湖泊科学动态

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热点文章

Recent global decline in endorheic basin water storages

Jida Wang, Chunqiao Song, John T. Reager; et al.

Endorheic (hydrologically landlocked) basins spatially concur with arid/semi-arid climates. Given limited precipitation but high potential evaporation, their water storage is vulnerable to subtle flux perturbations, which are exacerbated by global warming and human activities. Increasing regional evidence suggests a probably recent net decline in endorheic water storage, but this remains unquantified at a global scale. By integrating satellite observations and hydrological modelling, we reveal that during 2002–2016 the global endorheic system experienced a widespread water loss of about 106.3 Gt yr−1, attributed to comparable losses in surface water, soil moisture and groundwater. This decadal decline, disparate from water storage fluctuations in exorheic basins, appears less sensitive to El Niño–Southern Oscillation-driven climate variability, which implies a possible response to longer-term climate conditions and human water management. In the mass-conserved hydrosphere, such an endorheic water loss not only exacerbates local water stress, but also imposes excess water on exorheic basins, leading to a potential sea level rise that matches the contribution of nearly half of the land glacier retreat (excluding Greenland and Antarctica). Given these dual ramifications, we suggest the necessity for long-term monitoring of water storage variation in the global endorheic system and the inclusion of its net contribution to future sea level budgeting.

（来源：Nature Geoscience, 2018,11: 926-932）

中文点评：

研究发现全球内流区水储量不断下降

近日，由中国科学院南京地理与湖泊研究所宋春桥研究员同美国、加拿大、法国、德国和奥地利五国的科学家们组成的研究团队刊发在《自然》杂志子刊《自然-地球科学》上的研究论文指出，2002 至 2016 年间，全球内流区的水储量正不断下降，据估算内流区总水储量每年约减少 1000 亿立方米，这种损失速度，大约相当于每年干涸 1 个青海湖。

本项研究中，科研团队利用美国航天局(NASA)与德国航空中心联合发射的重力场恢复与气候试验重力卫星(GRACE)观测数据，结合光学遥感、多源测高卫星资料及水文模型，定量估算了全球内流区总水量及地表水、土壤水与地下水层三个主要水文要素的储量变化。研究结果显示，全球内流区的水储量在 21 世纪初正以惊人的速率下降，内流区的总水储量的下降速率是外流区（除南极和格陵兰冰盖区以外）的近两倍。内流区水储量减少，也是导致全球海平面上升的重要因素。研究同时发现，在不同内流区，地表水、土壤水和地下水对水量总亏损的贡献比重各有不同。例如，撒哈拉沙漠及阿拉伯地区的水储量下降，主要是因为地下水超采而导致水量入不敷出。而在欧亚大陆腹地，近一半的水储量减少是由于地表水亏损。该研究工作在全球尺度量化内流区水储量 21 世纪以来的大范围严重亏损，印证了全球变化研究关于“干旱地区变得更干”的结论。

（来源：中国科学报 2018-12-04）

Glacial lake outburst floods as drivers of fluvial erosion in the Himalaya

Kristen L. Cook, Christoff Andermann, Florent Gimbert; et al.

Himalayan rivers are frequently hit by catastrophic floods that are caused by the failure of glacial lake and landslide dams; however, the dynamics and long-term impacts of such floods remain poorly understood. We present a comprehensive set of observations that capture the July 2016 glacial lake outburst flood (GLOF) in the Bhotekoshi/Sunkoshi River of Nepal. Seismic records of the flood provide new insights into GLOF mechanics and their ability to mobilize large boulders that otherwise prevent channel erosion. Because of this boulder mobilization, GLOF impacts far exceed those of the annual summer monsoon, and GLOFs may dominate fluvial erosion and channel-hillslope coupling many tens of kilometers downstream of glaciated areas. Long-term valley evolution in these regions may therefore be driven by GLOF frequency and magnitude, rather than by precipitation.

（来源：Science，2018，362：53-57）

中文点评：

喜马拉雅山“冰蚀湖”急速融化对尼泊尔造成洪水威胁

气候变化将导致喜马拉雅山冰川以惊人的速度融化，甚至全部消失。2014年的一项调查发现，1977年至2010年间，尼泊尔有四分之一的冰川缩小，与此同时新出现了1466个湖泊，其中=21个湖泊被确定存在潜在危险。研究人员通过对2016年7月波特柯西河/逊卡什河水系冰蚀湖融化泛滥的综合观测数据进行分析，认为高海拔地区的冰川湖泊，可能引发洪水、泥石流，直接威胁下游尼泊尔人口稠密的南部平原，将会摧毁道路、重要能源项目以及沿途的整个村庄。同时，尼泊尔也是一个地震频发的国家，地震会引发湖水泛滥，巨大的冰川湖泊实际上是一个定时炸弹。由于成千上万人的生命受到冰川湖泊的威胁，2016年底，尼泊尔实施了一项大规模的工程，将深150米、长2公里的冰蚀湖（伊姆贾湖）里的水抽干。这是尼泊尔历史上第二次开展这项工程，该工程证明了冰川湖泊所带来的巨大挑战，这项工程持续了六个月，直到一条排水沟和预警系统建成。目前，湖水位降低了3.5米，已排出500多万立方米的水。由于全球变暖重塑了尼泊尔的山地地形，尼泊尔正努力在灾难发生前，排除这些安全问题。

（来源：根据新华网相关资料编译，2018-12-12）

摘要精选

Geographic and temporal variations in turbulent heat loss from lakes: A global analysis across 45 lakes

Woolway, R. Iestyn; Verburg, Piet; Lenters, John D.; et al.

Heat fluxes at the lake surface play an integral part in determining the energy budget and thermal structure in lakes, including regulating how lakes respond to climate change. We explore patterns in turbulent heat fluxes, which vary across temporal and spatial scales, using in situ high-frequency monitoring data from 45 globally distributed lakes. Our analysis demonstrates that some of the lakes studied follow a marked seasonal cycle in their turbulent surface fluxes and that turbulent heat loss is highest in larger lakes and those situated at low latitude. The Bowen ratio, which is the ratio of mean sensible to mean latent heat fluxes, is smaller at low latitudes and, in turn, the relative contribution of evaporative to total turbulent heat loss increases toward the tropics. Latent heat transfer ranged from similar to 60% to > 90% of total turbulent heat loss in the examined lakes. The Bowen ratio ranged from 0.04 to 0.69 and correlated significantly with latitude. The relative contributions to total turbulent heat loss therefore differ among lakes, and these contributions are influenced greatly by lake location. Our findings have implications for understanding the role of lakes in the climate system, effects on the lake water balance, and temperature-dependent processes in lakes.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2018, 63(6): 2436-2449）

Annual stratification patterns in tropical mountain lakes reflect altered thermal regimes in response to climate change

Robin E. Bell, Alison F. Banwell, Luke D. Trusel; et al.

Melting is pervasive along the ice surrounding Antarctica. On the surface of the grounded ice sheet and floating ice shelves, extensive networks of lakes, streams and rivers both store and transport water. As melting increases with a warming climate, the surface hydrology of Antarctica in some regions could resemble Greenland’s present-day ablation and percolation zones. Drawing on observations of widespread surface water in Antarctica and decades of study in Greenland, we consider three modes by which meltwater could impact Antarctic mass balance: increased runoff, meltwater injection to the bed and meltwater-induced ice-shelf fracture — all of which may contribute to future ice-sheet mass loss from Antarctica.

（来源：Nature Climate Change, 2018, 8:1044-1052）

Downwind footprint of an urban heat island on air and lake temperatures

Ann Cosgrove, Max Berkelhammer.

The urban heat island (UHI) effect was first documented ~200 years ago, making it the longest recognized anthropogenic effect on climate. Although anomalous heating in cities has been meticulously characterized, less is known about how the UHI affects surrounding regions. It is hypothesized that

downwind of cities a “heat plume” forms due to the advection of urban heat. This heat transport may have impacts beyond heating of the surface, such as disrupting atmospheric convection and influencing boundary layer structure, which influences weather, air quality, and human health. Here, a lagrangian atmospheric transport model, forced with archived data from a numerical weather model, is used to generate a three-dimensional map of an urban heat plume for a major city, Chicago. We document significant heating 100–200 m above the surface and 70 km downwind of the city. Over Lake Michigan, the scale of the plume is truncated nearly in half (~40 km), suggesting the lake is acting as a sink for the exported urban heat. Using satellite lake surface temperatures, we observed a disruption of the diurnal pattern of lake temperature beneath the plume, which supports a possible role of the lake in absorbing the heat plume. The results provide unique quasi-observational evidence for a significant footprint of cities on regional atmospheric structure and potentially on adjacent aquatic bodies.

（来源：npj Climate and Atmospheric Science, 2018,1:1-10）

Antarctic surface hydrology and impacts on ice-sheet mass balance

Tang, Xiangming; Krausfeldt, Lauren E; Shao, Keqiang; et al.

Harmful cyanobacterial blooms represent an increasing threat to freshwater resources globally. Despite increased research, the physiological basis of how the dominant bloom-forming cyanobacteria, Microcystis spp., proliferate and then maintain high population densities through changing environmental conditions is poorly understood. In this study, we examined the transcriptional profiles of the microbial community in Lake Taihu, China at 9 stations sampled monthly from June to October in 2014. To target Microcystis populations, we collected metatranscriptomic data and mapped reads to the M.aeruginosa NIES 843 genome. Our results revealed significant temporal gene expression patterns, with many genes separating into either early or late bloom clusters. About one-third of genes observed from M.aeruginosa were differentially expressed between these two clusters. Conductivity and nutrient availability appeared to be the environmental factors most strongly associated with these temporal gene expression shifts. Compared with the early bloom season (June and July), genes involved in N and P transport, energy metabolism, translation, and amino acid biosynthesis were down-regulated during the later season (August to October). In parallel, genes involved in regulatory functions as well as transposases and the production of microcystin and extracellular polysaccharides were up-regulated in the later season. Our observation indicates an eco-physiological shift occurs within the Microcystis spp. transcriptome as cells move from the rapid growth of early summer to bloom maintenance in late summer and autumn.

（来源：Environmental science & technology, 2018, doi:10.1021/acs.est.8b01066）

Western U.S. lake expansions during Heinrich stadials linked to Pacific Hadley circulation

D. McGee, E. Moreno-Chamarro, J. Marshall; et al.

Lake and cave records show that winter precipitation in the southwestern United States increased substantially during millennial-scale periods of Northern Hemisphere winter cooling known as Heinrich stadials. However, previous work has not produced a clear picture of the atmospheric circulation changes driving these precipitation increases. Here, we combine data with model simulations to show that maximum winter precipitation anomalies were related to an intensified subtropical jet and a deepened,

southeastward-shifted Aleutian Low, which together increased atmospheric river–like transport of subtropical moisture into the western United States. The jet and Aleutian Low changes are tied to the southward displacement of the intertropical convergence zone and the accompanying intensification of the Hadley circulation in the central Pacific. These results refine our understanding of atmospheric changes accompanying Heinrich stadials and highlight the need for accurate representations of tropical-extratropical teleconnections in simulations of past and future precipitation changes in the region.

（来源：Science Advances, 2018, doi:10.1126/sciadv.aav0118）

Coupling large-scale hydrological and hydrodynamic modeling: Toward a better comprehension of watershed-shallow lake processes

Munar, Andres Mauricio; Rafael Cavalcanti, J.; Bravo, Juan Martin; et al.

Changes in hydrological processes in large watersheds may heavily impact the dynamics of downstream aquatic ecosystems such as lakes and reservoirs. In general, simple approaches that neglect the spatial heterogeneity of watersheds impede understanding of the many processes occurring in these downstream aquatic ecosystems. In most cases, observed river discharges are used as the boundary condition for lake/reservoir modeling, which limits analyses of different situations and of areas that are ungauged or water bodies with little data available. Therefore, coupling hydrological models with hydrodynamic models seems to be a promising approach to allow one to understand how catchment features (e.g., land use, topography) and river discharges impact the dynamic patterns, including local circulation patterns, water levels and water quality in large water bodies in response to basin-wide forcing factors. In this study, we used a complex, spatially explicit, integrated approach to assess the hydrological responses to external forcing factors such as wind and river discharges, in the hydrodynamics of a large shallow subtropical lake. A large-scale integrated system composed of several sub-watersheds and a lake was analyzed by coupling a large-scale hydrological model with a hydrodynamic model. Our findings indicated that (i) the integrated model improved the capacity for representing the spatial and temporal variability of lake water-surface levels; (ii) the main hydrodynamic processes (water levels and flow structure) are controlled on a seasonal scale (months) by the river discharges, and on a short time scale (days) by wind influence (intensity and direction); and (iii) the modeling strategy allowed evaluation of anthropogenic stressors such as irrigation withdrawals on lake levels. This approach is an attempt to develop a physically based management model to simulate complex systems as a whole, allowing one to understand the main factors controlling the hydrodynamic processes and water levels, and accounting for internal (e.g., recirculation, horizontal mixing) and external factors (e.g., anthropogenic stressors, irrigation).

