a landslide dam arising from rapid sediment deposition, and downstream flooding due to barrier lake outburst. Two major landslides (each of volume similar to 10(7) m(3)) occurred successively on 10th October and 3rd November 2018 at Baige village, Tibet, China. Both landslides led to a natural dam that completely blocked the Jinsha River, along with a barrier lake filled with upstream river inflow. Although the first barrier lake breached naturally, a significant quantity of residual material from the first landslide dam was left behind without being eroded. After the second landslide occurred, a flood channel was urgently constructed to facilitate an artificial breach of the barrier lake as it formed. The Baige landslide-induced barrier lake is unique having triggered by two successive landslides and outbursts a mere five weeks apart. Here a computational investigation is presented of the hydro-sediment-morphodynamic processes of the Baige barrier lake, using a recent 2D double layer-averaged two-phase flow model. This is the first modelling study of the whole field and whole processes for the formation and outburst of a landslide-induced barrier lake as well as the resultant floods, without evoking presumptions on dam breach (which have prevailed for decades and bear much uncertainty). The computed results agree well with field observations in terms of landslide-generated waves, landslide dam morphology, stage and discharge hydrographs at the dam site and downstream flood hydrographs. The artificial flood channel is shown to be effective for alleviating downstream inundation. Water and grain velocities are demonstrated to be distinct, characterizing the primary role of grains in landslide dam and barrier lake formation and the dominant role of water in barrier lake outburst and the resultant flood. Relatively low inflow discharge and large initial landslide volume favour landslide dam and barrier lake formation, but delay the outburst and downstream flood. The present 2D double layer-averaged two-phase model holds great promise for assessing future landslide-induced multi-hazard chains in rivers, and informing mitigation and adaptation strategies.

(来源：JOURNAL OF HYDROLOGY 卷:596 出版年: 2021, **DOI:** 10.1016/j.jhydrol.2021.126134)

科学视点

Science：全球近 400 个湖泊生态系统发生变化

英国《自然》杂志近日发表的一项环境学研究发现，大量温带湖泊含氧量出现了大范围、长期的下降。这是一项针对近 400 个湖泊在 80 年时间里的变化研究，团队计算得出的这一趋势，被认为和气候变暖以及水体透明度下降有关，而这种下降趋势亦可能会威胁到至关重要的湖泊生态系统。

地球水体系统的溶解氧浓度会影响养分平衡、生物多样性、饮用水质量和温室气体排放。2019 年底一项包括 17 个国家科学家参与的研究表明，地球上海洋的氧气含量在过去 50 年间有逐年下降的趋势，自 20 世纪中期至今，地球海水含氧量下

降了 1%—2%；而据预测，到 2100 年将再减 1%—2%，发生氧气流失的是大多数生物所在的海洋上层，恐对整个生态系统的平衡造成危害。

虽然海洋的氧流失已经得到证明，但科学界一直以来对湖泊溶解氧浓度的变化还不够了解，这一定程度上是由于缺乏长期、大规模的研究。为解决这一问题，美国伦斯勒理工大学研究人员凯文·罗斯及其团队此次编制了 1941 年至 2017 年间由政府、大学、非营利组织采集的 393 个温带湖泊（全球范围，大部分位于欧美）的温度和溶解氧测量数据。这些淡水环境减少的溶解氧是海洋中观测到的 2 倍到 9 倍左右。

此前研究认为，全球变暖是造成海洋含氧量下降的主要原因。而在本次的湖泊研究中，研究人员也指出：水温上升与表层水氧浓度下降有关，而深层水氧含量下降则与更强的热分层（不同深度形成不同的温跃层）以及水体透明度降低有关。团队同时还指出了这些趋势的一些例外，比如大量湖泊（87 个）的水温和溶解氧浓度都出现了上升。不过，这种反常现象或许是由水华导致的，水华可能会让表层的氧浓度升高、深层的氧溶解度降低。当氧气量的减少出现在海洋中，已经意味着栖息地与生态多样性的流失；而湖泊含氧量的大范围变化，也暗示了水体能量与生物化学循环承受的压力以及生态系统面临的威胁。

（来源：科技日报，http://www.cas.cn/kj/202106/t20210608_4792027.shtml，2021-06-08）

青藏高原湖泊大部分处于非淡水状态

于十余年野外调查工作，中科院青藏高原所研究员朱立平等首次获取了青藏高原 2009 年至 2019 年期间大范围湖泊实测水质参数。科研人员发现，青藏高原湖泊大部分处于非淡水状态，营养化程度低；盐度总体呈南低北高，pH 值呈明显的南高北低。该研究成果近日在《科学通报》上发表。

据介绍，青藏高原湖泊广布，面积超过 1 平方公里的湖泊数量超过 1400 个，总面积超过 50000 平方公里，占据我国湖泊总面积一半以上，是地球上海拔最高、数量最多、面积最大的高原湖群区，是“亚洲水塔”的重要组成。该地区湖泊受人类活动干扰较小，湖泊的多种水质参数受水剖面能量分布、水汽能量交换，以及湖泊生态系统的影响，对区域气候和环境变化产生敏感响应。由于青藏高原大部分湖泊所处环境条件恶劣，缺乏湖泊水质参数实测数据，严重制约了我们对青藏高原湖泊时空变化的深入认识。

该文章的第一作者，中科院青藏高原所在读博士生刘翀介绍，研究团队获取的实测水质参数涉及 124 个封闭湖泊，总面积为 24570 平方公里，占青藏高原湖泊总面积的 53%。通过对水温、盐度、pH、叶绿素-a、蓝绿藻、溶解氧、荧光溶解有机质、浊度和透明度的分析发现：青藏高原淡水湖、盐湖皆有分布，目前绝大部分处于非淡水状态。湖泊盐度总体南低北高，大多数湖泊表现出碱性特征，营养化程度

低，浮游植物和溶解性有机质较少，浊度低，透明度高。湖泊 pH 值呈现明显的南高北低，湖泊水温呈现随季节波动、随海拔升高而降低的变化，湖水透明度随湖泊面积增加而加深。

该文章的通讯作者、中科院青藏高原所朱立平研究员表示，本研究首次提供了青藏高原大范围湖泊实测水质参数，为湖泊水环境参数的尺度变换和时空变化研究提供丰富的基础数据，有助于深入认识气候变化下青藏高原的湖泊水环境、水生态和水资源的关系。

（来源：《科学通报》，https://doi.org/10.1016/j.scib.2021.04.024，2021-06-26）

科学家揭示青藏高原降水年代际可预报性

6月10日，中国科学院大气物理研究所周天军研究团队在《科学进展》在线发表文章，利用最新的多模式年代际气候预测系统大集合样本气候预测结果，通过剔除不可预测的气候噪音、提取可预测的气候信号，在国际上首次揭示了青藏高原夏季降水的年代际可预报性。该成果对于亚洲水塔周边地区的水资源调控、经济和社会的可持续发展，以及科学应对青藏高原气候变化风险具有重要参考价值。

