湖泊科学动态

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- ***Science*** 文章：地质学数据为中国传说中的大洪水提供支持
- UNESCO 发布《2016 年世界水资源发展报告-水与就业》
- GRACE 卫星首次揭示青藏高原及周边多地区地下水增加
- 水污染防治行动计划投资超 4300 亿

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热点文章

➢ Climate warming reduces fish production and benthic habitat in Lake Tanganyika, one of the most biodiverse freshwater ecosystems

Andrew S. Cohen; Elizabeth L. Gergurich; Benjamin M. Kraemer; et al.

Warming climates are rapidly transforming lake ecosystems worldwide, but the breadth of changes in tropical lakes is poorly documented. Sustainable management of freshwater fisheries and biodiversity requires accounting for historical and ongoing stressors such as climate change and harvest intensity. This is problematic in tropical Africa, where records of ecosystem change are limited and local populations rely heavily on lakes for nutrition. Here, using a ~1,500-y paleoecological record, we show that declines in fishery species and endemic molluscs began well before commercial fishing in Lake Tanganyika, Africa's deepest and oldest lake. Paleoclimate and instrumental records demonstrate sustained warming in this lake during the last ~150 y, which affects biota by strengthening and shallowing stratification of the water column. Reductions in lake mixing have depressed algal production and shrunk the oxygenated benthic habitat by 38% in our study areas, yielding fish and mollusc declines. Late-20th century fish fossil abundances at two of three sites were lower than at any other time in the last millennium and fell in concert with reduced diatom abundance and warming water. A negative correlation between lake temperature and fish and mollusc fossils over the last ~500 y indicates that climate warming and intensifying stratification have almost certainly reduced potential fishery production, helping to explain ongoing declines in fish catches. Long-term declines of both benthic and pelagic species underscore the urgency of strategic efforts to sustain Lake Tanganyika's extraordinary biodiversity and ecosystem services.

（来源：PNAS, 2016, 113 (34): 9563-9568）

中文点评：

坦噶尼喀湖的捕鱼量与气候变暖

一项研究发现，持续的气候变暖正在减少非洲坦噶尼喀湖的捕鱼量，这个湖是一个关键的生态系统，为该地区提供了至多 60% 的动物蛋白。位于非洲中部的坦噶尼喀湖每年出产 20 多万吨鱼，它对于该地区的居民来说，是一个关键的蛋白质来源。尽管报告中渔业生产力的衰退反映了诸如过度捕鱼、森林砍伐以及水温上升等因素，几乎没有研究对这些变化进行记录并得出因果联系。Andrew Cohen 及其同事分析了来自这个湖的沉积物岩芯，并且构建出了一个大约 1500 年的古气候学记录，它是追踪温度和藻类与鱼类生产的关键替代指标。这个记录表明，持续的变暖与该湖的混合减少、藻类生产的停滞以及这个湖的软体动物和甲壳纲动物等关键底栖动物的氧合栖息地缩小了 38% 存在关联。此外，由于过去 500 年间该湖的温度增加与鱼类和软体动物化石数量的减少具有相关性，气候变化与这个湖的湖泊分层很可能对目前捕鱼量的衰退以及支持该湖生物多样性的关键栖息地濒临危险具有相关性。这项研究证明了气候变化对热带湖泊生态系统的影响，并且提出，急需实施干预措施从而维持

坦噶尼喀湖对这个地区的重要贡献。

（来源：http://zh.eurekalert.org/ 2016-08-09）

➢ Outburst flood at 1920 BC supports historicity of China's Great Flood and the Xia dynasty

Q Wu; Z Zhao; L Liu; et al.

China's historiographical traditions tell of the successful control of a Great Flood leading to the establishment of the Xia dynasty and the beginning of civilization. However, the historicity of the flood and Xia remain controversial. Here, we reconstruct an earthquake-induced landslide dam outburst flood on the Yellow River about 1920 BCE that ranks as one of the largest freshwater floods of the Holocene and could account for the Great Flood. This would place the beginning of Xia at ~1900 BCE, several centuries later than traditionally thought. This date coincides with the major transition from the Neolithic to Bronze Age in the Yellow River valley and supports hypotheses that the primary state-level society of the Erlitou culture is an archaeological manifestation of the Xia dynasty.

（来源：SCIENCE, 2016, 353(6299):579-582）

中文点评:

地质学数据为中国传说中的大洪水提供了支持

大禹治水传说中的大洪水是黄河流域的一次灾难性事件，夏朝被认为就是在该事件后诞生的。这次洪灾大约发生在公元前 1920 年，这一事件比传统上认为的要晚了几个世纪——这意味着夏朝及其著名君主大禹所开创的时代也可能比中国史学家所认为的要晚。根据中国的传说，大禹因治理洪水而名闻遐迩。Wu Qinglong 等认为，通过疏通，大禹驯服了具有破坏性的洪水，“这让他赢得了建立夏朝的天命...并标志着中国文明的开始。”大禹的故事在流传了一千年后被写入历史，然而，却一直找不到有关他治理洪水的地质学证据。

2016 年 8 月 5 日，学术期刊《科学》发表文章，为大禹传说中的大洪水提供了地质学证据。Wu Qinglong 研究团队在此通过重构沿着黄河发生的一系列事件（包括由山体滑坡所生成的偃塞湖及其堤坝溃决等）为一场洪水浩劫提供了地质学证据，这些证据或能成为大洪水的依据。研究人员对青海省某个堤坝下游在溃决时所留下的沉积物进行了绘测及年代测定。通过进一步的研究，他们确定，冲破堤坝的洪水势头巨大。用放射性碳测年技术对包括人骨在内的标本进行检测，他们将该洪水发生的年代定在公元前 1920 年。作者们说：“该洪水与古籍中描述的大洪水的主要特点有共同之处。”如果他们所测定的洪水确实是“大洪水”事件，那么，研究人员提出，夏朝开始的新的时间将是公元前 1900 年。这一日期不仅与黄河流域从新石器时代到青铜时代的重大过渡时间吻合（从而可能解决一个在中国历史上长期存在的有关夏朝开始时间与历史上这一重要时期之间关系的矛盾），而且它也与二里头文化开始的时间吻合；二里头文化是中国青铜器早期的主要文明，从而支持该文明是夏朝考古遗迹的论点。总之，结果揭示，这些重大的自然与社会政治事件在时间上的吻合可能成为一个

例证，即极端自然灾害将沿黄河居住的许多人群连在一起，他们对一场灾难做出了深刻、复杂的文化反应。

（来源：http://zh.eurekalert.org/ 2016-08-05）

摘要精选

The size-distribution of Earth's lakes

B. B. Cael; D. A. Seekell

Globally, there are millions of small lakes, but a small number of large lakes. Most key ecosystem patterns and processes scale with lake size, thus this asymmetry between area and abundance is a fundamental constraint on broad-scale patterns in lake ecology. Nonetheless, descriptions of lake size-distributions are scarce and empirical distributions are rarely evaluated relative to theoretical predictions. Here we develop expectations for Earth's lake area-distribution based on percolation theory and evaluate these expectations with data from a global lake census. Lake surface areas $\geqslant$8.5 km^2 are power-law distributed with a tail exponent ($\tau = 1.97$) and fractal dimension ($d = 1.38$), similar to theoretical expectations ($\tau = 2.05$; $d = 4/3$). Lakes <8.5 km^2 are not power-law distributed. An independently developed regional lake census exhibits a similar transition and consistency with theoretical predictions. Small lakes deviate from the power-law distribution because smaller lakes are more susceptible to dynamical change and topographic behavior at sub-kilometer scales is not self-similar. Our results provide a robust characterization and theoretical explanation for the lake size-abundance relationship, and form a fundamental basis for understanding and predicting patterns in lake ecology at broad scales.

（来源：SCIENTIFIC REPORTS, 2016, doi:10.1038/srep29633）

A lake data set for the Tibetan Plateau from the 1960s, 2005, and 2014

Wei Wan; Di Long; Yang Hong, et al.

Long-term datasets of number and size of lakes over the Tibetan Plateau (TP) are among the most critical components for better understanding the interactions among the cryosphere, hydrosphere, and atmosphere at regional and global scales. Due to the harsh environment and the scarcity of data over the TP, data accumulation and sharing become more valuable for scientists worldwide to make new discoveries in this region. This paper, for the first time, presents a comprehensive and freely available data set of lakes' status (name, location, shape, area, perimeter, etc.) over the TP region dating back to the 1960s, including three time series, i.e., the 1960s, 2005, and 2014, derived from ground survey (the 1960s) or high-spatial-resolution satellite images from the China-Brazil Earth Resources Satellite (CBERS) (2005) and China's newly launched GaoFen-1 (GF-1, which means high-resolution images in Chinese) satellite (2014). The data set could provide scientists with useful information for revealing environmental changes and mechanisms over the TP region.

（来源：SCIENTIFIC DATA, 2016, doi:10.1038/sdata.2016.39）

Erosion and deposition within Poyang Lake: evidence from a decade of satellite data

Zhang, Siyu; Liu, Yongxue; Yang, Yuhao; et al.

Poyang Lake, an important wetland in the Ramsar Convention List, is the largest freshwater lake in China and an essential component of the Yangtze River system. The lake is increasingly experiencing serious water crises including seasonal desiccation, decreased wetland area, and water shortages, all of which are closely related to progressive changes in the lake's topography over recent years. Atime-series of bottom topography would contribute to our understanding of the lake's evolution during the past several decades. However, quality bathymetric data for Poyang Lake are scarce owing to the highly dynamic and turbid nature of its water. To resolve this limitation, we used a total of 146 medium-resolution satellite images to build annual and quasi-annual bottom topography maps of Poyang Lake during the period from 2000 to 2010 based on the well-established waterline method. Our results show that: (1)the average elevation of the lakebed relative to sea level has decreased by 14.4 cm/yr. from 2000 to 2010; and (2)the observed annual changes in the lakebed elevation were well correlated (r = 0.84) with measured changes in the lake's annual net sediment flux. The observed trends may be attributed to the impacts of human activities, especially the operation of the Three Gorge Dams, frequent sand mining, and the implementation of a large water conservancy project. This decade-long quantitative understanding of the lake's evolution and bottom topography elevations might assist both researchers and local policymakers in ecological management, wetland protection, and lake navigation safety.

（来源：JOURNAL OF GREAT LAKES RESEARCH, 2016, 42(2): 364-374）

Development of a mobile phone application for the prediction of harmful algal blooms in inland lakes

Gotthold, J. P.; Deshmukh, A.; Nighojkar, V.; et al.

Harmful algal blooms mainly caused by cyanobacteria in freshwater ecosystems often present a health risk to the public within eutrophied shallow lakes due to algal toxins released into the water during the final stage of an algal bloom. Thus, algal growth should be carefully monitored during the summer season, especially in frequented recreational areas. Traditionally, water samples must be sent to a lab to analyze the data to predict algal blooms, costing time and money. Models on a smartphone predicting harmful algal blooms from easily measurable parameters could help individuals to take precautionary measures in order to prevent health risks from drinking and bathing in water and help to raise public awareness. In this work we present a mobile smartphone application that generates a prediction of the likelihood of an algal bloom from a variety of easily-measured input parameters that could be obtained by an informed smartphone user with simple instruments. Our model was implemented in an Android mobile phone application using App Inventor. The model we use is based on the Verhulst equation and allows users to enter any of the following measurements to predict and algal bloom: surface temperature, inverse Secchi depth, dissolved oxygen (DO) at the surface, and chlorophyll fluorescence (Chl-a).

Our model was developed using a data set by weekly sampling of eutrophication parameters (temperature, conductivity, DO, phosphate, ammonia, nitrite, nitrate, Chl-a, Secchi depth) during the summer season of 2013 (June-October) from a shallow lake situated in a recreational area within the town of Wolfenbuttel, Germany. Temperature differences within water depth layers were observed in mid-June, then partial circulation of the upper three water layers was reached in mid-August until

temperatures gradually reached equilibrium at the beginning of August (full circulation). This coincided with full development of algal bloom (cyanobacterial Chl-a values reaching 40 mu g L-1), Secchi depth values below 0.6 m and a sharp drop in phosphate and ammonia levels within the bottom water layer. Thus, phosphate concentration at lake bottom, temperature difference between water layers, and surface temperature were recognized as valuable parameters for a simple prediction model of harmful algal growth based on the Verhulst equation N-t = N-0 + (k-N-0)*exp(-r(0)*t). A partial least square analysis revealed parameters for estimation of chlorophyll fluorescence (total Chl-a (mu g L-1) = -6.4775 + 21.6396 * inverse Secchi depth (m) + 0.0006 * square (DO surface (%); r(2) = 0.69) as well as cyanobacterial chlorophyll fluorescence (cyanobacterial Chl-a (mu g L-1) = 0.409-0.7486 * surface temperature (degrees C) + 17.6979 * inverse Secchi depth (m); r(2) = 0.76) from this data set. From these datasets and models, we created a single model that uses Secchi depth in combination with either DO or temperature at the surface to predict algae blooms..

（来源：FUNDAMENTAL AND APPLIED LIMNOLOGY, 2016, 188(1): 1-17）

Verification of a simple band ratio algorithm for retrieving Great Lakes open water surface chlorophyll concentrations from satellite observations

Lesht, Barry M.; Barbiero, Richard P.; Warren, Glenn J.

We compared in situ surface chlorophyll concentration values measured between 2012 and 2015 as part of the U.S. Environmental Protection Agency's Great Lakes National Program Office (GLNPO) annual monitoring program with corresponding concentration estimates obtained by applying our previously published (Lesht et al., 2013) Great Lakes Fit (GLF) band ratio algorithm to data from the Moderate-resolution Imaging Spectroradiometer (MODIS) sensor. Coefficients used in the original GLF algorithm were derived from similarly matched GLNPO and satellite observations collected between 2002 and 2011. The Model II linear relationship between the original GLF-predicted log-transformed values and the new set (2012-2015) of field observations yielded intercept = 0.036, slope = 1.063, and r(2) = 0.830. Residuals for modeled chlorophyll concentrations below similar to 8.0 mg m(-3) were unbiased and normally distributed, but positively biased at higher modeled concentrations. When applied to the entire dataset (2002-2015), the linear relationship between the GLF-modeled and the observed values had intercept = 0.000, slope = 0.999, and r(2) = 0.820. New model coefficients derived from the entire (2002-2015) dataset were very similar to those obtained from the 2002-2011 data. Continual testing and assessment of any empirical model are desirable especially when the model is designed to be employed by a broad community. We conclude that this comparison of the GLF algorithm with the additional four years of independent data further validates its use for estimating surface chlorophyll concentrations from satellite observations of the open waters of the Great Lakes.