（来源：JOURNAL OF HYDROLOGY, 2018, 564: 424-441）

Combining Landsat observations with hydrological modelling for improved surface water monitoring of small lakes

Ogilvie, Andrew; Belaud, Gilles; Massuel, Sylvain; et al.

Small reservoirs represent a critical water supply to millions of farmers across semi-arid regions, but their hydrological modelling suffers from data scarcity and highly variable and localised rainfall intensities. Increased availability of satellite imagery provide substantial opportunities but the monitoring of surface

water resources is constrained by the small size and rapid flood declines in small reservoirs. To overcome remote sensing and hydrological modelling difficulties, the benefits of combining field data, numerical modelling and satellite observations to monitor small reservoirs were investigated. Building on substantial field data, coupled daily rainfall-runoff and water balance models were developed for 7 small reservoirs (1-10 ha) in semi arid Tunisia over 1999-2014. Surface water observations from MNDWI classifications on 546 Landsat TM, ETM + and OLI sensors were used to update model outputs through an Ensemble (n = 100) Kalman Filter over the 15 year period. The Ensemble Kalman Filter, providing near-real time corrections, reduced runoff errors by modulating incorrectly modelled rainfall events, while compensating for Landsat's limited temporal resolution and correcting classification outliers. Validated against long term hydrometric field data, daily volume root mean square errors (RMSE) decreased by 54% to 31200 m(3) across 7 lakes compared to the initial model forecast. The method reproduced the amplitude and timing of major floods and their decline phases, providing a valuable approach to improve hydrological monitoring (NSE increase from 0.64 up to 0.94) of flood dynamics in small water bodies. In the smallest and data-scarce lakes, higher temporal and spatial resolution time series are essential to improve monitoring accuracy.

（来源：JOURNAL OF HYDROLOGY, 2018, 566: 109-121）

Spatial and temporal dynamics of primary producers in shallow lakes as seen from space: Intra-annual observations from Sentinel-2A

Pinardi, Monica; Bresciani, Mariano; Villa, Paolo; et al.

Under the current high anthropic pressure and climate change scenarios, a trend towards increasing changes in the trophic status of shallow lakes, and the development of opportunistic floating species is to be expected. This raises the need for monitoring and management actions to prevent widespread environmentally negative effects (e.g., anoxia). An efficient approach to monitoring water quality and primary producers in inland waters is to integrate in situ with remote sensing data. In this work, satellite multispectral data acquired by Sentinel-2 A are used to assess the intra-annual spatial and temporal dynamics of phytoplankton abundance, in terms of chlorophyll-a (Chl-a) concentration and macrophyte Leaf Area Index (LAI) in a shallow eutrophic fluvial lake system (Mantua Lakes, Italy). Chl-a concentrations and LAI were derived from Sentinel-2 A data by applying a semi-empirical band ratio algorithm combined with a bio-optical model (BOMBER) for the former (Chl-a), and a semi-empirical model for the latter (LAI). These products were validated against in situ data (rRMSE = 20% for both products; R-2 = 0.93 for Chl-a; R-2 = 0.83 for LAI). Phytoplankton maps showed a marked intra-annual spatial and temporal variability, generally revealing a Chl-a concentration gradient from lotic to lentic waters. Air temperature was the main driver of Chl-a concentration, followed by water discharge and precipitation. The macrophyte LAI followed aquatic plant growth seasonally, and was independent of the hydro-meteorological data. Allochthonous and invasive macrophyte species (such as Nelumbo nucifera and Ludwigia hexapetala) had higher LAI compared than the Mantua Lakes' autochthonous floating-leaved species (e.g., Trapa natans and Nuphar lutea). Maps of the abundance of primary producers can be used to follow the temporal and spatial evolution of different communities and support management actions, e.g., by identifying potential algal bloom hotspots, or the optimal timing for measures to control invasive species overgrowth.

（来源：LIMNOLOGICA, 2018, 72: 32-43）

Effective fetch and relative exposure index maps for the Laurentian Great Lakes

Lacey A. Mason, Catherine M. Riseng, Andrew J. Layman; et al.

Wind exposure is a key physical driver of coastal systems in aquatic environments influencing circulation and wave dynamics. A measure of wind exposure is fetch, the distance over which wind can travel across open water. In large lake systems, such as the Laurentian Great Lakes, estimating fetch has proven to be difficult due to their vast size and complex topobathymetry. Here we describe the development of two spatially discrete indicators of exposure to provide a more accurate indicator of the influence of wind exposure in the nearshore of the Laurentian Great Lakes. We summarized wind data from offshore buoys and used existing tools to calculate effective fetch and a relative exposure index (effective fetch scaled by mean wind speed) at a 30-m grid cell resolution. We validated these models by comparing our exposure maps to the U.S. Army Corps of Engineers Wave Information Studies models and found general agreement. These exposure maps are available for public download for the years 2004–2014.

（来源：Scientific Data, 2018, http://doi.org/10.1038/sdata.2018.295）

Patterns of Host-Associated Fecal Indicators Driven by Hydrology, Precipitation, and Land Use Attributes in Great Lakes Watersheds

Dila, Deborah K.; Corsi, Steven R.; Lenaker, Peter L.; et al.

Fecal contamination from sewage and agricultural runoff is a pervasive problem in Great Lakes watersheds. Most work examining fecal pollution loads relies on discrete samples of fecal indicators and modeling land use. In this study, we made empirical measurements of human and ruminant-associated fecal indicator bacteria and combined these with hydrological measurements in eight watersheds ranging from predominantly forested to highly urbanized. Flow composited river samples were collected over low-flow (n = 89) and rainfall or snowmelt runoff events (n = 130). Approximately 90% of samples had evidence of human fecal pollution, with highest loads from urban watersheds. Ruminant indicators were found in similar to 60-100% of runoff-event samples in agricultural watersheds, with concentrations and loads related to cattle density. Rain depth, season, agricultural tile drainage, and human or cattle density explained variability in daily flux of human or ruminant indicators. Mapping host-associated indicator loads to watershed discharge points sheds light on the type, level, and possible health risk from fecal pollution entering the Great Lakes and can inform total maximum daily load implementation and other management practices to target specific fecal pollution sources.

（来源：ENVIRONMENTAL SCIENCE & TECHNOLOGY, 2018, 52(20): 11500-11509）

Large greenhouse gases emissions from China's lakes and reservoirs

Li, Siyue; Bush, Richard T; Santos, Isaac R; et al.

Freshwaters are important sources of greenhouse gases (GHGs) to the atmosphere that may partially offset the terrestrial carbon sink. However, current emission estimates from inland waters remain

uncertain due to data paucity in key regions with a large freshwater surface area, such as China. Here, we show that the areal fluxes of GHGs (carbon dioxide, methane, and nitrous oxide) from lakes and reservoirs in China are much larger than previous estimates. Our work summarized data from 310 lakes and 153 reservoirs, and revealed diffusive emissions of 1.56 (95% confidence interval: 1.12-2.00) Tg C-CH_4/y and 25.2 (20.8-29.5) Tg C-CO_2/y from reservoirs and lakes. Chinese lakes and reservoirs emit 175.0 (134.7-215.3) Tg CO_2 equivalent, with 73.4% of this forcing contributed by lakes. These aquatic sources are equivalent to 14.1%-22.6% of China's estimated terrestrial carbon sink. Our results suggest a disproportionally high contribution of China's reservoirs and lakes to national and global GHGs emissions, highlighting major data gaps and the need of including more artificial and natural lakes data from developing countries like China in global GHGs budgets.

（来源：Water research, 2018, 147:13-24）

Rapid niche expansion by selection on functional genomic variation after ecosystem recovery

Arne Jacobs, Madeleine Carruthers, Reiner Eckmann; et al.

It is well recognized that environmental degradation caused by human activities can result in dramatic losses of species and diversity. However, comparatively little is known about the ability of biodiversity to re-emerge following ecosystem recovery. Here, we show that a European whitefish subspecies, the gangfisch Coregonus lavaretus macrophthalmus, rapidly increased its ecologically functional diversity following the restoration of Lake Constance after anthropogenic eutrophication. In fewer than ten generations, gangfisch evolved a greater range of gill raker numbers (GRNs) to utilize a broader ecological niche. A sparse genetic architecture underlies this variation in GRN. Several co-expressed gene modules and genes showing signals of positive selection were associated with GRN and body shape. These were enriched for biological pathways related to trophic niche expansion in fishes. Our findings demonstrate the potential of functional diversity to expand following habitat restoration, given a fortuitous combination of genetic architecture, genetic diversity and selection.

（来源：Nature Ecology & Evolution, 2019:77-86）

Oxygenated Mesoproterozoic lake revealed through magnetic mineralogy

Sarah P. Slotznick, Nicholas L. Swanson-Hysell, Erik A. Sperling.

Terrestrial environments have been suggested as an oxic haven for eukaryotic life and diversification during portions of the Proterozoic Eon when the ocean was dominantly anoxic. However, iron speciation and Fe/Al data from the ca. 1.1-billion-year-old Nonesuch Formation, deposited in a large lake and bearing a diverse assemblage of early eukaryotes, are interpreted to indicate persistently anoxic conditions. To shed light on these distinct hypotheses, we analyzed two drill cores spanning the transgression into the lake and its subsequent shallowing. While the proportion of highly reactive to total iron (FeHR/FeT) is consistent through the sediments and typically in the range taken to be equivocal between anoxic and oxic conditions, magnetic experiments and petrographic data reveal that iron exists in three distinct mineral assemblages resulting from an oxycline. In the deepest waters, reductive dissolution of iron oxides records an anoxic environment. However, the remainder of the sedimentary

succession has iron oxide assemblages indicative of an oxygenated environment. At intermediate water depths, a mixed-phase facies with hematite and magnetite indicates low oxygen conditions. In the shallowest waters of the lake, nearly every iron oxide has been oxidized to its most oxidized form, hematite. Combining magnetics and textural analyses results in a more nuanced understanding of ambiguous geochemical signals and indicates that for much of its temporal duration, and throughout much of its water column, there was oxygen in the waters of Paleolake Nonesuch.

（来源：PNAS, 2018, 115(51): 12938-12943）

Legacy Lead Stored in Catchments Is the Dominant Source for Lakes in the U.K.: Evidence from Atmospherically Derived 210Pb

Yang, Handong; Shilland, Ewan; Appleby, Peter G; et al.

There has been a considerable reduction in anthropogenic lead (Pb) emission in the atmosphere in recent decades. However, the reduction in Pb inputs in many lakes does not match this as the Pb stored in catchment upper soil layers, derived from previous deposition, has become an important source although it is difficult to assess quantitatively. This work uses atmospherically deposited 210Pb as a tracer to track Pb movement, and so for the first time, we were able to calculate the relative Pb inputs from direct atmospheric deposition and catchment sources to lakes in the U.K. directly. Within individual lake sites, ratios of 210Pb/Pb in the catchment terrestrial mosses were normally an order of magnitude higher than those in the catchment surface soils, trapped lake sediments, and the surface sediments in the lake bottom. Results suggest that the Pb isotope signatures in the mosses are close to or dominated by atmospheric depositions, and it is reasonable to use the ratios of 210Pb/Pb in terrestrial mosses collected from the lake sites with a high annual rainfall over 2000 mm to represent those in atmospheric depositions. It reveals that after the reduction in Pb emissions, catchment Pb inputs now typically account for more than 95% of the total Pb entering the lakes.

（来源：Environmental science & technology, 2018, DOI: 10.1021/acs.est.8b04099）

Characterization of CDOM in saline and freshwater lakes across China using spectroscopic analysis

Song, Kaishan; Shang, Yingxin; Wen, Zhidan; et al.