利用参加第六次“国际耦合模式比较计划”（CMIP6）的“年代际气候预测计划”（DCPP）的多模式历史气候回报数据，周天军研究团队发现DCPP多模式对位于青藏高原腹地的羌塘高原夏季降水的年代际预测结果存在显著的“信噪比悖论”问题，即年代际气候预测系统中的信噪比要低于现实世界。该问题的存在，令气候模式中的可预测信号被较强的、不可预测的气候噪音所掩盖，使得青藏高原夏季降水的年代际可预报性被低估。而基于多模式大集合气候预测试验的集合平均预测结果，能够有效地剔除模式中不可预测的噪音，从而成功提取到可预测的信号。

针对回报结果时间演变位相与实际相符而振幅偏弱的问题，他们提出了一种兼顾长期变化趋势与年代际振荡信号的“方差订正”技术，使得预报结果在位相和振幅上都与观测高度吻合。进一步研究发现，羌塘高原夏季降水年代际变化的可预报性来源是北大西洋副极区涡旋区的海温异常，它通过激发出的大气遥相关波列，最终影响到下游的青藏高原降水变化。

利用实时年代际预测试验数据，该团队定量估算了羌塘高原夏季降水未来在2020-2027年间的变化。结果表明，相对于1986-2005年的气候平均态，羌塘高原夏季降水将增加0.27 mm/day (0.11-0.41 mm/day, 5%-95%不确定性)，这意味在可见的未来羌塘高原将处于偏湿状态、夏季降水量较之气候平均状况偏多约12.8%。

“面向未来10年的近期气候变化信息，对国家中长期决策具有重要的科学参考价值。前人多利用仅考虑不同排放情景的气候预估试验，来分析这一时段气候的可能变化。但是在这个时间段，气候系统内部变率和海洋热惯性的影响不亚于、甚至要远超温室气体等外强迫的作用，这使得气候预估结果的表现是噪音大于信号。”该文第一作者、中国科学院大气物理研究所博士生胡帅说，该研究考虑了海洋初始

化的年代际气候预测系统，是提供近期气候变化信息的最有效的工具。该工作表明，只要多模式集合样本的大数据足够，再辅以有效的方差订正技术，科学家有能力对青藏高原这一气候敏感区的未来近10年气候进行较为可靠的预测。

“近期年代际气候变化预测具有迫切的应用需求，世界气象组织（WMO）已经开始筹划准业务化试验。揭示青藏高原夏季降水的年代际可预报性是该领域的一个可喜进展，但是针对年代际预报问题，我们在科学和技术上仍面临着诸多亟待解决的难题。”该文通讯作者周天军强调。

周天军表示，在科学上，当前有效的海温年代际预报技巧多限于大西洋，在太平洋的技巧较低，而其中的物理机理尚不清楚。在技术上，开展年代际气候预测试验需要大量的高性能计算资源和存储资源，受资源所限，当前国际上的年代际预测试验大多仅能提供未来10年的预测信息。提升年代际预报的能力，尚需要国际科学界的携手努力。

（来源：中国科学报，相关论文信息：http://dx.doi.org/10.1126/sciadv.abf9395）

湖泊沉积揭示南亚季风北缘长江源区的古气候变化

以青藏高原为主体的第三极是目前全球变暖最强烈的地区，也是未来全球气候变化影响最不确定的地区。西风与印度季风两大环流是控制青藏高原气候与环境变化的决定性因素，位于两大环流的过渡区域的环境变化对环流具有敏感响应。长江源区处于现代南亚季风北缘，是受西风与季风协同影响的过渡地带和内外流区的分界地带，也是第二次青藏高原科考的江湖源核心区。各拉丹东冰川、多尔索洞错-赤布张错（大型湖泊）、沱沱河、扎加藏布（西藏最大内流河，色林错北岸的补给河流）等重要水资源在这里聚汇。目前，该区域尚缺乏覆盖万年以上的连续环境记录。

为此，中国科学院青藏高原研究所研究员朱立平带领的湖泊与环境变化团队利用赤布张错湖泊岩芯沉积物重建了长江源区过去 13000 年的古气候变化记录，评估了南亚季风与中纬度西风之间过渡带自晚冰期以来的古气候变化特点以及环流效应。科研人员对取自该湖的一根 548cm 岩芯进行粒度、元素与碳酸盐等多指标分析。结果表明，长江源区晚冰期末期以来的气候变化分为四个阶段：（1）晚冰期（12.7-10.6 ka）相对寒冷；（2）早全新世（10.6-6.6 ka）暖湿；（3）中晚全新世（6.6-1.9 ka）温凉偏冷和干燥；（4）最近的 2000 年出现变暖变湿的趋势。

与其他区域记录相比，该区域具有与季风和西风带非同步演化的过渡特征。长江源区有效湿度整体遵从南亚季风区的变化模式，即季风环流驱动了晚冰期以来的古气候变化，主要受增强的夏季太阳辐射控制，但到中全新世，有效湿度受八月份的太阳辐射影响，碳酸盐沉积增加。在中晚全新世，湖泊维持了中等水位，可能受

到西风效应（冷空气与降雪）和冰川融水叠加的影响。目前，该区域的气候水文条件处于温和偏湿的状态，可能接近早全新世的晚期。

该研究有助于评估长江源区这一环境变化敏感区水资源变化的未来发展趋势，为中华水塔乃至三江源区生态环境评估及相关研究提供更多科学参考。相关研究成果以 Paleoclimate changes over the past 13,000 years recorded by Chibuzhang Co sediments in the source region of the Yangtze River, China 为题，发表在 Palaeogeography, Palaeoclimatology, Palaeoecology 上。论文第一作者为青藏高原所博士后陈浩，论文共同通讯作者为研究员朱立平。

（来源：中国科学院院网，http://www.cas.cn/syky/202106/t20210609_4792291.shtml，根据相关资料编译）

铁光相互作用影响富营养化湖泊浮游植物生长

中科院青藏高原研究所湖泊与环境变化团队在《环境遥感》上发表研究论文，指出青藏高原湖泊透明度过去 20 年总体呈上升态势。

湖泊水质是青藏高原区域水环境和水生生态系统的重要组成要素，是“第二次青藏高原综合科学考察研究”专项中评估亚洲水塔功能的重要研究内容。目前，对青藏高原湖泊水质的大范围长时间序列调查极为缺乏。利用水质遥感（水色遥感）方法对水质参数进行反演，在海洋水色、内陆其他地区湖泊水质研究中已得到广泛应用，但在青藏高原地区的研究中尚未见，其原因在于缺乏实测水质数据、实测水色光谱和卫星遥感数据间建立的可靠反演模型及其充分验证。