（来源：JOURNAL OF GREAT LAKES RESEARCH, 2016, 42(2): 448-454）

Hydrological drivers of record-setting water level rise on Earth's largest lake system

Gronewold, A. D.; Bruxer, J.; Durnford, D.; et al.

Between January 2013 and December 2014, water levels on Lake Superior and Lake Michigan-Huron, the two largest lakes on Earth by surface area, rose at the highest rate ever recorded for a 2 year period beginning in January and ending in December of the following year. This historic event coincided with below-average air temperatures and extensive winter ice cover across the Great Lakes. It also brought an end to a 15 year period of persistently below-average water levels on Lakes Superior and Michigan-Huron that included several months of record-low water levels. To differentiate hydrological drivers behind the recent water level rise, we developed a Bayesian Markov chain Monte Carlo (MCMC) routine for inferring historical estimates of the major components of each lake's water budget. Our results indicate that, in 2013, the water level rise on Lake Superior was driven by increased spring runoff and over-lake precipitation. In 2014, reduced over-lake evaporation played a more significant role in Lake Superior's water level rise. The water level rise on Lake Michigan-Huron in 2013 was also due to above-average spring runoff and persistent over-lake precipitation, while in 2014, it was due to a rare combination of below-average evaporation, above-average runoff and precipitation, and very high inflow rates from Lake Superior through the St. Marys River. We expect, in future research, to apply our new framework across the other Laurentian Great Lakes, and to Earth's other large freshwater basins as well.

（来源：WATER RESOURCES RESEARCH, 2016, 52(5):4026-4042）

In-situ erosion of cohesive sediment in a large shallow lake experiencing long-term decline in wind speed

Wu, Tingfeng; Timo, Huttula; Qin, Boqiang; et al.

In order to address the major factors affecting cohesive sediment erosion using high-frequency in-situ observations in Lake Taihu, and the response of this erosion to long-term decline in wind speed, high frequency meteorological, hydrological and turbidity sensors were deployed to record continuous field wind-induced wave, current and sediment erosion processes; Statistical analyses and mathematic modeling spanning 44 years were also conducted. The results revealed that the unconsolidated surficial cohesive sediment frequently experiences the processes of erosion, suspension and deposition. Wind waves, generated by the absorption of wind energy, are the principal force driving this cycle. When the wavelength-to-water depth ratio (L/D) is 2-3, wave propagation is affected by lakebed friction and surface erosion occurs. When L/D > 3, the interaction between wave and lakebed increases to induce massive erosion. However, influenced by rapid urbanization in the Lake Taihu basin, wind speed has significantly decreased, by an average rate of -0.022 m s(-1) a(-1), from 1970 to 2013. This has reduced the erodible area, represented by simulated L/D, at a rate of -16.9 km(2) a(-1) in the autumn and winter, and -8.1 km(2) a(-1) in the spring and summer. This significant decrease in surface erosion area, and the near disappearance of areas experiencing massive erosion, imply that Lake Taihu has become calmer, which can be expected to have adverse effects on the lake ecosystem by increasing eutrophication and nuisance cyanobacteria blooms.

（来源：JOURNAL OF HYDROLOGY, 2016, 539:254-264）

Movements of the thermocline lead to high variability in benthic mixing in the nearshore of a large lake

Chowdhury, Mijanur R.; Wells, Mathew G.; Howell, Todd

The thermocline of Lake Ontario is in constant motion, and as it washes back and forth along the sloping lakebed there is a striking asymmetry in near-bed stratification and benthic turbulence between its rise and fall. Detailed field observations of the stratification and water currents from the summers of 2012 and 2013 showed that the thermocline motions had large amplitudes (as high as 15 m) and a dominant period between 16 and 17.5 h, corresponding to a near -inertial internal Poincare wave. During the falling phase, the warmer down-slope flow was strongly stratified with near -bed water temperature gradients of m(-1). In contrast during the rising phase of colder up-slope flow, there was an unstable stratification in near -bed water and large temperature overturns due to the differential advection of stratified waters, i.e., the shear -driven convective mechanism. Using a Thorpe-scale analysis of overturns, the inferred turbulent diffusivity during the up-slope flow was ic 5 x 10-4 m(2) s l. In striking contrast during the down -slope flow, the strong stratification had lower turbulent diffusivities of KZ -10(-6) m2 s(-1). The near bottom region of Lake Ontario within the thermocline swash-zone has intense biological activity and the highest concentrations of invasive dreissenid mussels. We discuss the potential biological implications of the striking variability in benthic mixing and near -bed stratification for nutrient cycling in the Lake Ontario nearshore.

（来源：WATER RESOURCES RESEARCH, 2016, 52(4): 3019-3039）

Can lake sensitivity to desiccation be predicted from lake geometry?

Haghighi, Ali Torabi; Menberu, Meseret Walle; Aminnezhad, Mousa; et al.

Declining lake levels (Aral Sea syndrome) can be caused by changes in climate, increased water use or changed regulation patterns. This paper introduces a novel lake geometry index (LGI) to quantify lake hydrological characteristics. The index was developed using a large representative dataset of lake hypsographic characteristics from 152 lakes and man-made reservoirs. Using the LGI index, lakes can be classified into five groups: groups 1-4 when LGI is 0.5-2.5, 2.5-4.5, 4.5-6.5 and 6.5-8.5, respectively, and group 5 when LGI is >8.5. Naturally shallow and vast lakes and wetlands fall into the first group and deep man-made reservoirs in narrow valleys are in group 5. The response of three different lake systems (LGI 0.75, 2.75 and 6.5) to different water flow scenarios was then simulated using the water balance equation. From this, the index 'potential lake area' (A(pot)) was developed to show lake responses to changed hydro-climatological conditions. A(pot) and LGI can be used to classify lakes into open or closed systems. Simulations showed that lakes with low LGI have a shorter response time to flow and climate changes. As a result, the impact of water balance restoration is faster for lakes with low LGI than for lakes with high LGI. The latter are also more vulnerable to climate variation and change.

（来源：JOURNAL OF HYDROLOGY, 2016, 539:599-610）

Fluctuations of Lake Orta water levels: preliminary analyses

Saidi, Helmi; Dresti, Claudia; Ciampittiello, Marzia

While the effects of past industrial pollution on the chemistry and biology of Lake Orta have been well

documented, annual and seasonal fluctuations of lake levels have not yet been studied. Considering their potential impacts on both the ecosystem and on human safety, fluctuations in lake levels are an important aspect of limnological research. In the enormous catchment of Lake Maggiore, there are many rivers and lakes, and the amount of annual precipitation is both high and concentrated in spring and autumn. This has produced major flood events, most recently in November 2014. Flood events are also frequent on Lake Orta, occurring roughly triennially since 1917. The 1926, 1951, 1976 and 2014 floods were severe, with lake levels raised from 2.30 m to 3.46 m above the hydrometric zero. The most important event occurred in 1976, with a maximum level equal to 292.31 m asl and a return period of 147 years. In 2014 the lake level reached 291.89 m asl and its return period was 54 years. In this study, we defined trends and temporal fluctuations in Lake Orta water levels from 1917 to 2014, focusing on extremes. We report both annual maximum and seasonal variations of the lake water levels over this period. Both Mann-Kendall trend tests and simple linear regression were utilized to detect monotonic trends in annual and seasonal extremes, and logistic regression was used to detect trends in the number of flood events. Lake level decreased during winter and summer seasons, and a small but statistically non-significant positive trend was found in the number of flood events over the period. We provide estimations of return period for lake levels, a metric which could be used in planning lake flood protection measures.

（来源：JOURNAL OF LIMNOLOGY, 2016, 75(S2):86-92）

What have we learned about ecological recovery from liming interventions of acid lakes in Canada and Italy?

Manca, Marina M.; Bonacina, Carla; Yan, Norman D.

The idea of launching another special issue of the Journal of Limnology on Lake Orta was born in 2014, on the 25th anniversary of its liming intervention, during an International Symposium on Lake Orta organized and hosted by the Pallanza Institute (http://www.ise.cnr.it/vb). The conference did not simply celebrate the past. While the liming of Lake Orta was undoubtedly a great national and international success, the speakers at the conference, instead sought to enlarge and deepen knowledge of patterns and mechanisms of lake ecosystem responses to the water quality improvements, or chemical recovery, that accompanied Lake Orta's liming.

（来源：JOURNAL OF LIMNOLOGY, 2016, 75(S2):1-3）

Giant ice rings on lakes Baikal and Hovsgol: Inventory, associated water structure and potential formation mechanism

Kouraev, Alexei V.; Zakharova, Elena A.; Remy, Frederique; et al.

Observations of giant ice rings on Lake Baikal (Russia) have recently sparked scientific and public interest. However, there is still no clear consensus on their origins. Here, we provide an inventory of the ice rings based on satellite imagery and photography for 1974-2014. We have identified 45 rings on Lake Baikal (compared with 13 previously known) and also for the first time four rings for the neighbouring Lake Hovsgol (Mongolia). The results of our hydrographic surveys beneath the ice rings in Lake Baikal in 2012-2014 and in Lake Hovsgol in 2015 show the presence of warm double-convex lens-like eddies

before and during manifestation of ice rings. We suggest that these eddies are the driving factor for the formation of ice rings in these lakes. We reassess the existing hypotheses of ice ring formation and discuss the potential mechanisms of eddy formation.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2016, 61(3):1001-1014）

A critical perspective on geo-engineering for eutrophication management in lakes

Lurling, Miquel; Mackay, Eleanor; Reitzel, Kasper; et al.

Eutrophication is the primary worldwide water quality issue. Reducing excessive external nutrient loading is the most straightforward action in mitigating eutrophication, but lakes, ponds and reservoirs often show little, if any, signs of recovery in the years following external load reduction. This is due to internal cycling of phosphorus (P). Geo-engineering, which we can here define as activities intervening with biogeochemical cycles to control eutrophication in inland waters, represents a promising approach, under appropriate conditions, to reduce P release from bed sediments and cyanobacteria accumulation in surface waters, thereby speeding up recovery. In this overview, we draw on evidence from this special issue Geoengineering in Lakes, and on supporting literature to provide a critical perspective on the approach. We demonstrate that many of the strong P sorbents in the literature will not be applicable in the field because of costs and other constraints. Aluminium and lanthanum modified compounds are among the most effective compounds for targeting P. Flocculants and ballast compounds can be used to sink cyanobacteria, in the short term. We emphasize that the first step in managing eutrophication is a system analysis that will reveal the main water and P flows and the biological structure of the waterbody. These site specific traits can be significant confounding factors dictating successful eutrophication management. Geo-engineering techniques, considered collectively, as part of a tool kit, may ensure successful management of eutrophication through a range of target effects. In addition, novel developments in modified zeolites offer simultaneous P and nitrogen control. To facilitate research and reduce the delay from concept to market a multi-national centre of excellence is required.

（来源：WATER RESEARCH, 2016, 97(SI):1-10）

Sustainability analysis of the management approach for six New Zealand lakes

Jenkins, Bryan

This paper describes a methodology for sustainability analysis based on failure pathways that can lead to the loss of system sustainability. For these failure pathways, critical variables can be identified by threshold values that define when the system changes from its sustainable state. The methodology also considers any management interventions being undertaken to address failure pathways and whether the extent of intervention is adequate to ensure the critical variables for the failure pathways remain below their threshold values. This methodology was then applied to the current management approaches for 6 New Zealand lakes: Lake Taupo, Lake Brunner, Lake Rotorua, Lake Omapere, Te Waihora/Lake Ellesmere, and Waituna Lagoon. Although diffuse nutrient pollution from land use intensification is affecting water quality of all of the lakes, the analysis identifies different failure pathways and different

critical variables, implying the need for different management interventions to achieve desired water quality outcomes. Overall findings were (1) that all lakes will require reductions in land use intensification in their catchments to achieve sustainable water quality; (2) there is evidence of positive innovations that could potentially improve water quality; and (3) the level of management intervention is insufficient to achieve the desired water quality objectives for the lakes.

（来源：LAKE AND RESERVOIR MANAGEMENT, 2016, 32(2): 101-115）

Temporal and spatial dynamics of large lake hypoxia: Integrating statistical and three-dimensional dynamic models to enhance lake management criteria

Bocaniov, Serghei A.; Scavia, Donald

Hypoxia or low bottom water dissolved oxygen (DO) is a world-wide problem of management concern requiring an understanding and ability to monitor and predict its spatial and temporal dynamics. However, this is often made difficult in large lakes and coastal oceans because of limited spatial and temporal coverage of field observations. We used a calibrated and validated three-dimensional ecological model of Lake Erie to extend a statistical relationship between hypoxic extent and bottom water DO concentrations to explore implications of the broader temporal and spatial development and dissipation of hypoxia. We provide the first numerical demonstration that hypoxia initiates in the nearshore, not the deep portion of the basin, and that the threshold used to define hypoxia matters in both spatial and temporal dynamics and in its sensitivity to climate. We show that existing monitoring programs likely underestimate both maximum hypoxic extent and the importance of low oxygen in the nearshore, discuss implications for ecosystem and drinking water protection, and recommend how these results could be used to efficiently and economically extend monitoring programs.

（来源：WATER RESOURCES RESEARCH, 2016, 52(6):4247-4263）

Homogenised daily lake surface water temperature data generated from multiple satellite sensors: A long-term case study of a large sub-Alpine lake

Sajid Pareeth; Nico Salmaso; Rita Adrian; et al

Availability of remotely sensed multi-spectral images since the 1980's, which cover three decades of voluminous data could help researchers to study the changing dynamics of bio-physical characteristics of land and water. In this study, we introduce a new methodology to develop homogenised Lake Surface Water Temperature (LSWT) from multiple polar orbiting satellites. Precisely, we developed homogenised 1 km daily LSWT maps covering the last 30 years (1986 to 2015) combining data from 13 satellites. We used a split-window technique to derive LSWT from brightness temperatures and a modified diurnal temperature cycle model to homogenise data which were acquired between 8:00 to 17:00 UTC. Gaps in the temporal LSWT data due to the presence of clouds were filled by applying Harmonic ANalysis of Time Series (HANTS). The satellite derived LSWT maps were validated based on long-term monthly in-situ bulk temperature measurements in Lake Garda, the largest lake in Italy. We found the satellite derived homogenised LSWT being significantly correlated to in-situ data. The new LSWT time series

showed a significant annual rate of increase of 0.020 °C yr−1 (*P < 0.05), and of 0.036 °C yr−1 (***P < 0.001) during summer.