Colored dissolved organic matter (CDOM) is a major component of DOM in waters, and plays a vital role in carbon cycling in inland waters. In this study, the light absorption and three-dimensional excitation-emission matrix spectra (EEMs) of CDOM of 936 water samples collected in 2014-2017 from 234 lakes in five regions across China were examined to determine relationships between lake water sources (fresh versus saline) and their fluorescence/absorption characteristics. Results indicated significant differences regarding DOC concentration and aCDOM(254) between freshwater (6.68 mg C L-1, 19.55 m-1) and saline lakes (27.4 mg C L-1, 41.17 m-1). While humic-like (F5) and fulvic-like (F3) compounds contributed to CDOM fluorescence in all lake waters significantly, their contribution to total fluorescence intensity (FT) differed between saline and freshwater lakes. Significant negative relationships were also observed between lake altitude with either F5 ($R^2 = 0.63$, $N = 306$) or FT ($R^2 = 0.64$, $N = 306$), suggesting that the abundance of humic-like materials in CDOM tends to decrease with increased in lakes altitude. In high-altitude lakes, strong solar irradiance and UV exposure may have

induced photo-oxidation reactions resulting in decreased abundance of humic-like substances and the formation of low molecular weight compounds. These findings have important implications regarding our understanding of C dynamics in lacustrine systems and the contribution of these ecosystems to the global C cycle.

（来源：Water research, 2018, 150: 403-417）

Low buffering capacity and slow recovery of anthropogenic phosphorus pollution in watersheds

J. -O. Goyette, E. M. Bennett, R. Maranger.

Excess anthropogenic phosphorus in watersheds, transported with runoff, can result in aquatic eutrophication, a serious global water quality concern. Watersheds can retain phosphorus, especially in their soils, which can serve as a buffer against the effect of excessive use of phosphorus. However, whether there is a quantifiable threshold at which a watershed exceeds its optimal phosphorus buffering capacity (beyond which riverine loads would dramatically increase) remains unknown. Here we quantified a watershed phosphorus buffering capacity threshold based on accumulation data over 110 years in 23 watersheds of a large North American river basin with globally representative agricultural soils. We found a surprisingly low threshold of just 2.1 t P km^{-2} (0.03 – 8.7 t P km^{-2}). Beyond this, further P inputs to watersheds cause a significant acceleration of P loss in runoff. Using a simple exponential decay model, the time estimated to eliminate legacy P via runoff in our watersheds ranges from ~ 100 to over 2,000 years. The rapidity with which the watershed buffering threshold can be surpassed during accumulation, particularly given current anthropogenic phosphorus input rates, versus the long return to baseline suggests that new strategies to reconcile watershed activities and water quality are urgently needed.

（来源：Nature Geoscience, 2018, 11: 921-925）

Spatial modelling of the regulating function of the Huangqihai Lake wetland ecosystem

Fu, Yicheng; Zhao, Jinyong; Peng, Wenqi; et al.

The regulating function is the least understood but probably most valuable service provided by an ecosystem. To estimate the impact of externalities on the regulating function of a wetland, we modelled the interdependence between activities that affect wetland characteristics and land utilization patterns. Nature-based solutions (NBS) can provide benefits for society, the economy and nature. The NBS solution for wetland bioremediation is proposed through a combination of ecosystem value provided by nature-based or artificial arable land. We constructed a model to simulate the dynamic spatial and temporal changes in the regulating function of a wetland to study the impact of agricultural and fishing activities on the functions and services of a wetland ecosystem. The model was used to determine the relationship between land use change, wetland range, water quality, and fish stocks. Huangqihai Lake (HQHL) is a relatively isolated lake in an area interlaced with agriculture and pasture zones. From 1973 to 2014, the "shrinkage" of the water area of HQHL approached 60%. Under the influence of humans and natural disturbances, the HQHL wetland faced enormous ecological risks, water pollution, area reduction, sharp biodiversity reduction, and fish extinction. The phosphorus (P) concentration seems to be a key

factor affecting both the reed growth in the nearshore areas of the Huangqihai Lake wetland and the breeding of phytoplankton in the core lake water area. Dividing this value by the 25,821 ha of the core wetland area affected by the reclamation, the cost per unit of lost fish production is USD$166/ha/yr. After deducting the externalities of the fishery, the net sustainable income from the conversion is USD$1717/ha. The spatial distribution of nutrient load externalities varies with the use of wetlands. In terms of fishery value, the additional nutrient load associated with the conversion of wetland uses would result in a reduction of at least 8% of the maximum sustainable yield. The conversion of wetland uses resulted in the loss of nutrient buffering functions. To compensate for the farmland's nutrient load buffer service, the government should provide arable land farmers USD$8.1 M/yr. It is theoretically feasible to implement an ecosystem service payment system that can effectively compensate for the loss of nutrient buffer function caused by the conversion of wetlands. The approach based on BNS we described may also have value in other ecosystems where regulatory functions include similar mechanisms.

（来源：JOURNAL OF HYDROLOGY, 2018, 564: 283-293）

Freshwater lake ecosystem shift caused by social-economic transitions in Yangtze River Basin over the past century

Ke Zhang, Xiangdong Yang, Giri Kattel,; et al.

Global lake systems have undergone rapid degradation over the past century. Scientists and managers are struggling to manage the highly degraded lake systems to cope with escalating anthropogenic pressures. Improved knowledge of how lakes and social systems co-evolved up to the present is vital for understanding, modeling, and anticipating the current and future ecological status of lakes. Here, by integrating paleoenvironmental, instrumental and historical documentary resources at multi-decadal scales, we demonstrate how a typical shallow lake system evolved over the last century in the Yangtze River Basin, an urbanized region containing thousands of shallow lakes. We find abrupt ecological shift happened in the lake ecosystem around the 1970s, with the significant reorganization of macrophyte, diatom and cladocera communities. The lake social-ecological system went through three stages as the local society transformed from a traditional agricultural before 1950s to an urbanized and industrialized society during the recent thirty years. The timing and interaction between social, economic and ecological feedbacks govern the transient and long-term dynamics of the freshwater ecosystem. Our results highlight the importance of accounting for the long-term dynamics and feedbacks between ecological, social and economic changes when defining safe operating spaces for sustainable freshwater ecosystem management.

（来源：Scientific Reports, 2018, https://doi.org/10.1038/s41598-018-35482-5）

Effects of Nutrient Limitations and Watershed Inputs on Community Respiration in a Deep, Tropical Lake: Comparison of Pelagic and Littoral Habitats

Weisman, Alecia; Chandra, Sudeep; Rejmankova, Eliska; et al.

Community respiration and nutrient limitation are frequently studied in pelagic habitats; however, comparisons of these processes between littoral and pelagic habitats are less common and do not exist from mountain lake ecosystems in the tropics. Community respiration was measured in the littoral benthic

and pelagic habitats of a deep, endorheic mountain lake in Guatemala. Community respiration rates were quantified using biochemical oxygen demand within a temperature controlled, dark, laboratory incubation. Community respiration was measured in the pelagic habitat in response to inorganic nitrogen, phosphorus, nitrogen and phosphorus, glucose, five different soils, and sewage additions and in the littoral habitat in response to inorganic nitrogen, phosphorus, nitrogen and phosphorus, and sewage additions. During all periods, community respiration was higher and more variable in the littoral habitat than in the pelagic habitat. The additions of nitrogen, phosphorus, and nitrogen and phosphorus had no effect on community respiration, in either habitat. Glucose and four of the five soil additions from various watershed vegetation types significantly stimulated community respiration in the pelagic habitat. Sewage additions elicited the highest response in both pelagic and littoral habitats. We demonstrate that community respiration in a tropical montane lake is not limited by inorganic nitrogen or phosphorus and is not colimited by both nutrients combined. Treatments containing organic carbon and organic nutrients were significant stimulators of community respiration; therefore, organic carbon is likely limiting community respiration in Lake Atitlan.

（来源：WATER RESOURCES RESEARCH, 2018, 54(8): 5213-5224）

Combining nutrient, productivity, and landscape-based regressions improves predictions of lakenutrients and provides insight into nutrient coupling at macroscales

Wagner, Tyler; Schliep, Erin M.

Empirical nutrient models that describe lake nutrient, productivity, and water clarity relationships among lakes play a prominent role in limnology. Landscape-based regressions are also used to understand macroscale variability of lake nutrients, clarity, and productivity (hereafter referred to as nutrient-productivity). Predictions from both models are used to inform eutrophication management globally. To date, these two classes of models are generally conducted separately, which ignores the known dependencies among nutrient-productivity variables. We present a statistical model that integrates nutrient-productivity and landscape-based regressions-where lake nutrients, productivity, and clarity variables are modeled jointly. We fitted a joint nutrient-productivity model to over 7000 lakes with three nutrients (total phosphorus, total nitrogen, nitrate concentrations), chlorophyll a concentrations, and Secchi disk depth as response variables and landscape features as predictor variables. Because lakes in different regions respond to landscape features differently, we focused our analysis on two subregions with different dominant land uses, the agricultural Midwest and the forested Northeast U.S. Predictive performance was enhanced by modeling nutrient-productivity variables jointly. We also found strong evidence that nutrient-productivity variables were coupled, and that only nitrate may be decoupled from other nutrient-productivity variables in the forested region. We speculate that these regional differences may be related to differences in the strength of biogeochemical cycles and stoichiometric controls between these regions. Jointly modeling nutrient-productivity variables in lakes effectively integrates the two dominant approaches for studying lakes nutrient-productivity relationships and provides novel insight into macroscale patterns of the coupling of nutrients, chlorophyll, and water clarity in lakes.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2018, 63(6): 2372-2383）

Recent ecological change in ancient lakes

Hampton, Stephanie E.; McGowan, Suzanne; Ozersky, Ted; et al.

Ancient lakes are among the best archivists of past environmental change, having experienced more than one full glacial cycle, a wide range of climatic conditions, tectonic events, and long association with human settlements. These lakes not only record long histories of environmental variation and human activity in their sediments, but also harbor very high levels of biodiversity and endemism. Yet, ancient lakes are faced with a familiar suite of anthropogenic threats, which may degrade the unusual properties that make them especially valuable to science and society. In all ancient lakes for which data exist, significant warming of surface waters has occurred, with a broad range of consequences. Eutrophication threatens both native species assemblages and regional economies reliant on clean surface water, fisheries, and tourism. Where sewage contributes nutrients and heavy metals, one can anticipate the occurrence of less understood emerging contaminants, such as pharmaceuticals, personal care products, and microplastics that negatively affect lake biota and water quality. Human populations continue to increase in most of the ancient lakes' watersheds, which will exacerbate these concerns. Further, human alterations of hydrology, including those produced through climate change, have altered lake levels. Co-occurring with these impacts have been intentional and unintentional species introductions, altering biodiversity. Given that the distinctive character of each ancient lake is strongly linked to age, there may be few options to remediate losses of species or other ecosystem damage associated with modern ecological change, heightening the imperative for understanding these systems.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2018, 63(5): 2277-2304）

Long-term limnological changes in the Ecuadorian paramo: Comparing the ecological responses to climate warming of shallow waterbodies versus deep lakes

Giles, Mark P.; Michelutti, Neal; Grooms, Christopher; et al.

1. Paramos are high-altitude ecosystems of grasslands and shrubs that sustain high levels of biodiversity and contain numerous lakes, ponds and wetlands that are a crucial source of water for millions. In the Andes, limnological data are rare from paramos and particularly so from shallow waterbodies that are prominent features of the landscape.

2. Here, we analyse fossil diatom assemblages using dated sediment cores from three shallow lakes in the paramo of southern Ecuador and document their response to recent climate changes. The two shallowest sites were <0.5 m deep and contained nearly identical diatom assemblages, dominated by Achnanthidium minutissimum and other benthic taxa. The deepest study site, at 4 m depth, differed notably from its shallower counterparts in that the dominant taxa were tychoplanktonic Aulacoseira species. All three study sites showed only minor assemblage shifts over the past similar to 200 years. This contrasts sharply with paleolimnological data from nearby deep lakes (Z(max) > 17 m) that recorded abrupt changes in diatom phytoplankton coincident with the onset of higher temperatures, reduced wind speeds and the onset of thermal stratification in recent decades.