该团队基于 2012-2019 年野外工作采集的 100 多个湖面水质及反射光谱数据，利用 Google Earth Engine 遥感大数据云处理平台，验证了青藏高原湖泊透明度遥感反演模型，并分析了过去 20 年湖泊透明度时空变化特征及原因。

结果表明，MODIS-MODOCGA 反射率产品的蓝绿波段较好地指示了青藏高原湖泊水面反射率，湖泊透明度反演模型达到较高精度。反演结果显示，湖泊透明度主要介于 3~10 米之间，并且与湖泊面积呈现显著的正相关关系。2000-2019 年期间，大于 50 平方千米的 152 个湖泊透明度主要呈上升趋势，平均变化速率为 0.033 米/年。湖泊透明度年际变化受降水影响较大，并与水体光学组分悬浮物、荧光溶解有机物、叶绿素 a 浓度存在不同强度的相关性。

该研究有助于进一步理解气候变化背景下青藏高原及内陆水体透明度变化特征，并且为湖泊水—气界面热量交换相关研究提供基础数据与研究参考。

（来源：科技日报，http://www.stdaily.com/02/jilin/2021-06/21/content_1158575.shtml，2021-06-21）

中国流域水环境演变及其驱动因素研究

流域水环境污染是影响全球水安全的突出问题之一，但从大区域尺度辨识流域水环境演变及其对自然因素与人类活动响应是水环境研究与管理亟待解决的难题；

尤其是过去二十年是中国经济快速发展与环境治理投入迅速增长时期，研究这一时期自然条件变化与社会经济发展背景下的水环境演变，有利于国家水环境污染防治的宏观决策。

在中国科学院青年创新促进会项目、国家自然科学基金等联合资助下，中国科学院南京地理与湖泊研究所黄佳聪副研究员、高俊峰研究员等科研人员，联合中国环境监测总站、中科院成都山地所、德国亥姆霍兹环境研究所、暨南大学、多伦多大学等单位，收集了全国十大流域气象、土地利用与水质等数据，分析了 2003-2018 年全国河流水质的空间格局与演变特征，构建了流域变化环境下的河流水质响应模型，诊断了河流水质变化的主控因子及其空间差异，量化了河流水质变化驱动因素的贡献比例及其不确定性，从地理学视角揭示流域自然因素与人类活动共同驱动下的河流水质响应机制。 研究结果表明：

1）2003-2018 年期间，全国十大流域河流水质总体改善。长江、黄河流域等六大流域水质有显著提升，海河流域水质提升幅度最大；河流水体富营养化有所缓解，重金属污染逐步消除，不足 0.3%监测点出现重金属污染；

2）总磷与氨氮污染仍是近年水环境污染的主因（贡献率>85%），其中东部水环境污染比例（17.2%）大于西部（4.6%），东部沿海地区水环境污染最严重（24.4%）；

3）流域人类活动是河流总磷/氨氮污染的主导因素（贡献率>75%），其中流域人口密度、农田与建设用地面积比例是河流总磷/氨氮变化的主控因素，地形气象等自然因素贡献较小。

基于上述研究结果，可进一步推论：东部高密度人口区与农业耕作区是我国氮磷污染防控的重点区域，点源与面源污染的协同防控才能更好实现氮磷污染治理目标。研究成果可为全国流域水环境污染的分区防控与治理提供科学依据，成果以 Characterizing the river water quality in China: Recent progress and on-going challenges 为题，发表在环境领域知名期刊 Water Research。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202106/t20210610_6081749.html，2021-06-10）

淡水盐碱化:人类可能面临生态环境新挑战

当前，全球内陆淡水水体盐度普遍上升，这种现象被称为“淡水盐碱化综合征”。有模拟预测显示，淡水盐碱化将成为未来全球的重要生态环境挑战之一。

中国科学院城市环境研究所水生态健康研究组（杨军团队）发现，盐度是塑造淡水微型真核浮游生物群落动态的主要驱动力。该研究为城市水体浮游生物群落生

态以及盐度小幅度变化的生态效应提供了新见解。相关成果近日在微生物领域国际期刊 Microbiome 上发表。

“人类可直接利用淡水，不能直接利用海水。淡水盐碱化会严重影响饮用水资源，破坏基础设施，例如，给水排水管道系统更容易腐蚀受损等。”中国科学院城市环境研究所研究员杨军告诉《中国科学报》，“此外，在自然生态系统中，盐碱化会危害淡水生态系统健康，高盐度胁迫可导致淡水生物的适合度降低、畸形率增加、死亡率升高。”

淡水盐碱化或盐度升高会导致生物多样性丧失、食物链缩短和食物链平均营养等级降低，从而对生态系统结构和功能造成不利影响。有模拟研究预测，淡水盐碱化将逐渐成为未来全球面临的重要生态环境挑战之一。

4 月 12 日，《生物地球化学》发表一项由美国马里兰大学进行的研究。该研究表明，环境中增加的盐可以与土壤和基础设施相互作用，释放出大量金属、溶解固体和放射性粒子的混合物。淡水盐碱化综合征会使饮用水含毒，并对人类健康、农业生产、基础设施、野生动物和生态系统造成负面影响。

4 月 21 日，《自然—可持续发展》上发表的文章预计，到 2100 年，美国一半以上的河流盐污染将增加 50%以上，如果不采取措施扭转这种淡水盐污染趋势，未来它会成为美国面临的首要环境挑战之一。

“引起淡水盐碱化的因素很多，包括自然因素和人为因素：海平面上升、海水入侵、全球气候变化、人类活动等。”杨军补充说，“全球气候变化将有可能极大改变全球的温度和降水模式，从而加剧内陆水体盐碱化程度。比如，降雨量下降、蒸发量上升，会进一步增加盐碱化程度。此外，污水排放、采矿、农业施肥等，都会影响水体盐度。”

尽管淡水盐碱化已引起科学家的警觉，但国际上关于内陆水体小幅度盐度变化对微型真核浮游生物群落的影响过程与效应的研究却很少。

为揭示小幅度盐度变化背景下，微型真核浮游生物群落的构建机制和网络稳定性，杨军等人在福建省厦门市集美区最大的景观水体（杏林湾水库）建立了长期定位生态观测研究站。研究收集并分析了杏林湾水库连续 13 个月的观测数据，发现研究期间盐度最低为 0、最高为 6.1‰。