（来源：SCIENTIFIC REPORTS, 2016, doi:10.1038/srep31251）

Responses to a warming trend and "El Nio" events in a tropical lake in western Mexico

Caballero, Margarita; Vazquez, Gabriela; Ortega, Beatriz; et al.

Lakes are sensitive ecosystems to climatic change but in the tropics it is frequently difficult to evaluate as there are few long-term records. In this paper hydrochemistry and phytoplankton data during the 2009-2010 "El Nio" are contrasted with non-"El Nio" conditions (pre- and post- the 2009-2010 event) and with long-term (23 years) meteorological and paleolimnological data from a lake in eastern Mexico. Meteorological data provide evidence of a recent (since year 2000) warming trend, and paleolimnological data show that the diatom assemblage changed at this time to a more diverse association, including low abundances of a small Cyclotella species (C. ocellata) and a small needle shaped species (Fragilaria nanana) to the previously dominant assemblage (Ulnaria delicatissima, Achnanthidium minutissimum). Phytoplankton associations during non-"El Nio" are consistent with the paleolimnological record (U. delicatissima-A. minutissimum, + Staurastrum sp.) but they changed at the onset of "El Nio" (May 2009), when N and P co-limitation favoured a Coelastrum reticulatum-C. ocellata assemblage. During "El Nio" winter (February 2010) colder temperatures led to a longer mixing period and a whole water column deoxygenation event that favoured a particularly low diversity association (Botryococcus sp.-Sphaerocystis sp.). The low diversity C. ocellata-bloom has no precedent for the last 23 years. The previous 1998-1999 "El Nio" had a similar low diversity assemblage but dominated by U. delicatissima. The different response of the phytoplankton to the two "El Nio" events is related with the warmer conditions since the year 2000, that lead to more stable stratification periods and more frequent or intense nutrient limitation, particularly during the warmer than average "El Nio" 2009-2010 summer. Under a global warming scenario, minor changes in ecosystem's base levels determine that even normal climatic variability events can cause unexpected changes in the ecosystem's diversity and species composition.

（来源：AQUATIC SCIENCES, 2016, 78(3):591-604）

Geospatial modeling approach to monument construction using Michigan from A.D. 1000–1600 as a case study

Meghan C. L. Howey; Michael W. Palace; Crystal H. McMichael.

Building monuments was one way that past societies reconfigured their landscapes in response to shifting social and ecological factors. Understanding the connections between those factors and monument construction is critical, especially when multiple types of monuments were constructed across the same landscape. Geospatial technologies enable past cultural activities and environmental variables to be examined together at large scales. Many geospatial modeling approaches, however, are not designed for presence-only (occurrence) data, which can be limiting given that many archaeological site records are presence only. We use maximum entropy modeling (MaxEnt), which works with

presence-only data, to predict the distribution of monuments across large landscapes, and we analyze MaxEnt output to quantify the contributions of spatioenvironmental variables to predicted distributions. We apply our approach to co-occurring Late Precontact (ca. A.D. 1000-1600) monuments in Michigan: (i) mounds and (ii) earthwork enclosures. Many of these features have been destroyed by modern development, and therefore, we conducted archival research to develop our monument occurrence database. We modeled each monument type separately using the same input variables. Analyzing variable contribution to MaxEnt output, we show that mound and enclosure landscape suitability was driven by contrasting variables. Proximity to inland lakes was key to mound placement, and proximity to rivers was key to sacred enclosures. This juxtaposition suggests that mounds met local needs for resource procurement success, whereas enclosures filled broader regional needs for intergroup exchange and shared ritual. Our study shows how MaxEnt can be used to develop sophisticated models of past cultural processes, including monument building, with imperfect, limited, presence-only data.

（来源：PNAS, 2016, 113(27):7443-7448）

Combining lake core records with the limnologic model DYRESM-CAEDYM to evaluate lakeresponse during the Little Ice Age and Medieval Climate Anomaly

Bracht-Flyr, Brandi; Fritz, Sherilyn C

The Little Ice Age and Medieval Climate Anomaly are two climatic intervals within the last 2000 years that had distinctive conditions in many North American paleoclimate reconstructions. During each of these intervals, the Crevice Lake, Montana paleorecord shows distinctive limnological characteristics inferred from fossil diatoms that reflect changes in temperature seasonality and lake thermal structure. A thermodynamic-ecological model, DYRESM-CAEDYM, was used to estimate climatic conditions during these time intervals and to explore the potential for linking paleo-records with lake models to evaluate the dynamic interactions of environmental variables in influencing diatom populations over time. The model effectively simulates the timing and distribution of Stephanodiscus and Cyclotella populations evident in the modern Crevice Lake observational data. In sensitivity tests altering multiple weather inputs had a greater effect on lake temperature isotherm patterns compared with changing only single variables, which suggests the interactive effect of multiple climate variables in affecting lake thermal structure. The model simulations show the importance of the rate of climate change in affecting lake thermal structure and diatom community structure, particularly during spring and early summer. The model also provides constraints on the range of changes in solar radiation, temperature, and wind speeds that may have produced the diatom communities characteristic of the Medieval Climate Anomaly, Little Ice Age, and contemporary times.

（来源：JOURNAL OF PALEOLIMNOLOGY, 2016, 56(1): 79-92）

Quantitative paleolimnological inference models applied to a high-resolution biostratigraphic study of lake degradation and recovery, Onondaga Lake, New York (USA)

Rowell, H. Chandler; Enache, Mihaela D.; Quinlan, Roberto; et al.

Once considered one of North America's most polluted lakes, today Onondaga Lake, New York, USA has surface-water quality last seen prior to 1900. Paleolimnological inference models based on the remains of diatoms and chironomids in an annually dated sediment core were used to reconstruct quantitatively the post-1700 history of phosphorus, specific conductance, and volume-weighted hypolimnetic oxygen levels in the lake. Ostracode and sediment chemical analyses contributed to a detailed interpretation of past lake conditions. Thirteen biostratigraphic intervals are described. Discernible aspects of water quality include climate variability, trophic state, duration of bottom water anoxia, abundance of seasonal algal blooms, trends in specific conductance (a proxy for salinity), nineteenth and twentieth century industrial influences, pollution control efforts back to the late nineteenth century, and the timing of biological response to physical changes in the lake. Before 1822, freshwater, oligotrophic to borderline mesotrophic (similar to 10 mu g/l TP) conditions existed in Onondaga Lake and seasonal anoxia occurred in the hypolimnion. After the lowering of its water level in 1822, the lake became mesotrophic (10-20 mu g/l TP). It became eutrophic (>20 mu g/l) at mid-century, but between 1900 and 1919 there were sporadic returns to mesotrophic conditions. Hypereutrophy (>100 mu g/l TP) prevailed from 1944 into the 1980s. Highest TP levels in the lake occurred during the 1950s through 1970s. Hypolimnetic anoxia increased after 1822 and the lake's profundal benthos declined markedly, disappearing entirely early in the twentieth century. The lake became progressively more saline during the mid-nineteenth century, and was brackish (specific conductance >500 mu S/cm) by the late nineteenth century. The highest salinity levels in the lake occurred from 1972 to 1980. Since the 1970s, inferences from paleolimnological analysis of the lake sediments reflect the well documented, steady decline of phosphorus concentration and salinity in Onondaga Lake, although chironomid-based evidence for abatement of deepwater anoxia is still lacking. This study demonstrates that quantitative paleolimnological inference models can be a valuable, complementary addition to lake management mechanistic modeling, as well as a key part of detailed historical water quality assessments.

（来源：JOURNAL OF PALEOLIMNOLOGY, 2016, 55(3): 241-258）

藏东南林芝晚更新世咸水湖

胡燕，季建清，徐芹芹；等

雅鲁藏布大峡谷直白以上地区分布着一系列湖相沉积阶地，这些阶地代表的古湖泊存续年代及成因特征反映了当时大峡谷地区的地质地理环境，特别是河流体系的演化。采用沉积学方法，对大峡谷入口处鲁霞地区一套湖泊沉积阶地中部与底部各选取一段剖面，连续采集黏土沉积物，对中部剖面样品进行 ^{14}C 定年测试与校正，得到 45~31 ka 的年龄区间。采用 X 射线粉晶衍射技术(X-ray diffraction，XRD)测定两段剖面中黏土各矿物组成：2μm 以下矿物中伊利石含量占绝对优势，次为绿泥石，蒙脱石和高岭石含量很少。利用 XRD 图谱分析伊利石结晶学特征，发现均具有很低的化学指数(chemical index，CI)和积分宽度(integral breadth，IB)，说明沉积的伊利石富 Fe-Mg、结晶程度极好，产出于物理风化盛行的环境。结合样品硼元素含量，使用 Couch 公式恢复湖泊古盐度大于 1‰，在 4.5‰~8.5‰之间，属于咸水湖范围，并且两段剖面从底部到顶部盐度持续升高。鲁霞地区湖泊阶地黏土矿物特征与古盐

度揭示出：在 45~31 ka 的晚更新世，甚至更晚时期，现今雅鲁藏布江河道发育位置存在一个古湖泊。古湖属于封闭型咸水湖泊，缺少外流水系，湖泊沉积的黏土矿物形成与物理风化过程相关，可能是湖盆周围冰川作用产物。

（来源：科学通报, 2016, 61(22): 2512-2523）

利用正交实验法优化青藏高原湖泊沉积色素提取与分析

梁洁; 李栋; 王明达; 等

沉积色素已经成为反映浮游植物生物量和群落结构的有效指标，被广泛应用到研究过去湖泊和海洋生态系统初级生产力变化及其对气候变化与人类活动的响应中。但是由于色素的特殊化学属性，不同的提取和分析方法对不同介质中的色素具有明显的选择性。因此，在不同区域，为获得浮游植物生物量和群落结构等信息，需要选择合适的色素提取和分析方法。本文利用 L9（3^4）正交实验方案，对青藏高原中部典型半对流型湖泊（达则错）和双季对流型湖泊（江错）表层沉积物进行对比研究，选择适用于青藏高原湖泊沉积色素的提取和分析方法。对比发现提取试剂的类型及含量、色谱柱和流动相分别是影响湖泊沉积色素提取与分析过程中的关键因素。利用丙酮：甲醇：水混合试剂（80：15：5，体积比），冰浴超声 30s 并低温静置 6h 对于青藏高原湖泊沉积色素提取具有最佳提取效率。在进行色素分析时，反相高效液相色谱（RP-HPLC）系统中采用 Eclipse Plus C8 色谱柱（150mm×4.6mm，粒径为 3.5mm），流动相 A 为甲醇：乙腈：0.25m 吡啶（50：25：25，体积比）；流动相 B 为甲醇：乙腈：丙酮（20：60：20,体积比），流动相 A 的 pH 利用醋酸调节为 6，柱温保持 40℃时，色素分离效果最好。本研究为进一步利用青藏高原湖泊沉积色素研究湖泊初级生产力变化和湖泊生态系统对气候变化和人类活动的响应提供了实验基础。

（来源：中国科学:地球科学, 2016, 4:497-508）

Arctic and Sub-Arctic shallow lakes in a multiple-stressor world: a paleoecological perspective

Smol, John P

Considerable progress has been made using experimental approaches and spatial surveys to better understand and manage shallow lake ecosystems. Meanwhile, research on the environmental histories of shallow lakes has lagged behind paleolimnological studies conducted on deeper systems, with most studies on shallow systems being completed over the last decade or so. Although shallow lakes may pose additional challenges to paleoenvironmental assessments, these potential shortcomings can often be identified and addressed. Due to their size, shallow lakes may act as amplifiers for a variety of environmental stressors, while dampening others. This overview summarizes a few recent studies assessing the long-term effects of multiple stressors on shallow lake ecosystems, with a particular focus

on Arctic and Sub-Arctic ponds. Issues related to climatic change (e.g., the rapid transformation of shallow ponds in polar regions), as well as recent paleolimnological studies using shallow lake sediments to track past flooding frequencies, assessing the effects of seabirds and other biovectors on terrestrial ecosystems, blending archaeology and paleolimnology, and investigating the paths and trajectories of different pollutants (e.g., contaminants from the burgeoning petroleum industry) are highlighted. Some potential avenues for future research are also discussed.

（来源：HYDROBIOLOGIA, 2016, 778(1):253-272）

Paleolimnological records of regime shifts in lakes in response to climate change and anthropogenic activities

Randsalu-Wendrup, Linda; Conley, Daniel J.; Carstensen, Jacob; et al.

Regime shifts in lake ecosystems can occur in response to both abrupt and continuous climate change, and the imprints they leave in paleolimnological records allow us to investigate and better understand patterns and processes governing ecological changes on geological time scales. This synthesis investigates paleolimnological records that display apparent regime shifts and characterizes the shifts as either smooth, threshold-like or bistable. The main drivers behind the shifts are also explored: direct climate influence on lakes, climate influence mediated through the catchment, lake ontogenetic processes and/or anthropogenic forcing. This framework helps to elucidate the relationship between driver and regime shift dynamics and the type of imprint that the associated regime shifts leaves in sediment records. Our analysis of the limited sites available (22 sites) show that smooth regime shifts are characterized with forcing and response variables acting on similar time scales, whereas regime shifts that demonstrate a threshold like response or a hysteresis response occur on shorter time scales than changes in drivers. The temporal resolution of the record, a common concern in paleo records, limits identification of the timing and rate of the regime shifts. When detected, past regime shifts offer rich opportunities to understand ecosystem responses to climate and other changes and to evaluate the mean state and natural variability of lake ecosystems on time scales of decades to millennia. There are a number of remaining challenges in understanding regime shifts and ecosystem dynamics in a paleolimnological perspective including lack of an appropriate temporal resolution and ecosystem feedback mechanisms. Combining paleoecology with contemporary studies can help clarify the scale of regime shifts and to distinguish patterns in ecosystem changes from natural variability.