3. In temperate and high-latitude regions, an overriding factor influencing freshwater ecosystems is the duration and extent of ice cover, which itself is closely linked to climate variables. In contrast, there is no winter ice cover and the growing season is continuous year round in our equatorial Andean sites. Instead,

rising temperatures are affecting deep lakes primarily by altering the physical structure of the water column resulting in greater periods of thermal stratification, which in turn drives changes in biota and other lake processes. However, this mechanism of change only affects deep lakes because shallow waterbodies are easily mixed by wind.

4. Our data demonstrate the differential response of large, deep lakes in the paramo compared to the relative complacency of changes in shallow waterbodies, which is in marked contrast to similar sites affected by seasonal ice cover.

（来源：FRESHWATER BIOLOGY，2018，63(10)：1316-1325）

Assimilation of ancient organic carbon by zooplankton in Tibetan Plateau lakes is depending on watershed characteristics

Su, Y.; Hu, E.; Liu, Z.; et al.

Ancient (i.e., radiocarbon depleted) organic carbon (OC) is exported from ice sheet, glacier, and permafrost systems and may be buried, respired, or assimilated in downstream aquatic systems. Few studies have explored the potential use of this ancient OC in lake food webs. We combined natural abundance radiocarbon and stable carbon isotope data (Delta C-14 and delta C-13) to study ancient OC utilization by zooplankton in six lakes covering a large climate gradient on the central and peripheral Tibetan Plateau. A depleted Delta C-14 signature of dissolved and particulate OC was found in the inflowing streams and lakes, ranging from - 49 parts per thousand to - 569 parts per thousand, corresponding to radiocarbon ages between 403 yr and 6757 yr. The Delta C-14 values for zooplankton in the lakes ranged from - 45 parts per thousand to - 264 parts per thousand, reflecting that zooplankton obtain C-14-depleted signatures through assimilation of ancient OC and/or indirectly through consumption of phytoplankton or aquatic plant utilizing C-14-depleted inorganic carbon. Moreover, ancient OC from inflowing streams contributed more to zooplankton diets in the temperate glacier area than in the cold glacier area. Assimilation of ancient OC by zooplankton in lakes is not only affected by drainage basin characteristics, such as the recharge coefficient of the lake, but also by the biogeochemical properties of OC. Use of ancient OC by zooplankton in high-altitude lakes may constitute an important link between the contemporary aquatic food webs and the glaciated watersheds. Our findings have important implications for the contribution of ancient carbon to the modern lake food webs of high-altitude and polar lakes.

（来源：LIMNOLOGY AND OCEANOGRAPHY，2018，63(6)：2359-2371）

Fish-mediated plankton responses to increased temperature in subtropical aquatic mesocosm ecosystems: Implications for lake management

He, Hu; Jin, Hui; Jeppesen, Erik; et al.

Although it is well established that climate warming can reinforce eutrophication in shallow lakes by altering top-down and bottom-up processes in the food web and biogeochemical cycling, recent studies in temperate zones have also shown that adverse effects of rising temperature are diminished in fishless systems. Whereas the removal of zooplanktivorous fish may be useful in attempts to mitigate

eutrophication in temperate shallow lakes, it is uncertain whether similar mitigation might be achieved in warmer climates. We compared the responses of zooplankton and phytoplankton communities to climate warming in the presence and absence of fish (Aristichthys nobilis) in a 4-month mesocosm experiment at subtropical temperatures. We hypothesized that 1) fish and phytoplankton would benefit from warming, while zooplankton would suffer in fish-present mesocosms and 2) warming would favor zooplankton growth but reduce phytoplankton biomass in fish-absent mesocosms. Our results showed significant interacting effects of warming and fish presence on both phytoplankton and zooplankton. In mesocosms with fish, biomasses of fish and phytoplankton increased in heated treatments, while biomasses of Daphnia and total zooplankton declined. Warming reduced the proportion of large Daphnia in total zooplankton biomass, and reduced the zooplankton to phytoplankton biomass ratio, but increased the ratio of chlorophyll a to total phosphorus, indicating a relaxation of zooplankton grazing pressure on phytoplankton. Meanwhile, warming resulted in a 3-fold increase in TP concentrations in the mesocosms with fish present. The results suggest that climate warming has the potential to boost eutrophication in shallow lakes via both top-down (loss of herbivores) and bottom-up (elevated nutrient) effects. However, in the mesocosms without fish, there was no decline in large Daphnia or in total zooplankton biomass, supporting the conclusion that fish predation is the major driver of low large Daphnia abundance in warm lakes. In the fishless mesocosms, phytoplankton biomass and nutrient levels were not affected by temperature. Our study suggests that removing fish to mitigate warming effects on eutrophication may be potentially beneficial in subtropical lakes, though the rapid recruitment of fish in such lakes may present a challenge to success in the long-term.

（来源：WATER RESEARCH, 2018, 144: 304-311）

Variability in mean size of phytoplankton in two floodplain lakes of different climatic regions

Iatskiu, Patricia; Bovo-Scomparin, Vania Mara; Segovia, Bianca Trevizan; et al.

Phytoplankton size has an important functional role in ecosystem processes, such as nutrient production and cycling. It has been suggested that warmer temperatures may favor the smaller organisms in biological communities. We evaluate the mean size of the phytoplankton organisms and apply a morphology-based functional groups (MBFG) approach. We use time series of two floodplain lakes that present mean annual temperature difference of 10A degrees C and similar hydrodynamic, area, and mean depth. We expected that a smaller mean size of MBFGs would be associated with higher temperatures. The Akaike Information Criterion was used to investigate environmental factors predicting the mean size of MBFGs within each lake. The mean size was most associated to nutrients and dissolved oxygen in the subtropical lake, and to temperature in the temperate lake. Large filaments with aerotopes and the small flagellated with siliceous exoskeletal structures showed high mean size at higher temperatures, thus contradicting temperature-size rules. Probably the high variability of mean size was provided by the high variability observed around environmental factors. Our findings reveal that other functional traits may be associated with the phytoplankters mean size, which result in adaptation to high variability of various environmental factors.

（来源：HYDROBIOLOGIA, 2018, 823(1): 135-151）

Chironomid incorporation of methane-derived carbon in plankton- and macrophyte-dominated habitats in a large shallow lake

Agasild, Helen; Kisand, Anu; Ainelo, Epp; et al.

1. While C-13-depleted carbon derived from biogenic methane can substantially contribute to the benthic secondary production in deep stratified lakes, its role in shallow lakes is less clear. We investigated the dynamics of delta C-13 and delta N-15 in the larvae of Chironomus plumosus throughout an annual cycle in two ecologically distinct basins (open-water plankton-dominated and sheltered macrophyte-covered) of a large (270 km(2)), shallow, polymictic and eutrophic lake (Vortsjarv, Estonia, North Europe). The larval stable isotopic compositions were linked to the presence of methane-oxidising bacteria (MOB) in larval guts and sediments.

2. Molecular detection of MOB revealed their presence in various sediment types, but stable isotope (SI) analysis revealed clear differences in the feeding of chironomid larvae between the plankton-and macrophyte-dominated habitats.

3. In the plankton-dominated habitat, the mean delta C-13 values of larvae remained relatively constant (-38.3% to -35.5%) and corresponded closely to the sediment delta C-13 values. Mean delta C-13 values of chironomid larvae were generally lower in macrophyte-dominated habitats (-43.4% to -33.0%), and both seasonal and individual variation in larval delta C-13 values were more pronounced. MOB presence in larval guts proved a dietary contribution from biogenic methane in macrophyte-dominated habitats. Both the SI and molecular results indicated that MOB could help support larvae even during the cold temperature-limited and ice-covered periods.

4. Our study indicates that methane-derived carbon makes a low but steady contribution to the larval chironomids throughout an annual cycle in large shallow Vortsjarv. However, this contribution can be substantially higher in the lake habitats with abundant macrophytes. The study provides further evidence that a carbon flow pathway from biogenic methane can contribute to the benthic food web under variable habitat conditions in a shallow polymictic lake.

（来源：FRESHWATER BIOLOGY，2018，63(11)：1433-1445）

Should we plant macrophytes? Restored habitat use by the fish community of Lake Apopka, Florida

Slagle, Zak J.; Allen, Micheal S.

Should we plant macrophytes? Restored habitat use by the fish community of Lake Apopka, Florida. Lake Reserv Manage. 00:00-00.Freshwater resources are impaired worldwide, and managers frequently use habitat restoration to mitigate anthropogenic disturbances to freshwater systems. Restoration attempts have not often been evaluated with respect to their benefits to the sportfish population, especially in lentic systems. Recent restoration techniques at Lake Apopka, Florida, have included planting of macrophytes, particularly spatterdock (Nuphar advena), to increase fish habitat, stabilize sediments, and sequester nutrients. We assessed fish community habitat use of recently restored habitat with comparison to both unrestored (non-vegetated) and natural vegetated littoral habitats. We compared relative abundance and species richness of the fish community across habitat treatments. We electrofished >30 transects in each of these 3 habitat treatments (i.e., natural, planted, and unrestored),

collecting relative abundance data for all fishes and habitat data including vegetation species and percent area coverage (PAC). Natural and planted habitat held greater PAC of vegetation than unrestored sites. Natural habitat supported the greatest relative abundance (as indexed by catch per unit effort) and the greatest species richness of fishes, while planted habitats and unrestored habitats supported fewer relative numbers and lower richness. Planted habitats are being utilized by the fish community, but were not significantly different from unrestored sites. Increased diversity of macrophytes in planted habitats could increase the benefits for these populations. Managers should consider continued monitoring and evaluation of planted sites to increase our understanding of the benefits of habitat restoration.

（来源：LAKE AND RESERVOIR MANAGEMENT, 2018, 34(3): 296-305）

Within versus between-lake variability of sedimentary diatoms: the role of sampling effort in capturing assemblage composition in environmentally heterogeneous shallow lakes

Hassan, Gabriela S.

The effect of within-lake diatom assemblages variability on sample representativity and its subsequent impact on between-lake comparisons were addressed in three environmentally heterogeneous shallow lakes from the Argentinean Pampas. Surface sediment samples were collected from the open waters and the highly vegetated littoral areas on a seasonal basis and analyzed for diatom assemblages composition. Within-lake variability was assessed by comparing the Bray Curtis distances between original data and the Monte Carlo-simulated average assemblages composition through non-metric multidimensional scaling (NMDS). Diatom assemblages showed a high variability in composition, evidencing large dispersions of samples around the centroid in NMDS plots. Permutational multivariate analysis of variance tests signaled significant differences in average composition between the three lakes, related mainly to their differences in conductivity and depth. Representativity of original samples was assessed through principal coordinates analyses ordinations of the three lakes, being samples lying in the overlapping areas of the plot classified as poor representatives of between-lake differences. Several samples, both from littoral and open waters, were classified as poor representatives through this method. Simulation allowed us to evaluate the effect of sample replication on improving between-lake comparisons, and showed that collecting two littoral and two open-water samples allowed us to faithfully capture differences in average composition among the three lakes. Hence, the results suggest that using a single sample to estimate diatom assemblages composition in these lakes should be avoided, as it fails to capture between-lake differences, leading to biases in compositional comparisons among lakes and regions. Consequently, including multiple samples from each lake when constructing calibration sets would be the best option to obtain reliable paleoenvironmental reconstructions from single sediment cores in these environmentally heterogeneous shallow lakes.

（来源：JOURNAL OF PALEOLIMNOLOGY, 2018, 60(4): 525-541）

A European Multi Lake Survey dataset of environmental variables, phytoplankton pigments and cyanotoxins

Evanthia Mantzouki, James Campbell, Emiel van Loon; et al.

Under ongoing climate change and increasing anthropogenic activity, which continuously challenge

ecosystem resilience, an in-depth understanding of ecological processes is urgently needed. Lakes, as providers of numerous ecosystem services, face multiple stressors that threaten their functioning. Harmful cyanobacterial blooms are a persistent problem resulting from nutrient pollution and climate-change induced stressors, like poor transparency, increased water temperature and enhanced stratification. Consistency in data collection and analysis methods is necessary to achieve fully comparable datasets and for statistical validity, avoiding issues linked to disparate data sources. The European Multi Lake Survey (EMLS) in summer 2015 was an initiative among scientists from 27 countries to collect and analyse lake physical, chemical and biological variables in a fully standardized manner. This database includes in-situ lake variables along with nutrient, pigment and cyanotoxin data of 369 lakes in Europe, which were centrally analysed in dedicated laboratories. Publishing the EMLS methods and dataset might inspire similar initiatives to study across large geographic areas that will contribute to better understanding lake responses in a changing environment.