“结果表明，盐度的小幅度增加导致微型真核浮游生物群落组成发生变化，生物多样性显著降低；盐度主要通过调控确定性—随机性过程的平衡来驱动微型真核浮游生物群落组成变化，即随着盐度的增加，确定性过程的相对贡献越来越重要；在低盐度条件下核心浮游生物网络的鲁棒性较高，而在中/高盐度条件下卫星浮游生物网络的鲁棒性更高。”该论文第一作者、杨军团队的博士生莫媛媛对《中国科学报》说，“总体而言，盐度是塑造微型真核浮游生物群落动态的主要驱动力。”

“淡水盐碱化可以直接影响浮游生物群落，进而影响水生态系统及其服务功能。”杨军补充说，该研究以微型真核浮游生物群落为对象，揭示了在低盐度条件下，即使小幅度的盐度增加也足以施加选择性压力，降低浮游生物多样性，并改变群落构建机制和网络稳定性。

鉴于盐度的小幅度上升未来在内陆水体发生频率将更高，在评估、模拟和预测盐度对沿海城市淡水生态系统的影响，以及城市水体的管理和保护时，应充分考虑浮游生物群落对盐度变化的响应。

淡水盐碱化水平主要通过水体盐度的变化进行评价。通常，淡水的含盐浓度在0.01‰至 0.5‰。“平均而言，1 升海水含盐 35 克左右，1 升淡水中含盐 0.5 克（万分之五）以下。”杨军说，“半咸水的含盐量在 0.5‰至 30‰之间，其中寡盐水含盐 0.5‰至 5‰、中盐水含盐 5‰至 18‰、多盐水含盐 18‰至 30‰。目前我们的研究发现，杏林湾水库最大盐度已经超出淡水范围，达到寡盐水和中盐水水平。”

有研究发现，当水体盐度达到一定阈值时，水生态系统将发生非线性突变。“即水体盐度在达到浓度临界值时，其微小变化将导致水生态系统结构和功能产生巨大的未知变化。”杨军强调说，“但是，不同水体盐度阈值随地质背景、气候变化、人类活动、海水入侵的迁移轨迹等一系列问题有待进一步研究。”

著名湖泊学家、丹麦奥胡斯大学教授 Erik Jeppesen 曾撰文指出，淡水生态系统对一些压力（如气候变化）的响应研究已取得诸多进展，但是有关水体中盐分浓度对内陆水体和沿海泻湖的影响研究还比较缺乏。目前，许多湖泊呈现出盐度持续增加的趋势，包括从淡水湖泊变为半咸水湖泊、半咸水湖泊盐度也正在进一步增加。同时，盐度与其他胁迫因素的交互作用（温度、营养物质和营养盐组成的类型）尚不明确。

“应建立全球通用规范的采样方法、实验方案和建模标准，进行跨气候区的科研合作，为解决、缓解内陆水体盐碱化问题提供有效的科学指导和应对策略。”杨军说。

Erik Jeppesen 认为，在区域和全球范围缓解内陆水体盐碱化加剧及其带来的负面影响，并提供科学有效的解决方案，需要水文学家、生态学家、数学家、经济学家、工程师、社会科学家之间的通力合作，并统筹协调政治家、非政府组织和公民积极参与。相关论文信息：https://doi.org/10.1186/s40168-021-01079-w

（来源：中国科学报，作者：张双虎，论文信息：http://news.sciencenet.cn/htmlnews/2021/6/459181.shtm）

基于生态因子对水力学参数适应阈值的水文连通性评价

在全球气候变化背景下，筑坝、围堤、建库等一系列人类活动削弱、甚至阻隔了湖泊与江、河的连通，并造成严重的生态影响；因此迫切需要一套稳健、易操作的工具实现对水文连通性的定量评估。

在国家重点研发计划和中国科学院战略性先导 A 专项等项目资助下，中国科学院南京地理与湖泊研究所张奇研究员团队的谭志强、李云良等科研人员基于已有研究开发了一个新的水文连通性评价工具（Connectivity Assessment Tool v1.0，CAST1.0）。

CAST1.0 是一个以参数/阈值推荐、数据预处理、连通性分析和结果预览为主要功能，耦合干湿变化以及水鸟、鱼类、浮游藻类和大型底栖动物适宜的水深、流速、水温阈值的“有效水文连通性”定量评估软件。

CAST1.0 在鄱阳湖成功应用，得到的主要结论包括：1）有效水文连通变化对关键水力学参数的响应遵循动态阈值效应；2）基于特定生态位的有效水文连通评估能够预测潜在生境分布；3）不同生态因子生境的空间关系表现出强烈的季节差异。相关研究论文“Assessing effective hydrological connectivity for floodplains with a framework integrating habitat suitability and sediment suspension behavior”发表在水环境领域权威期刊 Water Research。

CAST1.0 在生态环境保护方面具有重要的应用价值：（1）连通体作为潜在的物种生境是生物多样性保护的重点区域，为保护区划界以及针对不同物种制定相应的保护对策提供重要参考；（2）连通函数提供了整体连通可能发生突变的水位阈值，在有必要施加人为干预的情况下为合理调控湖区水位进而优化有效水文连通提供科学依据；（3）通过计算关键像元与其它像元的连通频率能够判断重要地理单元之间存在物质、能量和信息交换的可能性及潜在的连通路径，优化这些路径的属性有利于维持生物多样性和改善水质。CAST1.0 安装包、示例数据及中英文手册可以从更新的共享链接（http://doi.org/10.5281/zenodo.4952037）免费下载和使用。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202106/t20210617_6111119.html，2021-06-17）

非洲大陆径流的数据构建及其时空变化趋势归因

由于全球气候变化以及人口数量增长、取水量增加、农田面积扩大、森林减少，导致非洲地表径流过程发生重大变化，极端水文事件频繁发生，对人民生产生活造成较大影响。为了系统认识径流趋势对气候变化和人类活动的响应，南京地湖所刘元波研究员课题组对 535 个观测站点的河流流量数据的进行了统计，修正了径流曲线数法，构建了一个改进的非洲大陆 1981-2016 年月径流量数据集，此外还评估了月和年径流量数据、气候数据（降水和温度）和人类活动（农田和水的提取）的变化趋势。相关成果发表在环境领域的主流期刊上 Journal of Hydrometeorology。

研究发现：相比于大陆性气候变化（28％ • a-1），土地覆盖变化对实测净径流变化（0.30％ • a-1）的贡献更大（72％ • a-1），这种贡献是耕地扩展率为 0.46％ • a-1 以及降水量增加率为 0.07％ • a-1 的结果。 年径流趋势在热带地区为 0.21％ • a-1，在温带地区年为 0.16％ • a-1，在干旱地区为 0.91％ • a-1。热带地区径流的增加完全

是由于人类活动造成的，农田扩张了 0.53%·a-1，ΔRHAc=160%·a-1。气候变化是温带和干旱地区径流增加的主要因素，（ΔRPTc）贡献分别为 102%·a-1 和 117%·a-1。