（来源：JOURNAL OF PALEOLIMNOLOGY, 2016, 56(1):1-14）

云南星云湖现代盘星藻与湖泊水深关系及其化石记录的探讨

陈雪梅, 黄小忠, 唐领余; 等

盘星藻化石在我国第四纪湖相地层中频繁出现，但其在第四纪古环境研究中的指示意义存在较大的争议。一些研究认为盘星藻大量的出现代表了湖泊变浅，一些研究则认为盘星藻主要集中在湖泊水深较大的区域。本文对位于云南中部的星云湖现代水样和湖床表层沉积物样品中盘星藻的分布状态进行调查研究，结果显示湖面水体中盘星藻浓度在水平方向上随水深基本没有变化，在垂直方向上盘星藻在湖水底部

浓度最大，推测可能与盘星藻重力沉降及波浪扰动底泥产生的再沉积作用有关；湖床表层沉积物中盘星藻含量与水深无明显关系。初步认为，在一些较大湖泊的沉积物中，盘星藻的分布与水深的关系可能是沉积过程造成的，较大湖泊中风浪的作用使得盘星藻趋中沉积非常明显；而湖水中是否有大量盘星藻生长可能与河流输入、水体营养化状态、水温、pH、盐度等水环境状态有关。不同区域、不同类型的湖泊可能机制并不一样，没有统一的规律。因此，在第四纪古环境研究中将盘星藻含量作为水深的指标需结合其他指标综合分析。星云湖过去 3000 年化石盘星藻含量的变化与沉积物粒度和磁化率指示的区域人类活动强度变化趋势一致，且更敏感地响应了人类活动导致的湖泊水体富营养化过程。

（来源：科学通报, 2016, 61(21): 2395-2408）

Holocene high lake-levels and pan-lake period on Badain Jaran Desert

WANG NaiAng, NING Kai, LI ZhuoLun; et al.

Many lakes exist in southeastern Badain Jaran Desert and its hinterland, including 110 perennial lakes and some seasonal or extinct lakes. Geomorphological, sedimentological, and bioglyph evidence obtained from field investigations on Badain Jaran Desert lake group, alongside measurements and dating performed on lake relic, prove that these lakes expanded while the climate was relatively wet during early and middle Holocene. The dating results suggest that the pan-lake period of the Badain Jaran Desert began at 10 cal kyr BP, before which the limnic peat period occurred (11–10 cal kyr BP). Many lakes reached their maximal water-level during 8.6–6.3 cal kyr BP and retreated or dried up in the late Holocene (about 3.5–0 cal kyr BP). During that period, the precipitation at Badain Jaran Desert may have reached 200 mm yr-1 for 7.7–5.3 cal kyr BP, inferred from both the age and precipitation rate of calcareous root tubes. The water balance calculation shows that wetter and warmer climate and the increase of underground water recharge were key factors in maintaining and developing the lake group at both centennial and millennial time scales. Furthermore, lake surface expansion and the increasing fresh water availability set the background for the prosperous prehistoric culture.

（来源：SCIENCE CHINA Earth Sciences, 2016, 59(8):1633-1641）

Timing and causes of mid-Holocene mammoth extinction on St. Paul Island, Alaska

RRussell W. Graham; Soumaya Belmecheri; Kyungcheol Choy; et al.

Relict woolly mammoth (Mammuthus primigenius) populations survived on several small Beringian islands for thousands of years after mainland populations went extinct. Here we present multiproxy paleoenvironmental records to investigate the timing, causes, and consequences of mammoth disappearance from St. Paul Island, Alaska. Five independent indicators of extinction show that mammoths survived on St. Paul until 5,600 ± 100 y ago. Vegetation composition remained stable during the extinction window, and there is no evidence of human presence on the island before 1787 CE, suggesting that these factors were not extinction drivers. Instead, the extinction coincided with declining

freshwater resources and drier climates between 7,850 and 5,600 y ago, as inferred from sedimen-tary magnetic susceptibility, oxygen isotopes, and diatom and cla-doceran assemblages in a sediment core from a freshwater lake on the island, and stable nitrogen isotopes from mammoth remains. Contrary to other extinction models for the St. Paul mammoth population , this evidence indicates that this mammoth population died out because of the synergistic effects of shrinking island area and freshwater scarcity caused by rising sea levels and regional climate change. Degradation of water quality by intensified mammoth activity around the lake likely exacerbated the situation. The St. Paul mammoth demise is now one of the best-dated prehistoric extinctions , highlighting freshwater limitation as an overlooked extinction driver and underscoring the vulnerability of small island populations to environmental change, even in the absence of human influence.

（来源：PNAS, 2016, 113 (33) 9310-9314）

Phytoplankton community responses in a shallow lake following lanthanum-bentonite application

Lang, P.; Meis, S.; Prochazkova, L.; et al.

The release of phosphorus (P) from bed sediments to the overlying water can delay the recovery of lakes for decades following reductions in catchment contributions, preventing water quality targets being met within timeframes set out by environmental legislation (e.g. EU Water Framework Directive: WFD). Therefore supplementary solutions for restoring lakes have been explored, including the capping of sediment P sources using a lanthanum (La)-modified bentonite clay to reduce internal P loading and enhance the recovery process. Here we present results from Loch Flemington where the first long-term field trial documenting responses of phytoplankton community structure and abundance, and the UK WFD phytoplankton metric to a La-bentonite application was performed. A Before-After-Control-Impact (BACI) analysis was used to distinguish natural variability from treatment effect and confirmed significant reductions in the magnitude of summer cyanobacterial blooms in Loch Flemington, relative to the control site, following La-bentonite application. However this initial cyanobacterial response was not sustained beyond two years after application, which implied that the reduction in internal P loading was short-lived; several possible explanations for this are discussed. One reason is that this ecological quality indicator is sensitive to inter-annual variability in weather patterns, particularly summer rainfall and water temperature. Over the monitoring period, the phytoplankton community structure of Loch Flemington became less dominated by cyanobacteria and more functionally diverse. This resulted in continual improvements in the phytoplankton compositional and abundance metrics, which were not observed at the control site, and may suggest an ecological response to the sustained reduction in filterable reactive phosphorus (FRP) concentration following La-bentonite application. Overall, phytoplankton classification indicated that the lake moved from poor to moderate ecological status but did not reach the proxy water quality target (i.e. WFD Good Ecological Status) within four years of the application. As for many other shallow lakes, the effective control of internal P loading in Loch Flemington will require further implementation of both in-lake and catchment-based measures. Our work emphasizes the need for appropriate experimental design and long-term monitoring programmes, to ascertain the efficacy of intervention measures in delivering environmental improvements at the field scale.

（来源：WATER RESEARCH, 2016, 2016, 97(SI):55-68）

Fatty-acid profiles of juvenile lake trout reflect experimental diets consisting of natural prey

Happel, Austin; Stratton, Logan; Pattridge, Robert; et al.

It is relatively well-known that fatty-acid profiles of consumers reflect their diets. However, with fish, controlled studies that trace fatty-acid profiles of natural prey into consumers are lacking. We asked whether lake trout (Salmonidae: Salvelinus namaycush) fatty-acid profiles reflect diets at 4, 8 or 14weeks after feeding began. We also evaluated if calibration coefficients were similar for each diet, a key assumption of quantitative fatty-acid signature analysis (QFASA). In this study, juvenile lake trout were fed commercially available frozen diets of chironomids (Chironomidae: Chironomus spp.), copepods (Cyclopoida spp.), or Mysis (Mysidae: Mysis relicta) over a 14-week period. Accurate classification of lake trout into a priori diet groups was attained after 8weeks of feeding. Calibration coefficients were significantly different among diet groups, especially for lake trout that were fed chironomids, suggesting that diet-specific modifications to fatty acids occurred. Chironomid-fed lake trout grew significantly larger than others despite consuming prey that lacked long-chain essential fatty acids. Furthermore, chironomid-fed lake trout provide evidence for the conversion of 18:3n-3 into longer chain n-3 fatty acids. Our results call for additional studies to better understand how fatty acids reflect dietary origins prior to employing QFASA on wild freshwater fishes. QFASA could provide accurate diet estimates for freshwater fishes with low-diversity diet compositions, if calibration coefficients for each predator-prey relationship are incorporated。

（来源：FRESHWATER BIOLOGY, 2016, 61(9):1466-1476）

Genetic linkage of distinct adaptive traits in sympatrically speciating crater lake cichlid fish

Carmelo Fruciano; Paolo Franchini; Viera Kovacova; et al

Our understanding of how biological diversity arises is limited, especially in the case of speciation in the face of gene flow. Here we investigate the genomic basis of adaptive traits, focusing on a sympatrically diverging species pair of crater lake cichlid fishes. We identify the main quantitative trait loci (QTL) for two eco-morphological traits: body shape and pharyngeal jaw morphology. These traits diverge in parallel between benthic and limnetic species in the repeated adaptive radiations of this and other fish lineages. Remarkably, a single chromosomal region contains the highest effect size QTL for both traits. Transcriptomic data show that the QTL regions contain genes putatively under selection. Independent population genomic data corroborate QTL regions as areas of high differentiation between the sympatric sister species. Our results provide empirical support for current theoretical models that emphasize the importance of genetic linkage and pleiotropy in facilitating rapid divergence in sympatry.

（来源：NATURE COMMUNICATIONS, 2016, doi:10.1038/ncomms12736）

Loss of genetic diversity and reduction of genetic distance among lake trout Salvelinus namaycush ecomorphs, Lake Superior 1959 to 2013

Baillie, Shauna M.; Muir, Andrew M.; Scribner, Kim; et al.

North America's northern lakes are undergoing major changes. Lake Superior is the coldest and northernmost of the Laurentian Great Lakes. Here, we present an extension of a long-term data set that monitors genetic and phenotypic diversity of lake trout Salvelinus namaycush in Lake Superior. Hypotheses were investigated pertaining to loss of genetic diversity and genetic homogenization among three lake trout ecomorphs in Lake Superior during their recovery several decades after a major fishery collapse in the early 1960s. Comparison of a contemporary (2004-2013) microsatellite DNA data set to a previously published, post-collapse recovery period data set (1995-1999) indicated substantive losses in genetic diversity. Allelic richness decreased by 5.7%, 12.3%, and 6.8% at Isle Royale, Stannard Rock, and Klondike Reef, respectively. A 60.7% reduction in genetic distance among ecomorphs since the 1990s was detected. Comparisons with a third data set of samples collected during the fishery collapse (1959) indicated an overall 18.2% loss in allelic richness at Isle Royale. The amount of introgression among ecomorphs has likely increased over time. Apparent losses in genetic diversity could be a consequence of historical fishery harvests (early 1900s) exacerbated by intensive stocking (1950s-1980s) and invasions of non-native species (1960s-1990s). Overlap in foraging and breeding areas may have contributed to increasing levels of hybridization among ecomorphs. Knowledge of these processes will help to identify impediments and strategies for the maintenance of lake trout biodiversity in northern Great Lakes, and their re-establishment in the Laurentian Great Lakes.

（来源：JOURNAL OF GREAT LAKES RESEARCH, 2016, 42(2): 204-216）

Changes in the phytoplankton-bacteria coupling triggered by joint action of UVR, nutrients, and warming in Mediterranean high-mountain lakes

Duran, Cristina; Manuel Medina-Sanchez, Juan; Herrera, Guillermo; et al.

From an extensive study, we determined that heterotrophic bacterial production (HBP) variance in Sierra Nevada (Spain) lakes was explained mainly by excretion of organic carbon by algae (EOC), underlining a bacterial dependence on algal carbon. Subsequently, we studied how the interaction among global change factors such as ultraviolet radiation (UVR), nutrient inputs, and increased temperature affected this phytoplankton-bacteria coupling through in situ factorial experiments in two model high-mountain lakes, La Caldera, and Las Yeguas. Bacterioplankton were more sensitive than phytoplankton because the joint action of increased temperature and nutrient-addition unmasked an inhibitory UVR effect on HBP while reducing the inhibitory UVR effect on primary production (PP) (in La Caldera) or augmenting the net PP values (in Las Yeguas). The interaction among the three factors had a different effect on phytoplankton-bacteria coupling depending on the lake. Thus, in the colder lake (La Caldera), EOC was not adequate to meet the bacterial carbon demand (BCD), leading to a mismatch in phytoplankton-bacteria coupling. Contrarily, in the warmer lake (Las Yeguas), the phytoplankton-bacteria coupling was accentuated by the interaction among the three factors, with EOC exceeding BCD. These contrasting responses of phytoplankton-bacteria coupling may affect the microbial loop development, becoming reinforced in warmer and less UVR-transparent high-mountain lakes, but weakened in colder and more UVR-transparent high-mountain lakes, with implications in the C-flux of these sentinel ecosystems in a scenario of global change.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2016, 61(2):413-429）

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Predictions of establishment risk highlight biosurveillance priorities for invasive fish in New Zealand lakes

Leathwick, John R.; Collier, Kevin J.; Hicks, Brendan J.; et al.

The ability to predict invasive species spread is essential for effective biosecurity management and the allocation of scarce monitoring resources. Prevention of invasive fish incursions poses a significant challenge because of the wide physiological tolerances of many species, their mobility and the role that human vectors play in their spread. In New Zealand, seven introduced fish species are distributed to varying extents in lakes across the two main islands. We used field survey data from 470 New Zealand lakes to fit statistical models of the current geographic distributions of seven introduced species; the resulting models were then used to predict risks of future establishment of each species in 3595 New Zealand lakes >1ha. Initial models fitted using lake- and catchment-scale environmental predictors identified summer temperature among the top two most influential variables, with lake density and size also important for some species. Distribution models for Eurasian perch (Perca fluviatilis), rudd (Scardinius erythrophthalmus) and tench (Tinca tinca) were substantially improved by the addition of variables describing human population densities and lake accessibility. All seven species occurred most frequently in lakes close to human population centres suggesting that human-mediated dispersal has played at least some role in determining current distributions. Addition of a spatial variable, representing the presence or absence of the modelled species within the broader catchment within which each lake is located, improved the predictive performance of models for the brown bullhead catfish (Ameiurus nebulosus), perch and rudd. This finding indicates that the current distributions of these species include clusters of lakes within occupied' catchments, resulting in geographic patchiness that is independent of the available environmental and human population predictors. This distribution has most likely resulted from spread into accessible and suitable lakes from one or more initial liberation points, either by natural dispersal along waterways or through human-assisted movement. Predictions to all mapped lakes throughout New Zealand indicate (i) that the potential for future spread is greatest for catfish, perch and rudd and (ii) the high vulnerability to invasion for lakes along the east coast of both islands and in inland montane regions of the South Island. Our results allow for improved identification of lakes likely to be suitable for invasive fish species and which should therefore be accorded priority for surveillance; they highlight in particular the potential for perch and catfish to establish in higher-elevation lakes distant from human population centres.