（来源：Scientific Data, 2018, 5, https://doi.org/10.1038/sdata.2018.226）

Genome-scale fitness profile of Caulobacter crescentus grown in natural freshwater

Kristy L. Hentchel, Leila M. Reyes Ruiz, Patrick D. Curtis,; et al.

Bacterial genomes evolve in complex ecosystems and are best understood in this natural context, but replicating such conditions in the lab is challenging. We used transposon sequencing to define the fitness consequences of gene disruption in the bacterium Caulobacter crescentus grown in natural freshwater, compared with axenic growth in common laboratory media. Gene disruptions in amino-acid and nucleotide sugar biosynthesis pathways and in metabolic substrate transport machinery impaired fitness in both lake water and defined minimal medium relative to complex peptone broth. Fitness in lake water was enhanced by insertions in genes required for flagellum biosynthesis and reduced by insertions in genes involved in biosynthesis of the holdfast surface adhesin. We further uncovered numerous hypothetical and uncharacterized genes for which disruption impaired fitness in lake water, defined minimal medium, or both. At the genome scale, the fitness profile of mutants cultivated in lake water was more similar to that in complex peptone broth than in defined minimal medium. Microfiltration of lake water did not significantly affect the terminal cell density or the fitness profile of the transposon mutant pool, suggesting that Caulobacter does not strongly interact with other microbes in this ecosystem on the measured timescale. Fitness of select mutants with defects in cell surface biosynthesis and environmental sensing were significantly more variable across days in lake water than in defined medium, presumably owing to day-to-day heterogeneity in the lake environment. This study reveals genetic interactions between Caulobacter and a natural freshwater environment, and provides a new avenue to study gene function in complex ecosystems.

（来源：The ISME Journal, 2018, https://doi.org/10.1038/s41396-018-0295-6）

科技热点

全球大型湖库富营养化水体个数占比已达 63%

内陆湖库水体的富营养化已经成为全球性的环境问题。我国科学家利用遥感监测技术，获得世界首幅全球大型湖库营养状态分布图，发现全球大型湖库水体的总个数中已有 63%呈富营养化状态。相关论文发表在最新一期的《环境遥感》（Remote Sensing of Environment）杂志上。

由于内陆湖库水体光学特性复杂，水体水质参数反演算法的时间和空间扩展性不足，且湖库水体呈破碎性分布，在全球尺度进行湖库营养状态监测一直是水色遥感领域的一大难题。

中科院数字地球重点实验室张兵研究员长期从事湖泊/海洋的水色遥感研究，其团队利用 MODIS 数据开展全球大型湖库营养状态遥感监测研究，成功获得了首幅全球大型湖库营养状态分布图。他们利用水色指数对湖库营养状态做了评价，并设计了全球湖库水体边界自动化提取及验证方案，实现了对大型湖库营养状态的遥感监测。

研究结果表明，在 2012 年全球大型湖库水体中，富营养化水体个数占比达 63%，面积占比 31%；中营养水体个数占比 26%，面积占比 39%；贫营养水体个数占比 11%，面积占比 30%。富营养化水体面积普遍较小，贫营养水体面积普遍较大。

从空间上看，富营养水体主要集中在非洲中部、中国东部、北美洲中北部以及东南部等人口密集地区，贫营养水体主要集中在高山高原地区，如中国青藏高原、南美洲巴塔哥尼亚高原等地区。

以往科学家对青藏高原湖泊营养状态的研究很少，这次发表的论文可填补空白；长江中下游湖区水体颜色以绿色和黄绿色为主，水体以富营养状态为主，如太湖、巢湖、洞庭湖和鄱阳湖等是中国典型的浑浊富营养湖泊。

（来源：科技日报　2018-10-22）

最新研究揭示晚更新世河流袭夺过程

近日，以中国学者为主导的中加美3国学者在河流发育演化方面取得了研究成果——“更新世一次河流袭夺后的流域地貌突变”，发表于《自然·通讯》。这是一个关于两条河流打架（河流袭夺）的故事，主角分别为黄河和淮河的“娃”（支流）——柴汶河和沂河，结果是柴汶河打赢了沂河，时间是距今8万年以内。

河流袭夺是河流发育的一种现象又称“河流抢水”。8日，论文第一作者、四川大学水力学与山区河流开发保护国家重点实验室助理研究员范念念在接受科技日报

记者采访时介绍，自然界中，相邻几个水系在内外因素的影响下，可能会有一个水系侵蚀活跃，下切较深，甚至切穿分水岭，夺取分水岭另一侧位置较高河流的河源段。河流袭夺在河流发育中起重要作用，研究历史已超过一个世纪，但目前证据确凿且能较准确定年的案例非常稀少。

“我读中学时就注意到老家沂蒙山区的柴汶河，流向由东急剧转向西南，并在大拐弯上游形成壮丽的峡谷和瀑布。”范念念说，原来这个大拐弯就是袭夺湾。通过地形资料推演，刚刚发生河流袭夺时，这个瀑布有20多米高，然后逐渐延柴汶河向上游、向西后退了1.4公里，现在瀑布只有2—3米高。瀑布的这一后退过程塑造了峡谷。

柴汶河和沂河的分水岭位于山东省沂蒙山区的沂源县。范念念介绍，8万年前，古沂河经此地向东北方向流，古柴汶河则在此发源往西南方向流，二者相安无事，“井水不犯河水”。随着柴汶河源头向上游侵蚀、发展，最后切穿与古沂河的分水岭，从而将古沂河的上游河源段抢了过来，成为柴汶河上游。这样，成就了今天柴汶河“急转直下”的壮美风光。

“我们在这里发现3处卵石的走向、排列与现在的流向相反，确定了河流袭夺的发生；通过对古沂河河床沉积物，即紧贴卵石上层的沙子测年，确定了袭夺发生的时间。”范念念说，袭夺的典型地貌特征如袭夺河、被夺河、倒淌河、袭夺弯、风口和尼克点等均完好保留，是一起典型的河流袭夺案例，可为河流袭夺的地貌演化与机制研究提供天然范例与观测数据。

由于被袭夺，沂河源头水量急剧减少，积累了超过10米厚的沼泽沉积物。范念念介绍，这些沉积物的年龄在1万-3万年之间，包含了末次盛冰期，即距今1.6万-1.8万年前后。“当时，海平面下降超过120米，整个渤海几乎不存在，现在的山东半岛与韩国连在一起。这种剧烈后退的背景，一定会使得中国北方地区更加干冷。”范念念说，这些沉积物有望揭示中国东部海岸线急剧后退的气候特点，并完善西部黄土高原和荒漠的发育历史。

（来源：科技日报 2018-10-09）

喜马拉雅冰湖灾害调查和冰川变化研究取得新进展

喜马拉雅山脉冰川广泛发育，冰川作用强烈，该区域历史上多次爆发冰湖溃决洪水，是世界上冰湖灾害最严重的区域之一。之前有关溃决事件和参数的研究报道在爆发位置、溃决时间等方面存在很多的不一致，严重的制约了风险分析建模和灾害管理。为此，中科院成都山地灾害与环境研究所聂勇副研究员、刘巧副研究员等与来自Kansas State University、中科院地理资源所、University of California, Los Angeles、云南大学国际河流与生态安全研究院、四川师范大学、Karakoram

International University的联合研究团队对喜马拉雅山脉历史冰湖溃决灾害事件和重点区段冰川变化开展了深入的调查分析并取得新的进展。

在冰湖灾害调查方面，研究团队系统收集了喜马拉雅山脉相关文献资料、遥感影像和野外调查资料，基于遥感影像和地貌特征辨析溃决事件的可靠性，构建了冰湖灾害数据库；利用时序遥感数据揭示了一些未报道的溃决事件，同时更正了部分溃决事件的错误参数并利用近30年卫星数据监测了这些溃决冰湖近期状态，为冰湖灾害评估、监测预警提供了基础数据和理论支撑。

在冰川监测方面，研究团队建立了冰川冰湖信息遥感自动提取的方法，选择中尼经济走廊的关键区—吉隆藏布流域为案例区，阐明了吉隆藏布流域冰川变化、冰湖和表碛冰川扩张的过程，筛选出需要重点监测的冰湖，以期服务于中尼经济走廊的防灾减灾工作。

以上研究得到了国家自然科学基金(41571104, 41371094）、中科院STS项目(KFJ-STS-ZDTP-015)、中科院西部之光项目、四川省委组织部人才项目和成都山地所“一三五”重点培育方向项目(SDS-135-1708)的资助。相关研究结果已发表在国际学术期刊Geomorphology、Remote Sensing上

（来源：http://news.sciencenet.cn 2018-11-27）

河流食物链中检测到六十多种药用化合物

据英国《自然·通讯》杂志11月6日发表的一项研究，科学家在墨尔本附近6条河流中的水生无脊椎动物和河岸上的昆虫捕食者体内，检测到了60多种药用化合物。初步估计表明，位于食物链上游的动物——鸭嘴兽和褐鳟在理论上可能因为饮食而被暴露于某些药物，其剂量高达人类剂量的50%。

人类每天使用的化学品，如药品和个人护理产品，最终会进入附近的水域，因为废水处理设施无法有效清除它们。然而，它们的生物活性、暴露情况和生态影响，一直以来都不甚明了。

此次，澳大利亚莫纳什大学研究人员艾林·李察蒙德及其同事检测了澳大利亚墨尔本附近6条河流中的水生昆虫和陆地蜘蛛，以鉴定98种不同药物在其体内的浓度，包括抗抑郁药、止痛药、抗生素和抗组胺药（一种针对组胺介导的过敏性疾病有明确疗效、但存在一定不良反应的药物）。

研究团队发现，60多种化学物质在它们体内都达到了可检测浓度。已知的昆虫捕食者——河岸蜘蛛体内的化学物质浓度要高得多，研究人员认为，药物是在这些昆虫捕食者食用无脊椎动物时被转移到它们体内的。这也表明，这些化学物质在食物链上游具有所谓的“生物放大（富集）”作用，或者出现了浓度上升。

随后，研究团队使用昆虫体内的化学物质浓度信息，来估计食物链中其它昆虫捕食者——褐鳟和鸭嘴兽的药物暴露情况。根据计算结果，研究人员估计鸭嘴兽可能摄入了大约50%的人类抗抑郁药日推荐量。

对于这些新型水污染物的直接影响，还需要进一步开展工作，加以探索。

（来源：科技日报　2018-11-07）

生物多样性增加会破坏态系统的稳定

2018 年 10 月 17 日，Nature 发表题为《生物多样性增加和减少生态系统的稳定性》（Biodiversity Increases and DecreasesEcosystem Stability）的文章指出，在某些环境条件下，生物多样性的增加也可能破坏生态系统的稳定性。

生态系统可以为人类提供食物、水和其他资源及娱乐空间。因此，保持这些系统的功能和稳定非常重要，特别是在考虑到气候变化或环境污染的情况下。物种多样性的减少和增加会影响生态稳定性和生态系统功能与服务的可持续性。根据流行的观点，物种丰富的生态系统更加稳定，可以抵御干旱、炎热天气或杀虫剂等环境破坏。之前的实验与模型研究揭示，物种多样性对生态稳定性的单个组成部分存在积极、消极和无影响，例如时间变异性、抵抗力和恢复力。然而，多样性对生态系统整体稳定性的影响仍然未知。瑞士苏黎世大学（University of Zurich）的研究团队，以水生纤毛虫群落为研究对象，涉及 690 个微生物生态系统，在 40 天内采样 19 次，总共有 12939 次采样，了解时间变异性、抗性与生态系统整体稳定性如何响应物种多样性。

研究结果表明，物种丰富度增加了时间稳定性，但降低了对变暖的抵抗力。即无论温度如何，微型生态系统中物种群落越多样化，生物量生产波动越小；然而，在更高的温度下，原生动物产生的生物量越少，物种在系统中繁殖的越多。尽管通常情况下，预测会认为多样性对个体稳定性有负面影响，但以前的生物多样性研究很少发现这种负面协变。将研究结果与生态系统多功能性概念相结合，揭示了多样性对生态系统整体稳定性存在驼峰与 U 形影响。也就是说，生物多样性可以在生物多样性较低时提高生态系统的整体稳定性，在生物多样性较高时减少生态系统的整体稳定性。研究人员指出，将生态系统多功能性概念与生态系统稳定性联系起来，可以改变多样性对生态稳定性的感知效应，并有助于利用这种科学知识为政策制定提供信息服务。