土地覆盖变化是年径流量增加的主要因素。其中，由于由耕地扩展（0.02%·a-1-1.03%·a-1），非洲-印度洋海岸、林波波河流域、谢贝利-朱巴流域、沃尔特流域、几内亚湾、非洲-中东部海岸和马达加斯加等 7 个流域的径流变化趋势在 0.06%·a-1 至 1.38%·a-1 之间；而奥兰治河、纳米比亚－海岸、非洲－红海－亚丁湾海湾和赞比西河流域等 4 个流域，则由于取水量的增加（1.80%·a-1-3.23%·a-1），导致年径流量的减少。

气候变化是 25 个主要流域中 14 个流域径流变化的主要因素。其中非洲－南部内陆，非洲－西海岸，尼罗河，安哥拉－海岸，裂谷，非洲－西北海岸，尼日尔，地中海南部海岸，非洲北部内陆，乍得湖和塞内加尔等 11 个流域由于降雨增加（0.15%·a-1-0.73%·a-1），导致径流增加（0.08%·a-1-1.76%·a-1）；南非-西海岸，南非-南海岸和刚果等 3 个流域由于降水减少（-0.11%·a-1- -0.55%·a-1）以及温度升高（0.07%·a-1-0.17%·a-1）导致径流减少（-0.89%·a-1- -0.02%·a-1）。

本研究中所用统计方法的性能和简便性，可用于改进其他只有有限数据地区的径流估算，对提高非洲自然资源管理者和决策者对气候变化适应对策和农业土地利用政策的认识具有重要意义。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202106/t20210622_6115343.html，2021-06-22）

太湖溶解有机碳储量和收支遥感取得进展

在湖泊溶解有机碳不仅调节全球碳循环和气候变化，其被微生物分解过程会消耗水体溶解氧，并产生有害物质、危害水环境。河流会将流域大量的外源溶解有机碳输运进入湖泊，同时湖泊藻类增值等过程也会产生自源有机碳，两大来源的时空变异使得湖泊溶解有机碳时空差异大。为了更好理解湖泊在全球碳循环中的作用，促进湖泊水环境改善，非常有必要对湖泊溶解有机碳储量和收支进行遥感动态监测。

在国家自然科学基金和中科院先导专项等资助下，中国科学院南京地理与湖泊研究所段洪涛研究员团队刘东等基于遥感手段实现了太湖溶解有机碳储量和收支动态的研究，成果发表于国际顶级期刊 Remote Sensing of Environment 和 Science of the Total Environment。

以只经过大气瑞利校正的遥感反射率、气温和风速为输入，构建深度学习算法，可以绕过内陆水体精确大气校正难题，实现复杂富营养湖泊溶解有机碳浓度、储量和环湖河流碳通量的遥感估算。虽然，2008-2018 年环太湖河流输运入湖的溶解有机碳净通量是太湖储量的约 5.2 倍，但太湖的溶解有机碳的时空变异主要受控于藻类生消过程。此外，强降雨是河流输运有机碳进入太湖的重要决定因素，苕溪河有近

一半的入湖有机碳输运发生在强降雨期间，未来需要加大对出入湖河流有机碳输运的高时空观测与研究。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202107/t20210701_6124411.html，2021-07-01）

富营养湖泊藻总量三维遥感取得进展

藻华发生后，水下透明度会被极大的降低从而不利于水生植被生长，藻类细胞的分解还会消耗水体溶解氧并产生恶臭难闻的气体从而恶化水质。为了缓解藻华暴发的生态环境危害，需要知道湖水中藻类的含量和分布，由于卫星遥感只能反演表层/真光层的藻含量，而藻类在水柱中的分布会随水文-气象等条件进行垂直迁移，因此有必要进行水柱中藻总量遥感估算以更好的预判藻华危害。

在国家自然科学基金和水体污染控制与治理科技重大专项等资助下，中国科学院南京地理与湖泊研究所段洪涛研究员团队刘东等提出了一种面向过程的富营养化湖泊水柱中藻总量遥感方法，成果发表于地学领域国际顶级期刊 International Journal of Applied Earth Observation and Geoinformation。

将构建的方法应用于我国典型富营养巢湖，遥感反演的水柱中藻总量与实测结果具有可比性，偏差为-19.95%。巢湖 2003-2018 年长时间序列藻总量遥感结果表明：藻总量呈现出春季和夏季双峰特征，且夏季峰值更高；气温和氨氮是藻总量季节变化的主控因素；年平均藻总量在 2003-2010 呈增加，2012 年之后开始降低。与表层叶绿素浓度和藻华面积相比，藻总量可以更好的反映湖泊水质，且结合风速可应用于湖泊藻华暴发预测。构建的方法在富营养太湖的应用效果也表现良好。

（来源： http://www.niglas.ac.cn/xwdt_1_1/yjjz/202107/t20210713_6131141.html，2021-07-13）

极端气候事件加剧湖泊蓝藻水华的正反馈机制

自 2007 年蓝藻水华灾害引发饮用水危机事件之后，太湖全流域经历了大范围、高强度的污染治理和生态恢复，部分关键水质指标有所改善；但蓝藻水华并未得到有效遏制，太湖水体总磷浓度近年甚至出现反弹，2017 年蓝藻水华面积达到了历史最高纪录。

太湖水质和蓝藻水华情势波动和高强度治理的矛盾令人困惑，科学治太、精准治太的成效受到广泛质疑，阻碍了进一步实施太湖治理与保护政策和生态修复方案的制定。

在国家自然科学基金和水体污染控制与治理科技重大专项等资助下，中国科学院南京地理与湖泊研究所秦伯强研究员领导的国际研究小组通过开展多学科交叉研究，提出了“区域性极端气候条件促进太湖蓝藻水华暴发”的正反馈机制。相关成果近日发表于 Water Resources Research。

多源数据分析显示，太湖流域 2016 年降雨异常偏高导致外源输入剧增，同时，2016/2017 年冬季温度是 1960 年代有记录以来的最高值，造成越冬蓝藻生物量居高不下。研究表明，2015/2016 年的超强厄尔尼诺事件，耦合北大西洋年代际振荡（AMO）和太平洋十年涛动（PDO）等暖相位背景，共同诱发了太湖流域 2016 年强降雨以及随后的暖冬（图 1）。2017 年严重水华发生后由于光合作用、有机物降解等过程导致水体 pH 升高和湖底溶解氧浓度下降，促进底泥内源释放，加剧水华暴发，形成“营养盐累积—水华暴发—内源释放—富营养化加剧”的恶性循环，为水华持续暴发提供源源不断的物质基础（图 2）。

该研究科学诠释了全球变暖大背景下，区域性极端气候事件会进一步恶化湖泊水质、加剧湖泊富营养化和水华暴发。

（来源：http://www.niglas.ac.cn/xwdt_1_1/yjjz/202107/t20210714_6132454.html，2021-07-14）