（来源：FRESHWATER BIOLOGY, 2016, 61(9):1522-1535）

Invasion of exotic piscivores causes losses of functional diversity and functionally unique species in Japanese lakes

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Human activities affect not only species richness (SR) but also functional diversity (FD), but the consequences of species loss on FD may vary among communities. The loss of functionally unique species can result in a greater loss of FD, undermining the long-term persistence of ecosystems. We quantified the temporal changes in the SR and FD of native fish communities at the lake and drainage basin scales (N=45), and investigated the relationships among these declines in SR and FD, anthropogenic drivers, and lake morphometric characteristics. We also simulated random species loss and compared the observed FD to the expected FD to examine whether losses of functionally unique

species from the lakes and drainage basins had occurred. Overall, SR and FD at the lake scale decreased by 72.1 and 75.5% from historical to current (since 2000) time periods, respectively, but the loss rates were mitigated at the drainage basin scale because some of the species that have disappeared from lakes persist in the surrounding waterbodies. Of the drivers we considered, the richness of exotic piscivores was the most important predictor of changes in both SR and FD. Increases in exotic piscivore richness reduced the SR and FD. The consequences of species loss on FD varied among the lakes. Loss of functionally unique species at the lake scale occurred in 18 lakes and tended to be associated with increased exotic piscivore richness. In 5 of the 18 lakes, however, functionally unique species persist in the surrounding waterbodies. The persistence of these species may have the potential to increase the FD of lake fish communities. Our findings suggest the importance of the strategic management of exotic piscivores and interconnections between lakes and their surrounding waterbodies to ensure the persistence of native fish assemblages and associated ecological functionality.

（来源：FRESHWATER BIOLOGY, 2016, 61(7): 1128-1142）

Why do reed beds decline and fail to re-establish? A case study of Dutch peat lakes

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The decline in emergent reed beds in eutrophic shallow lakes in Europe has been linked to multiple factors, such as adverse water and sediment quality, shoreline development and fixed water level preventing recolonisation, recreational disturbances and herbivory by geese and muskrat. This study analyses the relative importance of these factors in a historical context and tests experimentally what currently may prevent the re-establishment of emergent reed beds. We examined the historical extent of emergent reed stands (1925-2013) in relation to long-term time series of lakeside housing development (1920-2013), abundance of greylag geese (Anser anser) and muskrat (Ondatra zibethicus) as well as water quality (1977-2013) for the shallow lowland peat lake district of Reeuwijk in The Netherlands. In addition, we carried out a comparative survey to generalise our results and an exclosure experiment to test whether current muskrat grazing pressure may hamper restoration efforts. A steady, linear decline in the extent of emergent reed beds over time corresponded significantly with a similar increase in lakeside house density. We found no correlation with herbivore stocks or water quality parameters. In the exclosures, rapid expansion of common reed (Phragmites australis), branched bur-reed (Sparganium erectum) and submerged pondweeds (Potamogeton spp.) occurred, suggesting muskrat herbivory as a factor-limiting emergent reed re-establishment in the foreshore. A combined understanding of the different roles of slow, long-term pressures (such as housing development) and present constraints (the continuous grazing pressure by muskrat despite a culling program) is crucial to the successful restoration of reed beds in shallow lakes.

（来源：FRESHWATER BIOLOGY, 2016, 61(9):1580-1589）

The impact of bird herbivory on macrophytes and the resilience of the clear-water state in shallow lakes: a model study

Van Altena, Cassandra; Bakker, Elisabeth S.; Kuiper, Jan J.; et al.

Shallow lakes have the potential to switch between two alternative stable states: a clear macrophyte-dominated and a turbid phytoplankton-dominated state. Observational and experimental studies show that in some lakes herbivory by birds may severely decrease macrophyte biomass, while in other lakes, the removed biomass by herbivory is compensated by regrowth. These contradictory outcomes might arise because of interplay between top-down control by bird herbivory and bottom-up effects by nutrient loading on macrophytes. Here, we use the ecosystem model PCLake to study top-down and bottom-up control of macrophytes by coots and nutrient loading. Our model predicted that (1) herbivory by birds lowers the critical nutrient loading at which the regime shift occurs; (2) bird impact on macrophyte biomass through herbivory increases with nutrient loading; and (3) improved food quality enhances the impact of birds on macrophytes, thus decreasing the resilience of the clear-water state even further. The fact that bird herbivory can have a large impact on macrophyte biomass and can facilitate a regime shift implies that the presence of waterfowl should be taken into account in the estimation of critical nutrient loadings to be used in water quality management.

（来源：HYDROBIOLOGIA, 2016, 777(1):197-207）

Hydrology-driven macrophyte dynamics determines the ecological functioning of a model Mediterranean temporary lake

Camacho, Antonio; Murueta, Nayeli; Blasco, Elena; et al.

The community composition and metabolism of Mediterranean temporary lakes are sensitive to meteorology, determining the length of the flooded period and water depth. We studied the biological communities and metabolism of Laguna de Talayuelas, a Mediterranean temporary lake selected as a model to disentangle key ecological processes. The development and activity of hydrophytes were determined by hydrology. Water depth favoured differential development of emerged-floating versus submerged species. Rooted macrophytes, especially Ranunculus, extracted nutrients from the sediments, making them bioavailable for phytoplankton after senescence. During the studied period the lake showed three functional phases. The first period, with low water depth, was governed by autotrophic processes and coincided with the development of submerged macrophytes. These accounted for most lake's productivity, and a highly diverse community was maintained. A second phase occurred by late spring, coinciding with a sudden increase of the water depth after strong rainfalls; then submerged macrophytes decayed and decomposed, and respiration increased. The lake had a net heterotrophic behaviour and biodiversity decreased. During the third period, in summer, nutrients released from macrophytes decomposition favoured phytoplankton blooms. The system turned to net autotrophy but now based on phytoplankton photosynthesis. Floating macrophytes developed, though the benthic component maintained net heterotrophy.

（来源：HYDROBIOLOGIA, 2016, 774(1):93-107）

Connectivity restoration of floodplain lakes: an assessment based on macroinvertebrate communities

Obolewski, Krystian; Glinska-Lewczuk, Katarzyna; Ozgo, Malgorzata; et al.

Successful rehabilitation programmes of river-floodplain systems require understanding of environmental

impacts of restoring hydrological connectivity. The present study is based on a field experiment carried out between 2008 and 2013 in a floodplain of a lowland river in northern Poland, in which two oxbow lakes isolated in the 1920s were reconnected to the main river channel. Water and macroinvertebrate samples were collected three to four times a year from six sites (n = 114). After reconnection, water quality in the oxbow lakes improved and diversity and abundance of macrozoobenthos increased, especially the density of Oligochaeta, Malacostraca, Trichoptera, Bivalvia and Gastropoda, while the density of Diptera decreased. Water flow and physico-chemical variables were the most important factors explaining their variance. A direct inflow of water into the reconnected oxbow lakes occurred only during the first 2 years of the study, followed by silting and overgrowing of the inlet to the upper arm. We propose that creating semi-lotic side channels connected to the river with one arm and only occasionally flushed with fresh river water is one of the most effective restoration strategies. However, at the whole river scale, the maintenance of diversified hydrological connections is the optimal solution.

（来源：HYDROBIOLOGIA, 2016, 774(1):23-37）

Past, present and future of the fish community of Lake Orta (Italy), one of the world's largest acidified lakes

Volta, Pietro; Yan, Norman D.; Gunn, John M

Since 1926, the fishes in Lake Orta, one of Italy's deepest natural lakes, were heavily damaged by profundal hypoxia and acidification linked to oxidation of ammonia from industrial effluents and by industrial metal pollution. Of the original 28 fish species, only perch survived the lake's contamination. Recently, the water quality of the lake has been largely restored by reductions in pollutant inputs, and a massive liming intervention. These interventions restored fish habitat, but it is unclear whether the recent fish reintroductions were successful, and the present status of the fish community is unknown. Here we reviewed the history of the Lake Orta fish assemblage. Using an extensive 2014 sampling campaign, we compared the present fish community to both its pre-pollution composition and to the assemblages of nearby un-polluted, but otherwise similar lakes, Lake Mergozzo and Lake Maggiore. While nearshore fish density now appears normal in lake Orta, the open water community remains impoverished both in numbers and in species. Epilimnetic and hypolimnetic benthic nets were dominated by perch and roach in all the three lakes, but the catch of pelagic nets differed among lakes. Perch (Perca fluviatilis), rudd (Scardinius erythrophthalmus) and brown trout (Salmo trutta) dominated in Lake Orta while shad (Alosa fallax lacustris) and coregonids (Coregonus spp.) were dominant in the open waters of the other two lakes, but missing from Lake Orta. Many fully or partially migratory species, including marble trout (Salmo trutta marmoratus), eel (Anguilla Anguilla) and barbel (Barbus plebejus) were also missing from Lake Orta, a consequence of their initial extirpation and blocked re-colonization routes along the River Strona. In comparison with both pre-pollution and contemporary reference data, the fish community of Lake Orta has not been rehabilitated. The recovery of the littoral community is complete, but cold water species such as burbot (Lota lota), Arctic charr (Salvelinus alpinus) and bullhead (Cottus gobio) are still lacking, as are the pelagic zooplanktivores European whitefish (Coregonus lavaretus) and shad, which dominate offshore communities in the reference lakes, as they did a century ago in Lake Orta. To propose priorities for fish community rehabilitation in Lake Orta, we categorized the conservation, ecological and fishing values of each missing fish species in the lake, and evaluated the cost and probability of success of the needed intervention for each species. This analysis indicated that rehabilitation of shad and European

whitefish should receive highest priority.

（来源：JOURNAL OF LIMNOLOGY, 2016, 75(S2):131-141）

Human development modifies the functional composition of lake littoral invertebrate communities

Twardochleb, Laura A.; Olden, Julian D

Residential shoreline and watershed development by humans are leading agents of environmental change in lake ecosystems that reduce abundances and diversity of littoral invertebrates. Invertebrate functional and life history traits are robust indicators of environmental quality and ecosystem functioning, yet surprisingly few studies have utilized trait-based approaches to assess impacts of human development to lake littoral communities. We assessed environmental characteristics of human development that impact functional diversity and structure the trait composition of invertebrate communities in lakes of northwestern United States. Multiple linear regressions revealed that functional diversity declined with increasing watershed development, lake total phosphorus, and littoral macrophyte cover. Results from multivariate constrained ordination and fourth corner analysis indicated that high phosphorus concentrations and abundant macrophyte cover removed taxa with semivoltine life histories and filter feeders from lake communities, and that both regional ecosystem and local habitat characteristics of human development were important determinants of invertebrate community structure. Human development had particularly pronounced effects on invertebrate communities in the sublittoral zone, for which overall community abundances declined. Our study indicates that human development favors lake communities dominated by multivoltine taxa and herbivores, which may have important implications for energy flow among terrestrial, littoral, and pelagic food webs..

（来源：HYDROBIOLOGIA, 2016, 775(1):167-184）

Terrestrial carbohydrates support freshwater zooplankton during phytoplankton deficiency

Sami J. Taipale; Aaron W. E. Galloway; Sanni L. Aalto; et al

Freshwater food webs can be partly supported by terrestrial primary production, often deriving from plant litter of surrounding catchment vegetation. Although consisting mainly of poorly bioavailable lignin, with low protein and lipid content, the carbohydrates from fallen tree leaves and shoreline vegetation may be utilized by aquatic consumers. Here we show that during phytoplankton deficiency, zooplankton (Daphnia magna) can benefit from terrestrial particulate organic matter by using terrestrial-origin carbohydrates for energy and sparing essential fatty acids and amino acids for somatic growth and reproduction. Assimilated terrestrial-origin fatty acids from shoreline reed particles exceeded available diet, indicating that Daphnia may convert a part of their dietary carbohydrates to saturated fatty acids. This conversion was not observed with birch leaf diets, which had lower carbohydrate content. Subsequent analysis of 21 boreal and subarctic lakes showed that diet of herbivorous zooplankton is mainly based on high-quality phytoplankton rich in essential polyunsaturated fatty acids. The proportion of low-quality diets (bacteria and terrestrial particulate organic matter) was <28% of the assimilated carbon. Taken collectively, the incorporation of terrestrial carbon into zooplankton was not directly related

to the concentration of terrestrial organic matter in experiments or lakes, but rather to the low availability of phytoplankton.

（来源：SCIENTIFIC REPORTS, 2016, doi:10.1038/srep30897）

Arrive, survive and thrive: essential stages in the re-colonization and recovery of zooplankton in urban lakes in Sudbury, Canada

Yan, Norman D.; Bailey, John; Mcgeer, James C.; et al.

The recovery of lakes from severe, historical acid and metal pollution requires that colonists of extirpated species arrive, survive and subsequently thrive. We employed 40 year records from weekly to monthly crustacean zooplankton samples from Middle and Clearwater lakes near Sudbury, Canada, to identify the main mechanistic bottlenecks in this recovery process. While both lakes now have circum-neutral pH, acidity decreased more rapidly in Middle Lake because of past liming interventions, while Clearwater Lake, being larger and supporting more housing, likely receives more zooplankton colonists than Middle Lake. Community richness increased much faster in Middle Lake than in Clearwater Lake, at 1.6 vs 0.9 species decade(-1), respectively. Richness has recovered in Middle Lake, when assessed against a target of 9-16 species collection(-1) determined from regional reference lakes, but it has not yet recovered in Clearwater Lake. Species accumulation curves and a metric of annual persistence show that this difference is a product not of greater rates of species introduction into Middle Lake, but rather to their greater annual persistence once introduced. Greater annual persistence was associated with better habitat quality (i.e., lower acid and metal toxicity) in Middle Lake, particularly early in the record, and lower planktivore abundance, more recently. These results support a growing consensus that ecological recovery of zooplankton from acidification and metal pollution does not depend strongly on propagule introduction rates which are adequate, but rather on propagule persistence, in lake-rich, suburban landscapes such as those near Sudbury.