（来源：资源环境科学监测快报 第 21 期 2018-11-01）

FAO 和 UNECE 关注森林和水的生态系统服务价值

2018 年 11 月 5 日，联合国粮食及农业组织（FAO）和联合国欧洲经济委员会（UNECE）联合发布的题为《森林和水：森林生态系统服务评估和支付》（Forests and Water：Valuation and Payments for Forest Ecosystem Services）的报告显示，森林和水资源的生态系统服务价值在很大程度上被低估了。

森林在生产和调节淡水流量方面发挥着重要作用。报告评估了森林的生态系统服务价值和各种流域服务付款（Payments for Watershed Services，PWS）的管理、设计和资金来源。评估结果显示：①森林和水可以产生多重效益，例如，促进碳减排、保护生物多样性并产生社会效益，但目前森林和水的生态系统服务功能在很大程度上被低估了。②基于伙伴关系的 PWS 在获取多种资金方面更加成功，确保了森林和水所有者或管理者的长期参与。③各国基于当地的最佳做法，采取跨行业的联动，有助于构建并实施 PES 立法。最后，报告为保护森林和水资源提出了 6 条建议：（1）建议聚焦生态系统的成本效益，深刻认识森林和水可以产生的多重效益及服务。（2）建议积累与运用科学知识，提高技术和能力，并促进利益相关者的协商和参与，以突破流域与森林经济评估的局限性。（3）建议通过识别明确的代理指标和生态系统服务指标，构建监测系统。（4）充分认识经济评估中潜在的限制性因素和挑战，恰当地评估森林和水生态系统服务价值的多样性。（5）构建 PES 原则和实践的交互理解平台，以确保主要决策机构（包括财政和税务机关）参与到新的 PWS 计划对话中。（6）促进法律框架的构建，为 PWS 计划设计提供指导和支持，以便其应用到地方层面。

（来源：资源环境科学监测快报 第 23 期 2018-12-01）

NASA 选定“火星 2020”着陆点该地曾覆盖湖泊

美国太空总署（NASA）11 月 19 日宣布，下一代火星车“火星 2020”的着陆地点将是火星赤道附近的耶泽洛陨石坑。该陨石坑宽 45 公里，约 35 亿至 39 亿年前曾覆盖着 500 米深的湖泊，是个河流三角洲。NASA 将在明年秋提交有关着陆点的最终报告。

据 NASA 研究员楚比兴介绍，耶泽洛陨石坑地貌古老多样，对研究火星很有价值。研究人员称，该处地质成分中有黏土和碳酸盐岩，还可能有昔日河流带来的各种矿物质，因此可能保留着有机分子及微生物迹象。

“火星 2020”将在 2020 年 7 月出发，2021 年 2 月抵达火星，寻找可能存在过的生命迹象。它将把火星岩土样本暂存在行星表面某处，待未来带回地球。NASA 称，此次的着陆点对未来 10 年的火星探测任务有重要意义。

不过，研究人员也表示，耶泽洛陨石坑的巨石、悬崖和风蚀地貌为着陆带来挑战。“火星 2020”项目科学家法利称，过去火星车难以在该处安全着陆，而 NASA 开发的“地形相对导航”新技术为安全着陆提供可能。

（来源：大公报 2018-11-21）

业界动态

首个跨省湖长协商协作机制建立

11月13日，水利部太湖流域管理局联合江苏省、浙江省河长办在江苏宜兴召开太湖湖长协作会议。会议审议通过太湖湖长协商协作机制规则，正式建立了太湖湖长协商协作机制。水利部副部长魏山忠，江苏、浙江省级太湖湖长等出席会议。

太湖湖长协商协作机制是我国首个跨省湖泊湖长高层次议事协调平台，是水利部太湖流域管理局贯彻习近平总书记关于长三角一体化发展战略部署的重要举措，积极助推流域湖长制工作的创新实践成果。机制设江苏、浙江省级太湖湖长和太湖局主要负责人三位召集人，成员包括沿太湖省、市不同层级湖长、主要出入太湖河流的县（市、区）河长、太湖局和相关省市河长办人员，并在面积大、岸线长的江苏省河长办设办公室，由江苏省河长办会同浙江省河长办和太湖局共同负责日常工作。

魏山忠充分肯定了太湖流域河湖长制工作成效。他指出，太湖流域河长制湖长制工作起点高、标准严、力度大、措施实、进度快，取得了显著成效，走在全国前列。召开太湖湖长协作会议，建立太湖湖长协商协作机制是太湖流域迅速落实长三角一体化国家战略的创新举措，机制的建立进一步凝聚了河湖治理和保护的合力，为深化河长制湖长制工作提供了新的思路和范例。

魏山忠强调，沿太湖各地要牢固树立绿水青山就是金山银山、人与自然和谐共生的理念，把维护河湖健康作为重大政治任务抓实抓好，尽快完善各级湖长体系，落实地方党政领导湖泊管理保护责任，扎实推进湖长制六大任务，确保在今年年底前不打折扣地完成全面建立湖长制的工作任务。同时，不断夯实河湖管护的工作基础，深入开展河湖“清四乱”专项行动，进一步加大考核问责力度，全力推动河长制湖长制从“有名”向“有实”转变。

会议就下阶段有关各方充分发挥太湖湖长协商协作机制优势提出明确要求。一是加强交流合作，强化信息互通、资源共享，着力构建齐抓共管、群策群力的太湖湖长工作新格局；二是狠抓任务落实，进一步统筹太湖湖长制目标任务，加强各地河长制湖长制重点工作的衔接，抓实抓好议定事项的落实；三是强化系统治理，建立完善“一湖一档”，编制完善“一湖一策”，齐心协力推动落实。同时，不断完

善工作形式，丰富工作内容，促进机制规范化、常态化、长效化运作，为流域各地乃至全国，特别是跨省跨区域湖泊实施湖长制提供示范借鉴。

（来源：中国水利网站　2018-11-16）

气候变化加剧我国北方地区水资源短缺

“气候变化一方面导致我国北方河川径流和地表水资源减少，另一方面温度上升使得农业、工业、生活和生态用水刚性需水增加。我国北方地区水资源短缺的矛盾将进一步突出。” 南京水利科学研究院院长、中国工程院院士张建云表示。他是在 6 日召开的第 8 届“基于全球水文实验与观测数据的水流情势研究”（以下简称 FRIEND）国际会议上做这番表述的。

通过对比 1980-2012 系列与 1956-1979 系列全国大江大河主要控制站河川径流变化，张建云指出，我国河川径流总体上呈减少趋势，其中海河流域、辽河流域和黄河下游地区减少明显。径流减少的同时，黄淮海流域地表水资源量也明显减少。未来全国水资源量可能进一步减少，总体上可能偏少 5%以内。

与此同时，用水需求却在增加。张建云认为，在全球气候变暖的背景下，地表温度在全国各地有不同程度的升高，而温度的上升带来了用水需求的增加。以农业灌溉用水为例，据作物净灌溉需水量对气候变化敏感系数分析，温度上升 1℃，农业净灌溉需水将增加约 1%-3%。

为应对气候变化带来的影响，水资源管理应由综合管理向适应性管理转变。张建云建议，一要节水优先，加强需求侧管理，减少水资源的刚性需求；二要提升水资源供给能力，建设跨流域调水工程，形成丰枯互济的国家水网；加强非常规水资源的开发利用，减缓水资源短缺的矛盾；三要加强水资源利用多目标安全与风险评估，实现多目标的协同管理和风险调控，保障协同发展。

面对变化环境下的全球水环境和水安全问题，水利部水文司司长蔡建元表示，需要进一步加强基础研究、提升观测手段、提高预测预报的科学水平，组织开展水文重大课题和技术装备的联合攻关，提升水文支撑保障能力。

“要加强物联网、大数据等信息技术在水文业务中的深度融合，提高水文水资源预测预报能力；推进无人机、卫星遥感等新技术新设备的广泛应用，加快水文可视化、智能化发展。”蔡建元强调。

（来源：科技日报　2018-11-07）

认清洪水“利害”打磨管理利器

洪水灾害是全球发生频率最高，且经济损失较严重的自然灾害。在全球气候变

化的大背景下，极端天气时有发生，使得洪水管理面对更多的不确定性。如何加强洪水风险综合管理，减小洪水灾害带来的损失和影响，无疑是世界各国共同面临的重要课题。

在近日召开的洪水管理国际论坛上，国际洪水管理论坛主席斯洛博丹·西蒙诺维奇教授指出，有些人在谈论洪水时喜欢用“管控”一词，但实际上人类是不可能控制自然的，只能采取一些干预措施来应对可能发生的灾害。

水利部防洪抗旱减灾工程技术研究中心原常务副主任程晓陶也认为，从控制洪水到洪水管理，是当代防洪战略转移的重要标志。作为国内较早开展洪水管理研究的专家之一，程晓陶介绍，洪水风险管理是洪水管理的模式之一，即在充分认识洪水“利、害”两面性的基础上，协调处理好人与洪水之间的关系。

水利部原总规划师张志彤认为，实施洪水风险管理是防洪的关键。他指出，受特殊地理和气候条件的影响和控制，中国约有70%的国土面积会遭受不同程度洪涝灾害的影响，江河洪水、山区洪水、暴雨内涝等洪涝灾害频发。

为了尽可能降低洪水带来的风险，编制风险图显得尤为重要。据介绍，近年来，财政部安排中央财政专项经费13.02亿元，推进实施《全国重点地区洪水风险图编制项目实施方案（2013—2015）》，合计编制完成了我国重要防洪区49.6万平方公里的洪水风险图，涵盖全国所有重点防洪保护区（40.8万平方公里），国家重要和一般蓄滞洪区78处（2.9万平方公里），主要江河中下游洪泛区26处（0.88万平方公里），重点和重要防洪城市45座（1.3万平方公里），中小河流重点河段198处（3.7万平方公里）。

围绕洪水风险管理，国际学术界已经形成了一些共识。但斯洛博丹·西蒙诺维奇认为，一方面洪水风险具有很多不确定性，另一方面，在洪水灾害的备灾、救灾等过程中，需要对风险进行评估，并得出评估数值，而为了更好地了解灾害过程中的动态变化情况，需要基于评估数值，对城市或地区应对灾害的“韧性”进行量化研究。

所谓“韧性”，强调的是对灾害的承受能力和适应性。通过量化“韧性”，可以了解在不同阶段，采取不同的措施会起到什么样的效果，进而更好地辅助决策。以曲线上升阶段为例，斯洛博丹·西蒙诺维奇指出，通过评估，可以决定采取什么样的灾害响应措施，比如是否需要动员更多的人力财力，以及延长或者缩短恢复重建的时间。菲利普·顾博维尔认为，应用智能解决方案，打造智慧城市，也是提升城市应对洪灾能力的重要手段。这首先需要安装多种传感器，收集地势地形、雨水等信息，以全面的视角对灾情进行高效的监测与评估。

此外，虚拟现实、增强现实等技术的应用，也将对于洪水灾害的研究和科普起到积极的作用。“通过虚拟现实技术，可以让年轻人带上头盔，体验洪水来临的场景。而增强现实技术，可以让人们模拟洪灾发生时的场景，进行救灾路线规划和演

练，从而增强应对的能力。”菲利普·顾博维尔说。

（来源：科技日报　2018-10-30）

美国未来水资源科学优先研究方向

近日，美国国家科学院发布《美国未来水资源科学优先研究方向》的研究报告，确定了美国在未来 25 年内水资源科学面临的挑战，以及全球水资源存在的问题和应对的创新技术，并提出了政策建议。

未来几十年，人口增长、气候变化、极端天气，以及与水有关的基础设施老化，威胁着水资源的利用与水质，解决与水资源使用有关的问题将至关重要。美国地质调查局水务分局（USGS-WMA）能够收集和提供与美国水资源有关的高质量、无偏见的科学信息，不仅能够在飓风、洪水和森林火灾等紧急情况下做出快速反应，而且在水资源的长期管理方面具有丰富的经验，能在很多方面帮助政府决策。