业界动态

我国最大的内陆咸水湖水位持续上升

习近平总书记 8 日来到青海湖仙女湾，实地察看青海湖环境综合治理、生物多样性保护工作成效。中国最美湖泊、中国最大内陆咸水湖、青藏高原物种基因库、青藏高原的“气候调节器”、高原蓝宝石——青海湖，曾因气候变暖、人类活动而日渐“消瘦”，减畜轮牧、退耕还草、植被恢复、人工增雨、河流治理——一系列生态保护项目与治理方案持续实施。天帮忙、人努力，如今，青海湖不断“长大”。2005 年以来，水位上升 3.27 米，恢复到 20 世纪 60 年代水平。2020 年 9 月，青海湖水体面积为 4588.81 平方公里，较近 10 年同期平均增大 164 平方公里，流域生态“华丽蝶变”。多年封湖育鱼，特有的珍贵鱼类青海湖裸鲤，资源蕴藏量达 10.04 万吨，较 2002 年保护初期增长 38 倍。多年系统保护，环湖草原旗舰物种普氏原羚数量从不足 300 只增长到 2700 多只，珍稀鸟类栖息地不断修复。鸟类由 1996 年的 164 种增加到 225 种，黑颈鹤数量 10 年增加三倍多。碧波荡漾、鱼鸟共生、牛羊徜徉、油菜花芬芳。青海湖畔迷人的画卷徐徐展开。

（来源：新华社，http://m.xinhuanet.com/2021-06/08/c_1127544043.htm, 2021-06-08）

我国科学家首获青藏高原大范围湖泊实测水质数据

2021 年 6 月 22 日，记者从中科院青藏高原所获悉，基于十余年野外调查工作，该所研究人员首次获取了 2009 年至 2019 年期间青藏高原大范围湖泊实测水质参数。研究发现，青藏高原湖泊大部分处于非淡水状态，营养化程度低；盐度总体呈南低北高态势，而 pH 值明显呈南高北低态势。相关研究成果发表在《科学通报》上。

青藏高原湖泊广布，面积超过 1 平方公里的湖泊数量超过 1400 个，是地球上海拔最高、数量最多、面积最大的高原湖群区。该地区湖泊受人类活动干扰较小，湖泊的多种水质参数对区域气候和环境变化敏感。“由于青藏高原大部分湖泊所处环境条件恶劣，缺乏湖泊水质参数实测数据，严重制约了我们对青藏高原湖泊时空变化的深入认识。”中科院青藏高原所研究员朱立平说。

研究团队获取的实测水质参数涉及124个封闭湖泊，总面积为24570平方公里，占青藏高原湖泊总面积的 53%。通过对水温、盐度、pH 值、蓝绿藻、溶解氧、荧光溶解有机质、浊度和透明度等进行分析，研究人员发现，青藏高原淡水湖、盐湖皆有分布，目前绝大部分处于非淡水状态；湖泊盐度总体南低北高，大多数湖泊表现出碱性特征，营养化程度低，浮游植物和溶解性有机质较少，浊度低，透明度高；湖泊 pH 值呈现明显的南高北低，湖泊水温呈现随季节波动、随海拔升高而降低的变化，湖水透明度随湖泊面积增加而加深。

朱立平表示，这项研究首次提供了青藏高原大范围湖泊实测水质参数，为湖泊水环境参数的尺度变换和时空变化研究提供丰富的基础数据，有助于深入认识气候变化下青藏高原的湖泊水环境、水生态和水资源的关系。

（来源：科技日报，http://www.stdaily.com/index/kejixinwen/2021-06/22/content_1158945.shtml, 2021-06-22）

甘肃首个黄河流域生态保护和修复工程研究中心获批

甘肃省发展和改革委员会认定“甘肃省黄河上游水源涵养区生态保护和修复工程研究中心”为 2020 年度省级工程研究中心。该中心由甘肃省生态环境科学设计研究院（省生态环境规划院）牵头，中科院西北生态环境资源研究院、甘肃省地质调查院、北京建工环境修复股份公司等共同发起成立。

甘肃省黄河上游水源涵养区生态保护和修复工程研究中心是深入贯彻习近平生态文明思想，全面落实习近平总书记对甘肃省的重要讲话和指示精神，以及在黄河流域生态保护和高质量发展座谈会上重要讲话的具体举措。

据介绍，该中心未来将围绕“定期开展生态健康预警评估、建立生态保护修复标准体系、打造生态保护和修复信息共享平台、研发生态保护修复共性和关键技术、建设生态保护修复智库队伍”五大重点任务，积极探索适宜黄河上游生态系统“山水林田湖草沙”一体化保护修复相关政策和技术标准，以黄河上游生态安全屏障建设为目标，为区域重大生态工程提供技术支撑，建立黄河上游自然生态的监管体系和标准、规范体系，生态系统健康状况评估指标和预警体系，研发和推广高寒区生态保护及修复技术方法。着力解决黄河上游水源涵养区生态保护和修复所面临的监管政策、标准体系不完善、技术研发支撑不足、人才力量不够、技术交流困难等问题，提高生态修复效率和技术供给的有效性，提升黄河生态保护修复领域核心竞争力。

近年来，北京建工修复公司围绕国家生态发展战略，发挥环境修复技术研发和工程应用优势，积极联合地方头部科研机构，深度布局和参与流域生态修复与环境保护工作。2019 年，与相关单位等共同成立“甘肃省土壤环境保护与污染防治工程研究中心”， 在助力和推进甘肃省土壤环境保护与质量改善方面发挥了重要作用。

（来源：科技日报, http://www.stdaily.com/index/kejixinwen/2021-05/31/content_1148676.shtml,2021-05-31）

长江源区近 13000 年古气候变化记录重建

记者从中国科学院青藏高原研究所获悉，利用青藏高原中部唐古拉山区赤布张错湖泊岩芯沉积物的多指标数据，该所研究人员重建了长江源区过去近 13000 年的古气候变化记录。研究表明，该区域经历了从冷干到暖湿再到凉干的过程，目前呈现暖湿化趋势。相关研究成果发表于国际地学《古地理、古气候、古生态》杂志。

以青藏高原为主体的第三极是目前全球变暖最强烈的地区，也是未来受全球气候变化影响最敏感的地区之一。西风与南亚季风是控制青藏高原气候与环境变化的决定性因素。长江源区处于现代南亚季风北缘，是受西风与季风协同影响的过渡地带和内外流区的分界地带。“该区域一直缺乏覆盖万年以上的连续环境变化记录。”中科院青藏高原所研究员朱立平说。