（来源：JOURNAL OF LIMNOLOGY, 2016, 75(S2): 4-14）

Environmental heterogeneity among lakes promotes hyper -diversity across phytoplankton communities

Maloufi, Selma; Catherine, Arnaud; Mouillot, David; et al.

The extent to which stochastic and deterministic processes influence variations in species communities across space and time remains a central question in theoretical and applied ecology. Despite their high dispersal ability, the composition of phytoplankton communities displays striking spatial variations among lakes even at small spatial scale. To investigate the mechanisms underlying the distribution of phytoplankton species, we evaluate the contribution of stochastic, spatial and environmental processes in determining -diversity patterns of phytoplankton at a regional scale. Phytoplankton communities were surveyed in 50 different lakes from north-central France, a region characterised by strong environmental heterogeneity. The regional species pool was characterised by extremely high -diversity levels, which were mainly explained by species replacement (i.e. turnover) rather than by differences in species richness (i.e. nestedness). Null models of random species distribution and spatial processes failed to explain observed -diversity patterns. At the opposite, local environmental conditions strongly influenced the degree of uniqueness of local phytoplankton communities, with the most contrasted environments,

including human-dominated areas, promoting highly distinct phytoplankton communities. Our results suggest that species-sorting mechanisms that arise from variations in local environmental conditions drive high species turnover at the region scale. Thus, in a landscape strongly impacted by cultural eutrophication, further anthropogenic impacts on aquatic ecosystems would likely induce regional homogenisation of phytoplankton communities. Overall, our study supports the fact that the management of lakes and reservoirs in anthropic landscapes should aim at maintaining environmental heterogeneity while preventing further eutrophication in order to favour the maintenance of high phytoplankton beta- and gamma-diversity.

（来源：FRESHWATER BIOLOGY, 2016, 61(5): 633-645）

Benthic-pelagic coupling drives non-seasonal zooplankton blooms and restructures energy flows in shallow tropical lakes

Burian, Alfred; Schagerl, Michael; Yasindi, Andrew; et al.

Zooplankton blooms are a frequent phenomenon in tropical systems. However, drivers of bloom formation and the contribution of emerging resting eggs are largely unexplored. We investigated the dynamics and the triggers of rotifer blooms in African soda-lakes and assessed their impact on other trophic levels. A metaanalysis of rotifer peak densities including abundances of up to 6 X 10(5) individuals L-1 demonstrated that rotifer bloom formation was uncoupled from the food environment and the seasonality of climatic conditions. A time series with weekly sampling intervals from Lake Nakuru (Kenya) revealed that intrinsic growth factors (food quality and the physicochemical environment) significantly affected rotifer population fluctuations, but were of minor importance for bloom formation. Instead, rotifer bloom formation was linked to sediment resuspension, a prerequisite for hatching of resting-eggs. Population growth rates exceed pelagic birth rates and simulations of rotifer dynamics confirmed the quantitative importance of rotifer emergence from the sediment egg-bank and signifying a decoupling of bloom formation from pelagic reproduction. Rotifer blooms led to a top-down control of small-sized algae and facilitated a switch to more grazingresistant, filamentous cyanobacteria. This shift in phytoplankton composition cascaded up the food chain and triggered the return of filter-feeding flamingos. Calculations of consequent changes in the lake's energy budget and export of aquatic primary production to terrestrial ecosystems demonstrated the large potential impact of nonseasonal disturbances on the functioning of shallow tropical lakes.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2016, 61(3): 795-805）

Phytoplankton, macrophytes and benthic diatoms in lake classification: Consistent, congruent, redundant? Lessons learnt from WFD-compliant monitoring in Poland

Kolada, Agnieszka; Pasztaleniec, Agnieszka; Bielczynska, Aleksandra; et al.

The lake monitoring programme compliant with the Water Framework Directive has been implemented in Poland since 2007. Currently, the methods for three biological quality elements (BQEs): phytoplankton (the Phytoplankton Multimetric for Polish Lakes, PMPL), macrophytes (the Ecological State Macrophyte Index, ESMI) and phytobenthos (the Diatom Index for Lakes, IOJ) are officially applied and internationally

intercalibrated. Based on the monitoring data from 256 lakes surveyed in 2010-2013 and assessed for all the three BQEs, we tested whether the assessment results obtained by the three biological methods were consistent and we searched for the causes of inconsistencies which we found. The lake classifications obtained from the PMPL and ESMI were highly consistent and the relationship between these metrics was relatively strong (R=0.66, p < 0.001). Both metrics correlated equally strongly with water quality indicators. However, the PMPL and ESMI indicated systematic dissimilarities in the sensitivity to eutrophication between shallow and deep lakes. In shallow lakes, the alarming symptoms of macrophyte community deterioration (lower values of ESMI) occurred at lower nutrient and Chla concentrations and were accompanied by a better status of phytoplankton (higher values of PMPL) than in deep lakes that can be explained by a synergistic effect of inorganic suspended solids and algal growth on water transparency. As a consequence, the positions of phytoplankton and macrophytes as early warning indicators in the eutrophication gradient in shallow lakes were inverted compared to those in deep lakes. Compared to the PMPL and ESMI, the IOJ method gave the least stringent assessment results, with 22% of lakes failing to meet the environmental objectives. The relationships between IOj and PMPL, and ESMI were relatively weak (R=0.17, p = 0.008 and R=0.17, p = 0.007, respectively). Moreover, the phytobenthos index IOJ correlated significantly more weakly with all the water quality indicators than either PMPL or ESMI did. The poor performance of the phytobenthos method in this study may suggest a limited indicator value of this BQE for lake assessment or inappropriate sampling design.

（来源：LIMNOLOGICA, 2016, 59:44-52）

The persistence of cyanobacterial (Microcystis spp.) blooms throughout winter in Lake Taihu, China

Ma, Jianrong; Qin, Boqiang; Paerl, Hans W.; et al.

Temperature is generally considered as a key factor controlling algal bloom formation. Previous studies have indicated that the bloom-forming cyanobacteria Microcystis spp. overwinters near the sediment surface and does not actively grow below 15 degrees C. However, satellite images and field collections from Lake Taihu, China have shown that Microcystis spp. blooms persisted when water temperatures were below 10 degrees C during winter, although their magnitudes were smaller than during periods of higher temperature. Winter Microcystis cells maintained low activity and were able to grow again when exposed to elevated temperatures (>= 12.5 degrees C). Hence, cyanobacterial blooms may appear year-round in eutrophic lakes. Temperature increases coupled with nutrient enrichment promoted the growth of cyanobacteria, while low temperature decreased the loss rate of Microcystis, allowing winter blooms to persist. High concentrations of overwintering vegetative cells may provide a large inoculum for blooms during warmer seasons. Controlling winter blooms may reduce their magnitude during the warmer seasons.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2016, 61(2): 711-722）

Rapid adaptation of harmful cyanobacteria to rising CO_2

Giovanni Sandrini; Xing Ji; Jolanda M. H. Verspagen; et al.

Rising atmospheric CO_2 concentrations are likely to affect many ecosystems worldwide. However, to what extent elevated CO_2 will induce evolutionary changes in photosynthetic organisms is still a major

open question. Here, we show rapid microevolutionary adaptation of a harmful cyanobacterium to changes in inorganic carbon (Ci) availability. We studied the cyanobacterium Microcystis, a notorious genus that can develop toxic cyanobacterial blooms in many eutrophic lakes and reservoirs worldwide. Microcystis displays genetic variation in the Ci uptake systems BicA and SbtA, where BicA has a low affinity for bicarbonate but high flux rate, and SbtA has a high affinity but low flux rate. Our laboratory competition experiments show that bicA + sbtA genotypes were favored by natural selection at low CO_2 levels, but were partially replaced by the bicA genotype at elevated CO_2 Similarly, in a eutrophic lake, bicA + sbtA strains were dominant when Ci concentrations were depleted during a dense cyanobacterial bloom, but were replaced by strains with only the high-flux bicA gene when Ci concentrations increased later in the season. Hence, our results provide both laboratory and field evidence that increasing carbon concentrations induce rapid adaptive changes in the genotype composition of harmful cyanobacterial blooms.

（来源：PNAS, 2016, 113(33): 9315-9320）

Comparison and Interpretation of Taxonomical Structure of Bacterial Communities in Two Types of Lakes on Yun-Gui plateau of China

Maozhen Han; Yanhai Gong; Chunyu Zhou; et al

Bacterial communities from freshwater lakes are shaped by various factors such as nutrients, pH value, temperature, etc. Their compositions and relative abundances would undergo changes to adapt the changing environments, and in turn could affect the environments of freshwater lakes. Analyses of the freshwater lake's bacterial communities under different environments would be of pivotal importance to monitor the condition of waterbody. In this study, we have collected freshwater samples from two lakes on Yun-Gui plateau of China, Lake Dianchi and Lake Haixihai, and analyzed the bacterial community structures from these samples based on 16S rRNA sequencing. Results have shown that: Firstly, the bacterial community of these samples have very different taxonomical structures, not only between two lakes but also among the intra-groups for samples collected from Dianchi. Secondly, the differences between samples from two lakes are highly associated with the chemical-geographical properties of the two lakes. Thirdly, for samples of Dianchi and Haixihai, analytical results of physicochemical, taxonomical structure and relative abundance of community revealed that extreme physicochemical factors caused by human activities have strongly affected the bacterial ecosystem in Dianchi. These results have clearly indicated the importance of combining biological profiling and chemical-geographical properties for monitoring Chinese plateau freshwater bacterial ecosystem, which could provide clues for Chinese freshwater ecosystem remediation on plateau.

（来源：SCIENTIFIC REPORTS, 2016, doi:10.1038/srep30616）

Surveys, simulation and single-cell assays relate function and phylogeny in a lake ecosystem

Sarah P. Preheim; Scott W. Olesen; Sarah J. Spencer; et al.

Much remains unknown about what drives microbial community structure and diversity. Highly structured environments might offer clues. For example, it may be possible to identify metabolically similar species as groups of organisms that correlate spatially with the geochemical processes they carry out. Here, we

use a 16S ribosomal RNA gene survey in a lake that has chemical gradients across its depth to identify groups of spatially correlated but phylogenetically diverse organisms. Some groups had distributions across depth that aligned with the distributions of metabolic processes predicted by a biogeochemical model, suggesting that these groups performed biogeochemical functions. A single-cell genetic assay showed, however, that the groups associated with one biogeochemical process, sulfate reduction, contained only a few organisms that have the genes required to reduce sulfate. These results raise the possibility that some of these spatially correlated groups are consortia of phylogenetically diverse and metabolically different microbes that cooperate to carry out geochemical functions.

（来源：NATURE MICROBIOLOGY, 2016, doi:10.1038/nmicrobiol.2016.130）

Impact of environmental factors on bacterial communities in floodplain lakes differed by hydrological connectivity

Lew, Sylwia; Glinska-Lewczuk, Katarzyna; Burandt, Pawel; et al.

We analysed total bacterial number and mean volume of cells at three sites in each of ten floodplain lakes in the Middle Basin of the Biebrza River, North-Eastern Poland to test bacterioplankton communities change according to the distance to the river. The composition of the bacterial communities was determined by fluorescent in situ hybridization method. Total number of bacteria in the lakes ranged from 4.0 to 7.48 cells x 10(6) mL(-1) with dominance by Actinobacteria, the contribution of which was positively correlated with water level. Old river channels (side-arms) featured Alpha- and Gammaproteobacteria. The community of Betaproteobacteria was limited by concentration of dissolved organic carbon. Archaea, in spite of a minor role (<3.65% of DAPI-4',6-diamidino-2-phenylindole) in the communities, showed a positive relation to floodplain lake isolation. Multivariate analysis demonstrated that bacterioplankton in riverine lakes was similar to that in rivers, while lakes with limited water exchange showed a similarity to fertile lakes. Water level and nutrients were among the factors determining bacterial community structure.

（来源：LIMNOLOGICA, 2016, 58: 20-29）

Accumulation of microcystins in a dominant Chironomid Larvae (Tanypus chinensis) of a large, shallow and eutrophic Chinese lake, Lake Taihu

Qingju Xue; Xiaomei Su; Alan D. Steinman; et al

Although there have been numerous studies on microcystin (MC) accumulation in aquatic organisms recently, the bioaccumulation of MCs in relatively small sized organisms, as well as potential influencing factors, has been rarely studied. Thus, in this study, we investigated the bioaccumulation of three MC congeners (-LR, -RR and -YR) in the chironomid larvae of Tanypus chinensis (an excellent food source for certain fishes), the potential sources of these MCs, and potentially relevant environmental parameters over the course of one year in Lake Taihu, China. MC concentrations in T. chinensis varied temporally with highest concentrations during the warmest months (except August 2013) and very low concentrations during the remaining months. Among the three potential MC sources, only intracellular MCs were significantly and positively correlated with MCs in T. chinensis. Although MC concentrations in

T. chinensis significantly correlated with a series of physicochemical parameters of water column, cyanobacteria species explained the most variability of MC accumulation, with the rest primarily explained by extraMC-LR. These results indicated that ingestion of MC-producing algae of cyanobacteria accounted for most of the MC that accumulated in T. chinensis. The high MC concentrations in T. chinensis may pose a potential health threat to humans through trophic transfer.

（来源：SCIENTIFIC REPORTS, 2016, doi:10.1038/srep31097）

Microscale decoupling of sediment oxygen consumption and microbial biomass in an oligotrophiclake

Jeske, Jan Torsten; Muller, Roger A.; Wendeberg, Annelie; et al.