1. 未来美国水资源科学优先事项

报告确定了美国未来 25 年内水资源科学面临的挑战。其水资源优先研究方向综合了已发表相关主题的成果和 USGS 当前的水资源科学研究，并采纳来自美国联邦、州、地方、非政府和学术界专家的意见，确定了以下跨水资源科学所面临的诸多挑战：

（1）了解水在地球系统中的作用。水在大气、岩石圈和生物圈中的流动促进了物理、化学和生物过程。了解水循环响应机制，并反馈到全球变化的趋势中，仍然是地球系统研究的关键挑战。

（2）量化水循环。有效管理水资源需要了解水的含量、状态和位置。由于水的存量、流量和停留在空间和时间上的变化使得水循环的量化非常困难，这也是未来水科学研究的方向之一。

（3）开发集成建模。模型是集成和综合不同观测数据、理解复杂的交互作用和测试假设，以及重建过去和预测未来系统发展轨迹的重要工具。

（4）量化社会水文系统的变化。了解人类活动如何影响水资源对管理美国和全球的水资源至关重要。

（5）确保可靠和可持续的水供应。人类社会依赖于清洁、可靠和可负担得起的地表水和地下水，饮用、食品、能源生产、工业活动、健康的生态系统、娱乐活动和旅游都离不开水供应。

（6）了解和预测与水有关的灾害。从经济和人类角度看，与水有关的灾害是最严重的自然灾害之一，而且由于人类活动和气候变化可能导致日益恶化。

2. 解决全球水资源科学问题

报告提出了 10 个总体的水资源科学问题，如果这些问题得到解决，将在未来对水资源科学的挑战做出最重要的贡献。对这组问题的进一步提炼，形成了五个更优先级别的问题。这些问题主要根据科学重要性、社会需求、与 USGS 任务的相关性以及与 USGS 合作伙伴的相关性等标准提出：①量化大气、地表水和地下水的质量和总量，以及它们在空间和时间上的变化；②人类活动对水量和水质的影响；③如何更有效和全面地进行水资源核算，以提供有关水资源供应和使用的数据？④气候变化如何影响水质、水量、水资源利用的可靠性以及与水有关的灾害和极端事件？⑤如何改善与水有关的长期风险管理？

其他 5 个问题也非常重要，但可以通过更广泛的水资源研究加以解决：⑥水循环在不久的将来对大气、岩石圈和生物圈的变化有哪些反应？水文反应如何反馈并加速或抑制大气、岩石圈和生物圈的变化？⑦如何改善气候、水文、水质和相关社会系统的短期预测？⑧制度、治理和制度弹性如何影响水量和水质？⑨如何更好地理解与水有关的危害和人类健康之间的联系?⑩在健康的社区和生态系统的前提下如何管理和维护水资源的竞争使用？

3．技术创新应对水资源挑战

新兴技术将有助于推动水资源所面临的挑战。此后的 25 年，更广泛来源的观测数据将提供更高的时间和空间分辨率。新技术的广泛采用支持开发新系统，快速收集来自不同来源的数据，以进一步评估、存储、处理和共享数据，发挥数据的最大作用。

新的传感器将推进水资源的观测和分析水平，但在测量和监测水质方面存在技术挑战。微传感器仍然是研究和开发的重要方向之一。环境 DNA（eDNA）技术已经可以从单个水样中检测入侵物种，这将对环境健康和恢复力具有重要意义。

管理“大数据”和整合多源异构数据有助于水资源模型的开发，为跨学科模型集成和不确定性提供辅助决策。

4．对美国水资源研究与管理的政策建议

根据上述水资源领域所面临的挑战和优先研究方向，报告提出以下建议：

（1）加强数据收集，开发基于 Web 的分析工具。为了使国家能够应对未来的水资源挑战，应该①使用创新技术加强水量、水质和用水监测，并建立数据库和开发监测平台；②进一步将公共科学纳入 USGS 数据收集活动，以增强传统监测网络；③研发更直观的基于 Web 的数据分析和可视化工具，以便更好地了解水资源的状况和趋势。

（2）与各机构和相关组织协调数据对接。USGS-WMA 作为提供水量、水质数据和信息的机构之一，应与其他机构和相关组织共同协调开发可访问的、开放编码的数据格式、协议、互动工具和软件。这种数据共享模式和综合多个观测点，更有

利于监测水量和水质变化的趋势。

（3）增加对人类活动与水资源关系的关注。应优先调查人类活动与地表水和地下水变化之间的关系，通过综合观测，结合受气候和社会经济因素影响的自然-人类系统模型研究与水有关的灾害。

（4）建立健全的水资源核算系统。应开展相关研究，了解如何最好和最有效地执行水资源核算，以及如何评估和呈现报告数据的不确定性。水资源核算应超出资源本身的测量范围，同时需考虑水资源利用的生物性、物理性和社会性约束。

（5）与各机构和相关组织就水资源数据标准和使用类别进行合作。作为国家收集用水数据和信息的部门之一，USGS-WMA 应与其他机构和相关组织合作，共同制定用水类别的标准、协议，并遵守各州、县和流域的通用标准。

（6）确保监测网络提供足够的信息来评估不断变化的情况。应定期评估地表水和地下水监测网络的状态，以确保这些网络能够为气候、农业和其他土地利用以及城市化带来的环境变化提供水文影响分析数据。

（7）重点关注极端水情的长期预测和风险评估。应优先考虑解决与洪水、干旱和水生污染物等水文原因相关的风险，设法了解气候变化、土地覆盖率和土地利用变化以及其他生物、物理和社会经济因素对水资源（水量、水质、极端事件和其他水文灾害）的影响。USGS 应该进一步开发综合模型，以帮助预测在不断变化的气候条件下的未来水文条件。这些活动需要资源管理者、决策者和社会科学家与其他 USGS 任务进行综合研究。

（8）开发涵盖整个水循环的多尺度、集成性的动态模型。WMA 应优先考虑多尺度和综合建模，利用地面传感和空中地球观测平台，将地上和地下水资源存储的水量、水质、自然与人类的驱动因素以及相互作用动态耦合。

（9）与代理机构和私营部门等机构内外合作。水资源挑战具有内在的跨学科性，USGS-WMA 应继续建立并保持强有力的合作，加强与 USGS 其他任务的联系，最大限度地发挥其在观测、研究、预测和提供水资源数据和问题方面的影响；加强与其他联邦和州相关机构以及国际机构（特别是跨界水问题）的联系，以应对更多的水资源挑战；评估并在其认为有利的情况下与私营部门合作，以开发新的数据源和平台，加强数据、信息、模型和其他产品的传播。

（10）建立一支准备应对新的水资源挑战的科学队伍。调整其当前和未来的研究队伍，以满足关键的战略需求，特别是提高包括改善水资源监测、自然-人类耦合系统建模、创新数据分析和可视化方法等方面的队伍能力。

（来源：资源环境科学动态监测快报 第 20 期 2018-10-15）

NOAA 资助开发新系统监测有害藻华

2018年10月17日，美国国家海洋与大气管理局（NOAA）通过海洋基金项目（Sea

Grant Program）资助开发一项观测浮游植物的自动化实时管理（PhytO-ARM）系统的新研究，该系统使用下一代机器人传感器监测沿海水域的致病微藻，项目由伍兹霍尔海洋研究所（WHOI）牵头，系统完成之后将极大地提高检测有害藻类的繁殖以及产生毒素的能力。该系统基于网络为水产养殖者、资源管理者及相关人员提供详细的实时信息。

PhytO-ARM系统以复杂的形式连接流式细胞显微成像仪（Imaging Flow Cytobot，IFCB）和高容量环境样本处理器（ESP）两个强大的传感器，分别具有连续记录浮游植物的显微镜图像和实时识别不同物种和毒素的功能。利用PhytO-ARM传感器的实时数据，资源管理者可以监测出在监测计划外的潜在有毒浮游植物细胞。

作为海洋基金项目的一部分，项目将在美国东北部和佛罗里达州的多个地点部署配置PhytO-ARM系统。研究人员称，该系统具有保护人类健康和提供水产养殖业最大化发展的潜力，其目的在于系统的简化设计使其能在多领域广泛应用，包括保障渔民贝类产量、资源管理者预测、应对疫情和保护人类健康等。该系统的研发将提高水产养殖业务的弹性，并将促进农业生产和管理的发展。

原文来源：http://www.whoi.edu/news-release/sea-grant-funds-new-technology-to-monitor-for-harmful-algal-blooms

（来源：科学研究动态监测快报 第22期 2018-11-15）

英国启动水产养殖计划

2018年11月19日，英国自然环境研究理事会（NERC）与英国生物技术与生物科学研究理事会（BBSRC）共同发起英国水产养殖计划。该计划资助12个项目，总经费510万英镑开展创新研究，应对英国水产养殖面临的战略挑战，帮助英国的水产养殖业健康发展。除了BBSRC和NERC资助外，还得到农业食品与生物科学研究所（AFBI）和环境、渔业和水产养殖科学中心（CEFAS）以及一系列行业合作伙伴的共同支持和合作。

英国水产养殖计划的12个新项目包括

（1）水产养殖遗传和育种创新研究。项目由爱丁堡大学罗斯休斯顿分校承担。

（2）引入本地测试和管理解决方案，实现安全可持续的贝类养殖。项目由罗伯特戈登大学承担。

（3）淡水再循环水产养殖系统对大西洋鲑鱼健壮性和对海洋疾病易感性的影响研究。项目由斯特灵大学负责。

（4）开发近海水产养殖所需的环境条件评估。项目由苏格兰海洋科学协会负责评估。

（5）研究新型疫苗靶标的被动和主动免疫，以保护鳟鱼免受增生性肾病（PKD）的侵扰。项目由阿伯丁大学负责。

（6）藻类粘合种植方法创新研究，改善英国大藻类栽培的经济效益。项目由苏格兰海洋科学协会承担。

（7）用于水产养殖中基于DNA的病原现场实时多重检测的文献平台建设。项目由格拉斯哥大学承担。

（8）浮游植物形态和光学特性传感器研发。项目由国家海洋学中心负责研发。

（9）养殖大西洋鲑鱼（Salmo salar）贫血症诊断技术研发。项目由苏格兰西部大学负责开发。

（10）水产养殖的藻类疫苗研发。项目由伦敦大学学院负责研发。

（11）确定控制多子小瓜虫（Ichthyophthirius multifiliis，淡水鱼类寄生虫，水产业的主要病因之一）的目标研究。项目由埃克塞特大学负责。

（12）用于提高区域牡蛎生产的利润、生物安全和碳足迹的磁无线传感器技术研发。项目由埃塞克斯大学负责。

（来源：资源环境科学监测快报 第23期 2018-12-09）

气候变化促使科学家重新思考沼泽管理

到目前为止，恢复美国佛罗里达大沼泽地丰富生态环境的努力主要集中在对抗污染物径流造成的破坏和恢复水的自然流动。但现在，一个专家小组呼吁联邦和州机构根据气候变化和海平面上升的威胁重新评估它们的计划。

10月16日，美国国家科学、工程和医学院发布了一份报告，要求大沼泽综合恢复计划（CERP）的管理人员进行“中期评估”，并提出新的评估应该考虑到“2050年及以后”湿地的可能状况，并模拟现有的修复项目在各种海平面上升情况下的表现。

提出该报告的委员会主席、俄勒冈州立大学环境经济学家William Boggess说：“可以用冰球运动打个比方，我们应该追着冰球跑，而不是停在当下球的位置上。”

大沼泽曾经包括超过100万公顷的湿地、锯草平原和横跨佛罗里达州南部的树木岛屿，但农业和人类定居已经使这些生态环境减少了一半。农业径流中的磷杀死了在大沼泽地自然低磷条件下生长旺盛的锯草。取而代之的是茂密的香蒲，它们堵塞了动物和鸟类取水的通道。目前，这里的80种植物和动物正受到威胁或濒临灭绝。

CERP成立于2000年，旨在恢复和更好地管理大沼泽地，是一项历时数十年的努力。在过去5年里，平均每年投入2.3亿美元的CERP项目，致力于努力根除外来入侵植物和恢复湿地的水流模式。