为此，研究人员对取自该区域赤布张错的湖泊岩芯进行粒度与元素等多指标分析，评估了南亚季风与中纬度西风之间过渡带自晚冰期以来的古气候变化特点以及环流效应。结果显示，长江源区晚冰期末期以来的气候变化分为 4 个阶段：距今 12700 年—10600 年的晚冰期相对寒冷；距今 10600 年—6600 年的早全新世比较暖湿；距今 6600 年—1900 年的中晚全新世温凉偏冷和干燥；最近 2000 年，气候出现变暖变湿的趋势，又以最近 500 年最为显著。

“长江源区过去 1 万多年的有效湿度，整体遵循南亚季风区的变化模式，即早全新世有效湿度最大，中全新世湿度逐渐降低，晚全新世干燥，目前该区域气候水文条件处于温和偏湿的状态，可能接近早全新世晚期。”朱立平说，这项研究有助于评估长江源区水资源变化的未来发展趋势，为三江源区生态环境评估及相关研究提供科学参考。

（来源：科技日报, http://www.stdaily.com/kjrb/kjrbbm/2021-06/09/content_1153155.shtml, 2021-06-09）

长江流域碳中和产业技术创新中心在武汉揭牌

5 月 24 日，中国地质大学（武汉）与武汉金龙集团合作协议签订暨长江流域碳中和产业技术创新中心（以下简称“产业中心”）揭牌仪式举行。校长王焰新、副校长赖旭龙等学校有关单位负责人以及企业有关领导、部门负责人出席本次会议。

赖旭龙致欢迎词并简要介绍学校情况，金龙集团董事长助理雷晨介绍企业发展及产业中心设想，环境学院院长马腾汇报“产业中心”发展规划。雷贤忠、王焰新

分别代表企业、学校签署合作协议，并共同为产业中心揭牌。根据协议，武汉金龙集团将提供 2000 万元的研发经费支持中心建设。

校企双方将发挥地大学科优势和武汉金龙集团行业优势，共建长江流域碳中和产业技术创新中心。“产业中心”将围绕 “3060 碳达峰、碳中和”和“长江大保护”国家重大战略需求，立足武汉，覆盖湖北，面向长江流域，辐射全球，以生猪养殖产业链碳中和为突破口，拓展至综合农业和生态环保等其他行业。

“产业中心”将在 5-10 年内建设成为碳中和数据中心、技术中心、人才中心，加大力度发展科研项目，努力成为国家碳中和战略科技力量，并将企业打造成为武汉国际碳中和示范区。

（来源：科技日报, http://www.stdaily.com/index/kejixinwen/2021-05/24/content_1136929.shtml, 2021-05-24）

中科院构建柴达木盆地北缘湖泊多源信息观测平台

记者从中国科学院青海盐湖研究所获悉，为详细地观测分析柴北缘湖泊或盐湖水位上涨与资源元素变化及生态环境响应，在青海省创新平台建设专项资金支持下，中科院青海盐湖所青海省盐湖地质与环境重点实验室研究团队构建柴达木盆地北缘“资源型”和“生态型”湖泊多源信息观测平台，该平台观测数据将为盐湖生产安全、基础设施保护等多方面提供科学依据。

青海柴达木盆地是我国盐湖资源最主要的集中分布区，其中钾、锂、镁、硼等盐湖资源储量均位全国前列，潜在经济价值巨大，关系国家的粮食安全、能源安全、资源安全和战略安全，对国民经济的发展和国家安全具有重大的战略意义。

近年来，在全球气候变暖和水量增补背景下，柴达木盆地北缘（简称柴北缘）受祁连山水系补给的多个湖泊（盐湖）湖面明显上涨。随着柴达木盆地气候暖湿化，湖泊或盐湖入湖水量增加，势必引起资源开发模式和湖泊生态系统的变化。

青海省盐湖地质与环境重点实验室研究团队介绍，柴北缘山前湖泊可分为两种类型，一类是“资源型”湖泊，另一类是“生态型”湖泊。随着水量增补和湖面扩张，“资源型”湖泊湖水淡化和资源品位下降，“生态型”湖泊周边动植物群落和生态系统变化，部分湖泊湖面上涨已开始危及周边道路和公共基础设施，湖泊外溢还将影响周边盐湖资源开发。加快构建柴北缘典型盐湖湖面扩张外溢预警评估及其对钾硼锂铍资源影响的多源信息平台，是当下及未来盐湖资源开发和生态环境保护的迫切需求和有力保障。

目前，青海省盐湖地质与环境重点实验室樊启顺研究团队完成相关观测设备的安装和调试工作。该项目初步选取托素湖、可鲁克湖、小柴旦湖、苏干湖四个湖泊进行气象和水位观测设备架设，对湖泊所在区域风速、风向、降水量变化等多个相关因子进行观测和室内分析。

（来源：科技日报, http://www.stdaily.com/index/kejixinwen/2021-05/19/content_1134201.shtml ,2021-05-19）

水生所与生态环境部长江流域生态环境监督管理局签署合作协议

6 月 8 日，中国科学院水生生物研究所与生态环境部长江流域生态环境监督管理局（以下简称“长江局”）签署关于长江生态环境保护合作机制的框架协议。

签约会上，水生所所长殷战表示，在《生态环境部与中国科学院签署深化生态保护监管领域合作备忘录》框架下，水生所与长江局充分发挥各自优势，携手建立长江生态环境保护合作机制，加强联合研究、深化人员交流、推进平台建设、推动成果应用与共享，相信这些合作机制的建立，将为共同推进长江大保护、深入打好长江保护修复攻坚战提供科技支撑。

长江局局长徐翀表示，双方将以此次签约为契机，充分利用各自资源优势，重点在“十四五”规划的监督执行、长江保护法的贯彻实施、水生态考核体系等方面推进务实合作。

（来源：中国科学院院网, http://www.cas.cn/cg/zh/202106/t20210611_4792910.shtml,2021-06-11）

首个地方流域共同立法 云贵川“共防共治”赤水河

赤水河是长江流域唯一保持自然流态的一级支流，是长江上游众多珍稀特有鱼类的重要栖息地和繁殖场所。作为我国首个地方流域共同立法，云南、贵州、四川三省联动，以“决定”加“条例”的方式，共同立法保护赤水河流域，相关决定和条例将于今年 7 月 1 日起同步实施。

6 月 18 日，全国人大常委会办公厅举行主题为“云贵川三省共同立法保护赤水河流域”的集体采访。全国人大环资委法案室主任欧琳说，赤水河流域保护共同立法，强化流域共防共治，实现区域立法从“联动”到“共立”的跃升，为其他地区相关立法提供借鉴。

从“分河而治”到共同保护

赤水河发源于云南省昭通市赤水源镇，流经贵州、四川。欧琳说，近年来，云贵川三省在长江流域率先建立第一个跨省生态补偿机制，赤水河流域生态保护和环境治理取得积极成效。但由于各省行政区域内的流域功能定位、产业布局、保护方式和执法标准等存在差异，“分河而治”带来的流域管理难题还较为突出，需要以系统观念和法治思维推进共同保护。