Sediments of aquatic ecosystems are hotspots for biological activity. Here, we address the question if, within surface sediments, oxygen consumption is linearly related to cell abundance. In addition, we identify habitat-specific factors influencing underlying microbial processes. Sediment microcosms were established from three sites within oligotrophic Lake angstrom nnsjon, Sweden, to use microsensors for measuring oxygen profiles and estimate spatially resolved oxygen consumption rates at the water-sediment interfaces. To evaluate differences between habitats, we measured sediment carbon content and C:N:P as a proxy for diagenetic state and organic matter bioavailability. Epifluorescence microscopy was used to assess the microscale distribution and size of surface-colonising microorganisms. There was no linear correlation between oxygen consumption rates and microbial cell abundances. Cell-specific respiration rates were highest in the profundal compared to the littoral- and inflow-sediment microcosms, whereas vertical variability in all these parameters was highest at the inflow, intermediate in the littoral and least variable in profundal sediments. Illumina sequencing of spatially resolved 16SrRNA genes was used to test for possible influence of bacterial diversity on spatially resolved oxygen consumption rates. Bacterial -diversity decreased over depth at each site, but was also lower in sediments from the most active profundal zones of the lake compared to the inflow. We suggest that bacteria in profundal sediments mainly use highly oxidised organic compounds, resulting in overall low growth yield despite high metabolic activity. In the lake inflow and the littoral, more reduced organic substrates of terrestrial origin are used at lower rates but with higher yield.

（来源：FRESHWATER BIOLOGY, 2016, 61(9):1477-1491）

Distribution patterns and environmental correlates of Thaumarchaeota abundance in six deep subalpine lakes

Callieri, Cristiana; Hernandez-Aviles, Salvador; Salcher, Michaela M.; et al.

The presence of the mesophilic Thaumarchaeota (Thaum) in deep lakes seems to be restricted to oligotrophic lakes, where they have been found in the deep hypolimnion. We evaluated the vertical distribution of Thaum in six subalpine deep lakes, in spring and summer, to ascertain if there was a Thaum vertical gradient common to all the lakes in the region, possibly related to lake mixing and stratification. We examined nine environmental variables potentially correlated with Thaum abundance. Thaum abundance ranged from 0.61 x 10(3) to 236 x 10(3) cells mL(-1), representing between 0.02 and 19 % of total prokaryotic cells, in the six lakes across different seasons. Although their absolute and

relative abundance varied along the trophic gradient and with mixing conditions, a general pattern common to all the deep lakes was observed. In summer, the abundance of Thaum significantly increased with depth in all the lakes. Temperature emerged as the main environmental correlate of Thaum abundance in deep subalpine lakes. In spring, at low water temperature their abundance was significantly higher in warmer lakes and lower in colder lakes. Conversely, in summer, the correlation with temperature was inverse and Thaum thrived preferentially in the colder hypolimnion.

（来源：AQUATIC SCIENCES, 2016, 78(2): 215-225）

Microbial and diagenetic steps leading to the mineralisation of Great Salt Lake microbialites

Aurélie Pace; Raphaël Bourillot; Anthony Bouton; et al.

Microbialites are widespread in modern and fossil hypersaline environments, where they provide a unique sedimentary archive. Authigenic mineral precipitation in modern microbialites results from a complex interplay between microbial metabolisms, organic matrices and environmental parameters. Here, we combined mineralogical and microscopic analyses with measurements of metabolic activity in order to characterise the mineralisation of microbial mats forming microbialites in the Great Salt Lake (Utah, USA). Our results show that the mineralisation process takes place in three steps progressing along geochemical gradients produced through microbial activity. First, a poorly crystallized Mg-Si phase precipitates on alveolar extracellular organic matrix due to a rise of the pH in the zone of active oxygenic photosynthesis. Second, aragonite patches nucleate in close proximity to sulfate reduction hotspots, as a result of the degradation of cyanobacteria and extracellular organic matrix mediated by, among others, sulfate reducing bacteria. A final step consists of partial replacement of aragonite by dolomite, possibly in neutral to slightly acidic porewater. This might occur due to dissolution-precipitation reactions when the most recalcitrant part of the organic matrix is degraded. The mineralisation pathways proposed here provide pivotal insight for the interpretation of microbial processes in past hypersaline environments.

（来源：SCIENTIFIC REPORTS, 2016, doi:10.1038/srep31495）

Lake-type-specific seasonal patterns of nutrient limitation in German lakes, with target nitrogen and phosphorus concentrations for good ecological status

Dolman, Andrew M.; Mischke, Ute; Wiedner, Claudia

1. Eutrophication is a global environmental problem that leaves many lakes with impaired ecological status. Human activity has increased the total concentrations of both nitrogen and phosphorus in aquatic systems, but their relative influence on phytoplankton biomass is uncertain. Their action as alternative limiting resources complicates assessment of their relative influence and disagreement may be in part due to seasonal shifts and lake-type-specific differences in the prevalence of limitation by nitrogen versus phosphorus. Debate continues as to whether measures to reduce nitrogen would be beneficial in addition to controls placed on phosphorus.

2. We used a piecewise model to test whether total nitrogen (TN) concentrations, in addition to total phosphorus (TP), influence phytoplankton biomass in 369 lowland German lakes. The piecewise model

predicts biomass from TN for low N : P ratio lakes, and from TP for high N : P ratio lakes. We tested three N : P mass ratios to divide lakes: dissolved inorganic nitrogen to TP (DIN : TP), DIN to dissolved reactive phosphorus (DIN : DIP) and TN : TP. TN was a better predictor of biomass than TP when either the DIN : TP ratio was below 1.6, DIN : DIP was below 8.4, or TN : TP below 29; predictions were most accurate when using the DIN : TP ratio.

3. To investigate seasonal and lake-type-specific patterns of N and P limitation, we used the DIN : TP ratio, together with absolute concentrations of DIN and DIP, to predict the limiting nutrient at each lake in each month of the vegetation period. N limitation was much more common in polymictic than stratified lakes. While a high proportion of both stratified and polymictic lakes were P limited in early spring (60-70%), for polymictic lakes, we found a strong shift from P limitation to N limitation in summer: more than 50% of polymictic lakes were N limited between June and September and only 15-30% were P limited.

4. To obtain lake-type-specific nutrient targets we estimated the average TN and TP concentrations at which lakes of different types achieved good ecological status according to EU water framework directive criteria. Stratified lakes achieved good ecological status at concentrations of 400-500 mu g L-1 TN or 20-35 mu g L-1 TP, while for polymictic lakes values of 500-1000 mu g L-1 TN, or 35-75 mu g L-1 TP were required.

5. We estimate that nitrogen has an important influence on phytoplankton biovolume, and thus ecological status, for many polymictic lakes in Germany. While there is some uncertainty in the nutrient targets required to achieve good ecological status, this uncertainty is small compared with the range of concentrations currently observed, and lakes with moderate or worse status have concentrations of both TN and TP that are far above these current target estimates.

（来源：FRESHWATER BIOLOGY, 2016, 61(4): 444-456）

Influence of glacial landform hydrology on phosphorus budgets of shallow lakes on the Boreal Plain, Canada

Plach, Janina M.; Ferone, Jenny-Marie; Gibbons, Zabrina; et al.

A comparative study of three shallow lake catchments in contrasting glacial landscapes (coarse-textured outwash, fine-textured-till hummocky moraines and glacio-lacustrine clay-till plains) demonstrated a distinct landform control on the proportion and type of surface and groundwater sources influencing total phosphorus ([P]) and total dissolved phosphorus ([DP]) concentrations, and P budgets of lakes on the Boreal Plain of the Western Boreal Forest, Alberta, Canada. Lakes located on fine-textured landforms had high [P] and [DP] (median 148 and 148 mu g L-1 glacio-lacustrine plains; 99 and 63 mu g L-1 moraine, respectively) linked to shallow groundwater loadings from near-surface peat with high [P] from adjacent wetlands. In contrast, the lowest lake [P] and [DP] (median 50 and 11 mu g L-1, respectively) occurred on the coarse-textured landform, reflecting greater inputs of deep mineral-groundwater with low [P] from quartz-rich substrates. Annual lake P budgets reflected lake connectivity to the surrounding landform and relative contributions of P by surface versus groundwater. They also reflected distinct scales of groundwater (larger-scale versus short, shallow-flow paths) with differing [P] between landform types and occurrence of internal biogeochemical P cycling within landforms. A regional lake survey reflected trends from the catchment-scale, linking landform type to potential P sources as well as

topographic position to potential trophic status across the Boreal Plain. Together, the results provide a conceptual framework for the scale of interactions between lakes and surrounding source waters influencing P loadings in differing hydrogeological landscapes, important to management strategies and predicting impacts of land-use disturbances on productivity of Boreal Plain lakes.

（来源：JOURNAL OF HYDROLOGY, 2016, 535: 191-203）

Dissolved organic carbon and its potential predictors in eutrophic lakes

Toming, Kaire; Kutser, Tiit; Tuvikene, Lea; et al.

Understanding of the true role of lakes in the global carbon cycle requires reliable estimates of dissolved organic carbon (DOC) and there is a strong need to develop remote sensing methods for mapping lake carbon content at larger regional and global scales. Part of DOC is optically inactive. Therefore, lake DOC content cannot be mapped directly. The objectives of the current study were to estimate the relationships of DOC and other water and environmental variables in order to find the best proxy for remote sensing mapping of lake DOC. The Boosted Regression Trees approach was used to clarify in which relative proportions different water and environmental variables determine DOC. In a studied large and shallow eutrophic lake the concentrations of DOC and coloured dissolved organic matter (CDOM) were rather high while the seasonal and interannual variability of DOC concentrations was small. The relationships between DOC and other water and environmental variables varied seasonally and inter annually and it was challenging to find proxies for describing seasonal cycle of DOC. Chlorophyll a (Chl a), total suspended matter and Secchi depth were correlated with DOC and therefore are possible proxies for remote sensing of seasonal changes of DOC in ice free period, while for long term interannual changes transparency-related variables are relevant as DOC proxies. CDOM did not appear to be a good predictor of the seasonality of DOC concentration in Lake Vortsjarv since the CDOM DOC coupling varied seasonally. However, combining the data from Vortsjarv with the published data from six other eutrophic lakes in the world showed that CDOM was the most powerful predictor of DOC and can be used in remote sensing of DOC concentrations in eutrophic lakes.

（来源：WATER RESEARCH, 2016,102:32-40）

Sediment-water interaction in phosphorus cycling as affected by trophic states in a Chinese shallow lake (Lake Donghu)

Chen, Xi; Li, Hui; Hou, Jie; et al.

Lake sediment substantially accumulates nutrients, while little is known regarding the conditions under which it tends to be a sink or source of phosphorus. It is postulated that the above functions were largely dependent on trophic state. To test this hypothesis, composition, abundance, and size-spectrum of phytoplankton were studied in a Chinese shallow lake (Lake Donghu), together with concentrations and sorption behaviors of phosphorus in water column and sediment. Relationships among these variables were also examined by structural equation model. In the basins with the lowest phosphorus concentration, sediment was a phosphorus source as judged by equilibrium phosphorus concentration, directly affecting the abundance of phytoplankton with smaller size. Contrastingly, in the basins with the highest phosphorus concentration, sediment tended to uptake phosphorus, companied by the lowest ratio of nitrogen to phosphorus, diversity, and evenness of phytoplankton with the smaller size one

dominating. Oscillatoria sp. was directly affected by ammonia and phosphorus. Moreover, with a balanced exchange of phosphorus between sediment and water column, phytoplankton increased markedly with the highest diversity and evenness in the basins having intermediate phosphorus concentration. Overall, trophic state modulated sediment functions to supply nutrient and was in turn greatly affected by the sediment in shallow lakes.

（来源：HYDROBIOLOGIA, 2016, 776(1):19-33）

Horizontal differences in ecosystem metabolism of a large shallow lake

Idrizaj, Agron; Laas, Alo; Anijalg, Urmas; et al.

The causes of horizontal differences in metabolic activities between lake zones are still poorly understood. We carried out a two-year study of lake metabolism in two contrasting parts of a large shallow lake using the open-water technique based on high-frequency measurements of dissolved oxygen concentrations. We expected that the more sheltered and macrophyte-rich southern part of the lake receiving a high hydraulic load from the main inflow will exhibit equal or higher rate of metabolic processes compared to the open pelagic zone, and higher temporal variability, including, anomalous metabolic estimates such as negative gross primary production (GPP) or community respiration (CR) due to rapid water exchange. Our results showed that anomalous metabolic estimates occurred at both stations with a similar frequency and were related rather to certain wind directions, which likely contributed to stronger water exchange between the littoral and pelagic zones. Periods of auto- and heterotrophy (daily mean NEP> or <0) had a 50:50 distribution at the Central Station while the proportions were 30:70 at the Southern Station. High areal GPP estimated in our study exceeding nearly twice the long-term average C-14 primary production, showed the advantages of the free-water technique in integrating the metabolism of all communities, a large part of which has remained undetected by the traditional bottle or chamber incubation techniques.

（来源：JOURNAL OF HYDROLOGY, 2016, 535: 93-100）

Metabolic and physiochemical responses to a whole-lake experimental increase in dissolved organic carbon in a north-temperate lake

Zwart, Jacob A.; Craig, Nicola; Kelly, Patrick T.; et al.

Over the last several decades, many lakes globally have increased in dissolved organic carbon (DOC), calling into question how lake functions may respond to increasing DOC. Unfortunately, our basis for making predictions is limited to spatial surveys, modeling, and laboratory experiments, which may not accurately capture important whole-ecosystem processes. In this article, we present data on metabolic and physio-chemical responses of a multiyear experimental whole-lake increase in DOC concentration. Unexpectedly, we observed an increase in pelagic gross primary production, likely due to a small increase in phosphorus as well as a surprising lack of change in epilimnetic light climate. We also speculate on the importance of lake size modifying the relationship between light climate and elevated DOC. A larger increase in ecosystem respiration resulted in an increased heterotrophy for the treatment basin. The magnitude of the increase in heterotrophy was extremely close to the excess DOC load to the treatment basin, indicating that changes in heterotrophy may be predictable if allochthonous carbon

loads are well-constrained. Elevated DOC concentration also reduced thermocline and mixed layer depth and reduced whole-lake temperature. Results from this experiment were quantitatively different, and sometimes even in the opposite direction, from expectations based on cross-system surveys and bottle experiments, emphasizing the importance of whole-ecosystem experiments in understanding ecosystem response to environmental change.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2016, 61(2): 723-734）

Inflow rate-driven changes in the composition and dynamics of chromophoric dissolved organic matter in a large drinking water lake

Zhou, Yongqiang; Zhang, Yunlin; Jeppesen, Erik; et al.