但这份新报告指出了该地区面临的另一些问题：自2000年以来，海平面上升了约7厘米，佛罗里达州南部预计到2100年海平面将上升0.8米。海水会产生复杂而矛

盾的影响。它会使植物根部退化，从而促进侵蚀，但也能阻止微生物分解植物，从而导致土壤堆积。但不断变化的侵蚀和涨潮模式可能会使CERP项目复杂化。

因此，报告说，考虑到气候变化的影响，CERP应该采用最新的气候模型，并任命一位独立的“大沼泽首席科学家”，以确保这些模型为所有CERP项目提供信息。

（来源：《中国科学报》 第3版 2018-10-24）

上海等四地率先完成水源地环境整治

生态环境部11月11日表示，从目前进展情况看，上海、宁夏、湖南、青海等4省份已率先完成水源地环境整治相关任务，并分别建立了完善的、适合本地特色的工作机制。内蒙古、河北、山东、浙江等11省份任务完成率达90％以上；四川、安徽、云南、海南等4省份任务完成率均在85％以上，达到进度要求。

从各地市完成情况看，在涉及的全国276个地市中，湖南长沙、山东日照等100个地市已全部完成相关整治任务。

不过，目前还有12个省份任务完成率未达进度要求，分别为天津、江苏、广东、北京等。一些地市水源地整治工作相对迟缓，如甘肃临夏、江西鹰潭、安徽阜阳、广东河源、江苏扬州等6个地市任务完成率低于50％。

生态环境部表示，距离今年年底不足60天，余下问题多是一些“硬骨头”，任务仍十分艰巨。在尚未完成整治任务的省份中，5省份剩余问题超过50个，依次是广东197个、江苏73个、云南73个、广西66个、江西65个，占剩余问题总数的60％。

（来源：科技日报 2018-11-12）

新技术加快改善雄安新区水环境质量

国家水专项“雄安新区国家水环境技术转化体系构建与综合示范”课题启动会12月13日在京举行。雄安新区生态环境局局长曹海波在会上表示，希望通过国家生态环境保护科技成果转化综合服务平台，筛选一批整装成套的技术，形成系统解决方案，为雄安新区建设和白洋淀治理工程提供支持。

白洋淀被称为“华北之肺”，近年来水质有所好转。据河北省环保厅于2016年6月公布的数据，白洋淀水质为劣Ⅴ类，重度污染；2017年2月、2018年10月，白洋淀水质均为Ⅳ类，轻度污染。但是雄安新区的建设和人口入住等，将带来较大的用水需求和环境压力。

“雄安新区国家水环境技术转化体系构建与综合示范”课题提出，以解决环境科技转化“最后一公里”的瓶颈为重点，开展水环境技术成果评估、二次开发、技

术交易、产业孵化等关键技术、平台建设和配套政策研究。

（来源：科技日报　2018-12-14）

保障丹江口库区水质重金属稳定达标

10月9日，国家水专项“丹江口库区小流域特色矿产重金属污染全过程控制关键技术研究与示范”课题负责人、北京科技大学能源与环境工程学院林海教授在接受科技日报记者专访时说，课题研发了入河特征重金属污染削减生态缓冲屏障技术等五大关键技术，实现了示范河段镉、汞、铅、砷、钒、铬重金属浓度稳定低于地表水Ⅱ类标准限值的目标。

“不像氨氮、有机物等污染物，重金属在环境中是无法自然降解的，会迁移、富集在生物体内，危害较大。”林海说。

于是，“十二五”国家水体污染控制与治理科技重大专项“南水北调工程水质安全保障关键技术研究与示范”项目中设置了“丹江口库区小流域特色矿产重金属污染全过程控制关键技术研究与示范”课题，由北京科技大学作为课题技术牵头单位。

该课题主要针对丹江口水库水源区特色支柱产业钒矿采选、加工过程带来的特征重金属污染问题，提出了“源头控制—清洁生产—过程阻控—末端治理—流域污染控制—目标管理”的研究思路，以重金属污染治理为目标，构建水源区钒矿采选加工全过程重金属污染控制技术体系。

“根据各特征重金属污染程度高低，通过不同重金属富集植物的最优搭配，可同时削减河道水体、岸边土壤及入河地表径流中多种重金属，特别适合于矿区河道重金属污染原位修复，同时开发出集挺水、浮水、沉水植物于一体的生态浮床等。拦截沟采用填充材料与微生物组合技术，在削减重金属污染负荷的同时延长填充材料更换周期，有效降低污染治理成本，降低入河重金属负荷。”林海说，示范工程实施后连续监测3个月发现，示范河段水质指标中重金属钒、铬、砷、镉、铅和汞污染浓度已稳定低于地表水Ⅱ类标准限值，实现了重金属污染控制水质的目标管理。

（来源：科技日报　2018-10-10）

云南高原湖泊过度开发洱海环湖生态频遭破坏

洱海位于云南大理州，是苍山洱海国家级自然保护区的重要组成部分，也是大理市集中式饮用水水源地。生态环境部22日对云南大理的洱海流域环境问题进行通报，认为大理州对洱海周边旅游无序开发管控不到位，矿山生态破坏问题整改不力，洱海环湖生态遭到破坏，洱海水质呈下降趋势。

监测数据显示，2017年，洱海部分污染物年均浓度较2015年上升，其中总磷上升27%、化学需氧量上升11%、总氮上升10%、综合营养状态指数上升8%、藻类细胞数上升68%、高锰酸盐指数上升9%。2016-2017年，洱海水质类别均评价为Ⅲ类，连续两年未达到水环境功能区Ⅱ类水质要求。

据统计，2013-2016年，洱海流域餐饮客栈出现“井喷”。洱海流域核心区内共排查在建违章建筑1084户、餐饮客栈2498户，其中1947户证照不齐。违章建筑和违规餐饮客栈，侵占大量洱海湖滨带，损害洱海生态环境。此外，2015-2016年，大理市审批环洱海拆旧建新高达4713户，为餐饮客栈无序发展推波助澜，导致大量生活污水直排环境，并出现了部分湖泊“边治理、边破坏”“居民退、房产进”等现象。

洱海流域大理石等矿产资源丰富。经排查，洱海流域内57家非煤矿山中，有9家违法生产、27家取缔关停不彻底、19家未开展生态恢复或恢复效果差。如大理市瑞泽建材厂凤翥页岩矿等企业，在已责令关停情况下，长期以“来料加工”之名行违法生产之实，以清理山体塌方为由擅自私挖盗采等。

在高原湖泊中，洱海的情况并非孤例。22日，中央第六环境保护督察组向云南省反馈“回头看”及专项督察情况，2016-2017年，除泸沽湖和抚仙湖外，包括洱海在内的其余7个高原湖泊，水质均未达到水环境功能区要求。并由于考核不严，导致一些工作难以落实到位，截至2018年5月底，洱海流域已建成的村落污水处理设施，约80%不能稳定达标排放。

中央环保督察反馈，九大高原湖泊“十三五”规划项目整体完工率仅20%。阳宗海应于2017年底前完工的环湖截污工程至今尚未建成，其服务范围内每天有6000余吨污水直排环境等。流域内农业面源污染尚未得到有效管控。大理、玉溪等市州未严格按云南省“十三五”生态农业发展规划要求调整种植业结构，洱海、抚仙湖、星云湖、杞麓湖等流域大蒜、蔬菜、花卉种植面积居高不下，面源污染问题突出。2017年洱海流域开展监测的12条农排沟出水总氮平均浓度超标4倍，其中团结沟总氮浓度最高超标21倍；纳入监测的12个主要入湖河流断面中，有6个不达标，严重影响洱海水质。

重金属污染是云南省面临的突出环境问题，也是督察的重点。中央环保督察反馈，文山州80万吨历史遗留砷渣无害化处置进展缓慢，红河州建水县政府及有关部门对违法行为长期失察，致使5000余吨铅锌冶炼废渣露天堆存，环境风险突出等。

（来源：光明网　2018-10-23）

科技助力 51 万尾土著鱼“回归”丽江程海

日前，云南永胜县程海湖2018年第三次增殖放流活动12月18日在丽江程海湖畔举行。当天，共向程海增殖放流51万尾土著鱼苗。

随着数十万尾鱼苗沿放流槽进入程海湖，人工繁育的大眼圆吻鲴、杞麓鲤两种程海土著鱼再次回归程海湖。这也是今年丽江市永胜县组织的第三次增殖放流活动和今年规模最大的增殖放流活动。

据永胜县程海管理局副局长张雷介绍，此次永胜县政府与负责土著鱼扩繁的创意工贸有限公司一起，配合中科院昆明动物研究所和云南省环境科学院，共同筹集资金100万元，增殖放流俗称为“红翅鱼”的圆吻鲴6万尾、杞麓鲤45万尾。今年举行的三次增殖放流活动中，已先后放流92万尾。

面对程海湖水生态环境的严峻形势，永胜县加快了程海湖水生态系统恢复，并积极探索“以鱼净水、以鱼养水、以鱼调水”的治理方式，土著鱼增殖放流活动将在恢复程海水生生物资源、维护生物多样性、改善水生态环境等方面起到积极作用。此前，永胜县得到了云南省科技厅、中国科学院昆明动物研究所、云南省环境科学院等单位的支持，苏州弘化社慈善基金会、永胜创意工贸有限公司等社会力量也积极参与其中，鱼种繁育工作取得了前所未有的成效。

中国科学院昆明动物研究所杨君兴研究员告诉记者，土著鱼是维系高原湖泊生态系统平衡的重要组成部分，它有助于水环境的调节与水体的净化，同时具有较高的经济价值。2016年以来，中科院昆明动物研究所给程海土著鱼种群的繁育无私地提供技术支持，已取得喜人效果，目前他们正开展7个极度濒危的程海土著鱼种的繁育工作。今后，他的研究团队还将争取各方面的支持，与当地政府与企业一道，共同实现云南程海土著鱼的规模化繁育，并分期分批放流到程海，让原本已在湖体消失的土著鱼“参与”高原湖泊治理，并成为当地旅游业的新“招牌”。

（来源：科技日报　2018-12-21）

洞庭湖—琵琶湖水生态可持续发展对话会在长沙召开

11 月 13 日，“洞庭湖——琵琶湖水生态可持续发展对话会”在长沙召开，旨在深化湘滋政府部门、社会组织、企业、学术界之间建立的对话机制，总结并宣传 5 年来涉水科技合作成效，为“一湖四水”水生态环境的改善和提升发挥科技引领和支撑作用。

湖南省副省长陈飞、滋贺县知事三日月大造、日本国际协力机构(JICA)中国事务所所长中里太治出席开幕式并致辞，湖南省政协副主席、省科技厅厅长赖明勇主持。滋贺县议会议长川岛隆二与湖南师大附中博才实验中学刘雨薇同学共同宣读了《“洞庭湖——琵琶湖”母亲湖保护行动倡议》。

陈飞表示，湖南与滋贺以“湖”为缘而结为友好省县关系的三十五年来，在两省县政府和民间的不懈努力下，双方交流频繁，经贸、教育、文化、科技、环保等领域合作成效明显，结下了深厚的友谊。现在，两省县又以“湖”“水”为平台，

围绕水生态与环保农业主题，如何进一步优化水生态，抓好水经济，加快构建开放型经济发展新格局，积极推进交流合作，实现互利双赢。

会议主旨报告和专题报告阶段，来自水利部科技推广中心、亚欧水资源研究和利用中心、滋贺县琵琶湖环境部、滋贺县琵琶湖环境科学研究中心、滋贺县立大学等中日双方的 11 名专家就湖泊水生态环境的创新管理、政策措施、治理技术、环保意识提升等方面，作了学术报告和经验分享，与会代表也广泛参与并交流互动，共同为湖泊水生态可持续发展提出了很好的意见、建议与解决方案。

与此同时，会议嵌入湖南水资源问题，也是深入贯彻落实生态文明建设、长江经济带建设、洞庭湖生态经济区等国家战略，深化推进“一湖四水”生态保护行动的务实举措。两省县共同搭建的“母亲湖”保护科技合作论坛这一交流平台，将为“母亲湖”生态保护及其环保产业方面提供有力的科技支撑，也将为全球湖泊水生态可持续发展提供经验借鉴和典范作用。

本次会议由湖南省人民政府、滋贺县主办，湖南省科学技术厅、湖南省政府外事侨务办公室、亚欧水资源研究和利用中心、日本滋贺县琵琶湖环境部、日本滋贺县商工观光劳动部、日本滋贺县琵琶湖环境科学研究中心共同承办。

（来源：http://www.czt.gov.cn，2018-11-13）