2021 年 5 月，云贵川三省人大常委会分别审议通过了关于加强赤水河流域共同保护的决定以及各自省份的赤水河流域保护条例。

欧琳说，以“共同决定”+“条例”的方式开展赤水河流域保护立法工作，增强了立法的整体性和针对性。共同立法解决了国家层面难以为每个流域专门立法的问题，推动地方治理协同合作，依法协调利益冲突，促进共同保护水环境，强化共同的法律责任，共同破解流域生态保护和区域经济社会发展中的共性难题，为地方流域共同立法探索了新路子、新模式，提供了新经验。

从“要我保护”到“我要保护”

贵州省人大常委会法工委副主任李勇表示，三省在立法工作中，以赤水河全流域保护一盘棋的战略思维，聚焦上下游、左右岸、干支流之间产业布局、发展需求、环境准入、污水排放标准、环境监管执法等不一致带来的难点焦点问题。着力于跨行政区域的协调配合、联防联控，以法治观念完善三省协同保护机制，形成上下游联动、干支流统筹、左右岸合力，推动省际间跨区域生态环境保护共同治理，“构建赤水河流域共抓大保护新格局”。

不过，各省条例也体现了地方立法的特色和可操作性。比如云南条例对生态保护补偿问题规定较为全面，加强赤水河流域特有的红色文化资源保护传承；四川条例增加了流域保护与乡村振兴、新型城镇化战略相结合的内容，将四渡赤水旧址等红色文化资源与教育培训、乡村振兴和旅游发展相结合。

欧琳说，通过“共同决定”在赤水河流域保护重大问题上做出共同承诺、分别承诺和有关约束、制约规定，强化流域共防共治，同时通过条例的方式细化三省保护赤水河流域的防治措施、法律责任等内容，体现各自特色，为依法保护赤水河流域提供了法治保障，推动实现从“要我保护”到“我要保护”的转变。

从长江保护法到赤水河流域保护的共同立法，通过加强立法推动流域区域协调发展，已成为当前立法工作的一个重要课题。全国人大常委会法工委经济法室副主任杨合庆说，全国人大常委会已将黄河保护立法列入今年的立法工作计划，有关方面正在抓紧草案起草工作。

（来源：科技日报, http://www.stdaily.com/index/kejixinwen/2021-06/20/content_1158287.shtml,2021-06-20）

“长江模拟器示范基地”揭牌

我国长江流域系统综合治理有了科技重器。6 月 10 日，由中国科学院与重庆市政府共同建设的长江模拟器科学装置（以下简称长江模拟器）战略合作协议在重庆广阳岛签约，“长江模拟器示范基地”同时揭牌。

大数据驱动的决策系统

“简单来说，长江模拟器是大数据驱动的长江流域综合模拟与调控决策系统。”中国科学院院士、武汉大学教授夏军向科技日报记者介绍，长江模拟器是以水系统科学理论为基础，以长江流域为对象，以流域水循环为纽带，将自然过程与社会经济过程相耦合的流域模拟系统及其软硬件装置。

流域模拟系统是一个涉及水—土—气—生—人等多要素多过程的复杂巨系统，要在科学统筹的前提下实施流域系统治理，实现流域绿色发展，面临的主要难点就是缺乏强有力的科技支撑。通过建设长江模拟器，实现水循环、水环境、水生态和社会经济过程耦合模拟，集成创新流域水生态恢复和水环境治理技术体系，夏军院士表示，“长江模拟器可以说是科技创新支撑长江流域综合管理的体现”。

长江模拟器的研发，统筹考虑了生态系统整体性和流域的系统性，是自然科学与社会科学的深度交叉，强调大数据和人工智能信息支持，具有监测—模拟—评价—预警—决策支持功能，可应用于农业、水利、水资源管理、航运、防洪、环境保护等多个领域。

与现有的国家大科学装置地球模拟器相比，长江模拟器以流域为研究对象，具有更高的空间分辨率和更快的时间响应，能直接服务流域生态文明建设。

三大功能全面把脉长江流域

“长江模拟器主要有‘了解过去长江、认识现在长江、展望未来长江’三大功能。”中国科学院地理科学与资源研究所研究员占车生介绍，了解过去长江，即基于中生代以来地质历史时期的考古、古地质、古地貌、古气候研究成果，再现长江流域历史演化过程。

认识现在长江，即通过建设流域水系统全面监测监控能力，发展流域水系统全面模拟能力，模拟再现近几十年来长江流域水环境水生态的演变过程，系统诊断流域水环境水生态问题的成因和机制，提出综合调控策略和具体管理措施。

展望未来长江，即针对未来可能的气候变化情景及社会经济发展情景，模拟预测不同情景下的流域水环境水生态演变趋势，分析不同绿色发展路径下流域绿色发展水平的时空差异，提出相应的调控对策和政策措施建议。

据了解，长江模拟器建设涉及 6 个关键环节，包括建设长江流域空天地一体化立体监测系统，建设长江流域多源数据共享系统，研发长江流域水系统综合模拟模型，建立长江流域绿色发展评估系统，建立长江流域生态文明公众参与和教育平台，建成科学研究与政府决策的沟通平台。

长江模拟器的建成，将为流域水灾害预警、流域水环境水生态现状评估、流域水资源和生态系统管理与调控提供有效科技手段，为流域长远规划、管理和应对提供科学依据。

核心大脑在重庆辐射全流域

长江模拟器是中国科学院地理科学与资源研究所、重庆绿色智能技术研究院、南京地理与湖泊研究所、大气物理研究所、水生生物研究所以及武汉大学、长江水利委员会长江科学院、中国环境科学研究院等十几家单位参与建设的一项重大科技工程。

重庆是长江上游生态屏障的最后一道关口，目前重庆正在积极将广阳岛打造为“长江风景眼、重庆生态岛”。夏军院士表示，长江模拟器落地重庆广阳岛，将支撑重庆在长江生态文明建设上发挥“领头羊”的作用。

长江模拟器建设拟分为三期，第一期长江模拟器将支撑大河文明馆和智慧广阳岛建设；第二期将针对重庆生态文明建设科技需求，拓展长江模拟器的功能，建设

长江流域水环境水生态监测网络；第三期将争创国家大科学装置，同时建设长江模拟器科创园区。

据了解，目前长江模拟器和广阳岛野外科学观测站已纳入智慧广阳岛三期实施，一期机房环境建设已完成，长江模拟器总体规划已通过专家论证。

（来源：科技日报, http://www.stdaily.com/index/kejixinwen/2021-06/16/content_1156621.shtml,2021-06-16）