Drinking water lakes are threatened globally and therefore in need of protection. To date, few studies have been carried out to investigate how the composition and dynamics of chromophoric dissolved organic matter (CDOM) in drinking water lakes are influenced by inflow rate. Such CDOM can lead to unpleasant taste and odor of the water and produce undesirable disinfection byproducts during drinking water treatment. We studied the drinking water Lake Qiandao, China, and found that the concentrations of suspended particulate matter (SPM) in the lake increased significantly with inflow rate ($p < 0.001$). Similarly, close relationships between inflow rate and the CDOM absorption coefficient at 350 nm a(350) and with terrestrial humic-like fluorescence C3 and a negative relationship between inflow rate and the first principal component (PC1) scores, which, in turn, were negatively related to the concentrations and relative molecular size of CDOM ($p < 0.001$), i.e. the concentration and molecular size of CDOM entering the lake increased proportionately with inflow rate. Furthermore, stable isotopes (delta D and delta O-18) were depleted in the upstream river mouth relative to downstream remaining lake regions, substantiating that riverine CDOM entering the lake was probably driven by inflow rate. This was further underpinned by remarkably higher mean chlorophyll-a and in situ measured terrestrial CDOM fluorescence (365/480 nm) and apparent oxygen utilization (AOU), and notably lower mean PC1 and CDOM spectral slope (S275-295) recorded in the upstream river mouth than in the downstream main lake area. Strong negative correlations between inflow rate and a(250):a(365), S275-295, and the spectral slope ratio (S-R) implied that CDOM input to the lake in rainy period was dominated by larger organic molecules with a more humic-like character. Rainy period, especially rainstorm events, therefore poses a risk to drinking water safety and requires higher removal efficiency of CDOM during drinking water treatment processes.

（来源：WATER RESEARCH, 2016,100:211-221）

Dynamic changes in the abundance and chemical speciation of dissolved and particulate phosphorus across the river-lake interface in southwest Lake Michigan

Lin, Peng; Guo, Laodong

Phosphorus (P) concentrations and primary production in the Great Lakes have declined since the 1980s, but changes in biogeochemical cycling pathways of different P species remain poorly understood. Water samples were collected for the measurements of different P species to examine the dynamics of P in the water column across the river-lake interface from the Milwaukee River to open Lake Michigan. Dissolved

inorganic P (DIP) concentrations were as high as 3049 nM in river waters, but decreased dramatically to as low as 1167 nM in open lake waters. Total dissolved P was mostly measured in the form of DIP in river waters (73% +/- 18%), whereas dissolved organic P (DOP) became the predominant species (85% +/- 18%) in lake waters. Colloidal P (>1 kDa) comprised 58% +/- 16% of the bulk DOP in river waters, but decreased to 23% +/- 5% in ologotrophic lake waters, showing again contrasting biogeochemical regimes between river and lake waters. Biological processes and coagulation/sedimentation were largely responsible for the removal of river-derived P species and active transformation between inorganic and organic P occurred in both dissolved and particulate phases across the river-lake interface. Increased water column P inventory over the winter of 2013-2014 likely resulted from an accumulative effect of both atmospheric and riverine inputs in the upper water column, and benthic nepheloid layer processes coupled with quagga mussels excretion for the lower water column, respectively. High partition coefficient values (logK(d) of 4.33-7.01) and a "particle concentration effect" on the partitioning of P between dissolved and particulate phases attested the particle-reactive nature of P in lake waters.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2016, 61(2): 771-789）

Increase in benthic trophic reliance on methane in 14 French lakes during the Anthropocene

Belle, Simon; Millet, Laurent; Lami, Andrea; et al.

Lakes play a key role in the regulation of the global carbon cycle. However, their functioning can be strongly impacted by anthropogenic pressures and climate variability. Understanding the response of the carbon cycle to environmental changes remains a crucial, elusive goal for both ecosystem managers and aquatic ecologists. In particular, the relations among lake physical and chemical properties, landscape structure and lake carbon cycling must be studied to predict future trends in lake functioning. Sediment cores were collected from the deepest part of 14 small French lakes that differed in lake properties (elevation, conductivity, area, area of the watershed) and land-use class (forest, wetland, agricultural land and urban area). The sampling strategy employed the top-bottom approach (a comparison between present-day conditions and reference' conditions at Medieval period, c. AD 1000). For each sample, the following variables were analysed: isotopic carbon composition of sedimentary organic carbon (C-13(OM)), C-13 of chironomid remains (C-13(HC)), and sedimentary pigments (total carotenoids, TC). Stepwise multiple regression analysis showed that the size of the catchment area may affect C-13(OM) values for the Medieval samples (R-2=0.36, P<0.05), such that the flux of terrestrial organic matter increases with the size of the watershed. However, this relation is not observed in the present-day samples, and the influence apparently becomes largely anthropogenic. For these present-day samples, the proportion of agricultural land in the watershed appears to be the primary driver of lake biogeochemical cycles through a direct effect on nutrient availability (R-2=0.24, P<0.05) and through an indirect effect on the benthic carbon cycle. The results also confirm the widespread existence of a pathway for methane-derived carbon contribution to chironomid biomass (up to 61% of chironomid biomass) and suggest that high-conductivity lakes are highly sensitive to the presence of this pathway (more than 75% of the lakes in our dataset have benthic food webs apparently dependent on biogenic methane; CH4). The results may indicate that the high-conductivity lakes (from the Jura Mountains) are more vulnerable to anthropogenic activities than low-conductivity lakes because high-conductivity water provides an excellent nutritive medium for the development of photoautotrophic production. Studying

within-lake CH4 dynamics and the response of the CH4 cycle in high-conductivity lakes appear to be crucial for understanding both regional carbon budgets and lake trophic functioning.

（来源：FRESHWATER BIOLOGY, 2016, 61(7): 1105-1118）

Methane emissions proportional to permafrost carbon thawed in Arctic lakes since the 1950s

Katey Walter Anthony; Ronald Daanen; Peter Anthony; et al

Permafrost thaw exposes previously frozen soil organic matter to microbial decomposition. This process generates methane and carbon dioxide, and thereby fuels a positive feedback process that leads to further warming and thaw1. Despite widespread permafrost degradation during the past ~40 years2, 3, 4, the degree to which permafrost thaw may be contributing to a feedback between warming and thaw in recent decades is not well understood. Radiocarbon evidence of modern emissions of ancient permafrost carbon is also sparse5. Here we combine radiocarbon dating of lake bubble trace-gas methane (113 measurements) and soil organic carbon (289 measurements) for lakes in Alaska, Canada, Sweden and Siberia with numerical modelling of thaw and remote sensing of thermokarst shore expansion. Methane emissions from thermokarst areas of lakes that have expanded over the past 60 years were directly proportional to the mass of soil carbon inputs to the lakes from the erosion of thawing permafrost. Radiocarbon dating indicates that methane age from lakes is nearly identical to the age of permafrost soil carbon thawing around them. Based on this evidence of landscape-scale permafrost carbon feedback, we estimate that 0.2 to 2.5 Pg permafrost carbon was released as methane and carbon dioxide in thermokarst expansion zones of pan-Arctic lakes during the past 60 years.

（来源：NATURE GEOSCIENCE, 2016, 9:679–682）

Major changes in CO_2 efflux when shallow lakes shift from a turbid to a clear water state

Jeppesen, Erik; Trolle, Dennis; Davidson, Thomas A.; et al.

Lakes can be sources or sinks of carbon, depending on local conditions. Recent studies have shown that the CO_2 efflux increases when lakes recover from eutrophication, mainly as a result of a reduction in phytoplankton biomass, leading to less uptake of CO_2 by producers. We hypothesised that lake restoration by removal of coarse fish (biomanipulation) or invasion of mussels would have a similar effect. We studied 14-22 year time series of five temperate Danish lakes and found profound effects on the calculated CO_2 efflux of major shifts in ecosystem structure. In two lakes, where limited colonisation of submerged macrophytes occurred after biomanipulation or invasion of zebra mussels (Dreissena polymorpha), the efflux increased significantly with decreasing phytoplankton chlorophyll a. In three lakes with major interannual variation in macrophyte abundance, the efflux declined with increasing macrophyte abundance in two of the lakes, while no relation to macrophytes or chlorophyll a was found in the third lake, likely due to high groundwater input to this lake. We conclude that clearing water through invasive mussels or lake restoration by biomanipulation may increase the CO_2 efflux from lakes. However, if submerged macrophytes establish and form dense beds, the CO_2 efflux may decline again.

（来源：HYDROBIOLOGIA, 2016, 778(1):33-44）

In-lake measures for phosphorus control: The most feasible and cost-effective solution for long-term management of water quality in urban lakes

Huser, Brian J.; Futter, Martyn; Lee, Jeff T.; et al.

Both in-lake and catchment measures designed to reduce phosphorus (P) loading were implemented as part of a 12.3 million USD restoration project for the Minneapolis Chain of lakes in Minnesota (USA). Treatment wetlands, 'in-pipe' measures, and in-lake aluminum sulfate (alum) treatment were applied to restore water quality in the four urban lakes. Different alum dosing methods led to between 4 and 20+ (modeled) years of water quality improvements in these lakes after treatment and only one of the four lakes continues to meet water quality goals approximately 25 years after the project started. Due to limited space and poor performance, reduction of total external loads was low (1-13%) for three lakes. Changes to internal P sediment release rates after application of alum correlated well with epilimnetic total P (TP) concentrations in these lakes, indicating that improvements in water quality were mainly driven by reduced internal loading via in-lake measures. Substantial reductions to external P loading were only achieved at Cedar Lake (49%) via conversion of an existing natural area to a treatment wetland, but even Cedar Lake is no longer meeting management goals. When expressed in terms of dollars spent per unit P removed, in lake alum treatment was on average 50 times more effective than in-catchment measures. The results of this study indicate that substantial external nutrient reductions may not be adequate to sustainably maintain water quality in urban lakes and that continued in-lake management of P accumulated in lake sediment will not only be necessary, but will also be more cost efficient relative to in-catchment measures.

（来源：WATER RESEARCH, 2016, 97(SI):142-152）

Longevity and effectiveness of aluminum addition to reduce sediment phosphorus release and restore lake water quality

Huser, Brian J.; Egemose, Sara; Harper, Harvey; et al.

114 lakes treated with aluminum (Al) salts to reduce internal phosphorus (P) loading were analyzed to identify factors driving longevity of post-treatment water quality improvements. Lakes varied greatly in morphology, applied Al dose, and other factors that may have affected overall treatment effectiveness. Treatment longevity based on declines in epilimnetic total P (TP) concentration averaged 11 years for all lakes (range of 0-45 years). When longevity estimates were used for lakes with improved conditions through the end of measurements, average longevity increased to 15 years. Significant differences in treatment longevity between deeper, stratified lakes (mean 21 years) and shallow, polymictic lakes (mean 5.7 years) were detected, indicating factors related to lake morphology are important for treatment success. A decision tree developed using a partition model suggested Al dose, Osgood index (01, a morphological index), and watershed to lake area ratio (related to hydraulic residence time, WA:LA) were the most important variables determining treatment longevity. Multiple linear regression showed that Al dose, WA:LA, and 01 explained 47, 32 and 3% respectively of the variation in treatment longevity. Other variables (too data limited to include in the analysis) also appeared to be of importance, including sediment P content to Al dose ratios and the presence of benthic feeding fish in shallow, polymictic lakes.

（来源：WATER RESEARCH, 2016, 97(SI):122-132）

Long-term efficiency of lake restoration by chemical phosphorus precipitation: Scenario analysis with a phosphorus balance model

Hupfer, Michael; Reitzel, Kasper; Kleeberg, Andreas; et al.

An artificial increase of phosphorus (P) retention in lakes with a long residence time and/or a large mobile sediment P pool by adding P binding chemicals can drastically shorten the time these lakes require to reach water quality targets. Suitable tools to optimize timing and extent of external and internal measures are lacking. The one-box model, a mass balance tool for predicting the P trend in the water under different management options was applied to highly eutrophic Lake Arendsee (a = 5.14 km(2), z(max) = 49 m), Germany. Mass developments of blue green algae and increasing hypolimnetic oxygen deficiencies are urgent reasons for restoring Lake Arendsee. Detailed studies of P cycling and scenario analyses with the one-box model led to the following conclusions: i) immediate improvement of the trophic state is only possible by in-lake P inactivation because of the long water residence time (56 years); ii) a gradual external P load reduction, even if the effect is delayed, will assure the sustainability of the scheduled Al application beyond one decade; iii) a twofold precipitation reduces the risk of failure compared to a singular application with an overdose related to the relevant internal P pools.

（来源：WATER RESEARCH, 2016, 97(SI):153-161）

From greening to browning: Catchment vegetation development and reduced S-deposition promote organic carbon load on decadal time scales in Nordic lakes

Anders G. Finstad; Tom Andersen; Søren Larsen; et al

Increased concentrations of dissolved organic carbon (DOC), often labelled “browning”, is a current trend in northern, particularly boreal, freshwaters. The browning has been attributed to the recent reduction in sulphate (S) deposition during the last 2 to 3 decades. Over the last century, climate and land use change have also caused an increasing trend in vegetation cover (“greening”), and this terrestrially fixed carbon represents another potential source for export of organic carbon to lakes and rivers. The impact of this greening on the observed browning of lakes and rivers on decadal time scales remains poorly investigated, however. Here, we explore time-series both on water chemistry and catchment vegetation cover (using NDVI as proxy) from 70 Norwegian lakes and catchments over a 30-year period. We show that the increase in terrestrial vegetation as well as temperature and runoff significantly adds to the reduced SO4-deposition as a driver of freshwater DOC concentration. Over extended periods (centuries), climate mediated changes in vegetation cover may cause major browning of northern surface waters, with severe impact on ecosystem productivity and functioning.

（来源：SCIENTIFIC REPORTS, 2016, doi:10.1038/srep31944）

Increasing sulfate concentrations result in higher sulfide production and phosphorous mobilization in a shallow eutrophic freshwater lake

Chen, Mo; Li, Xiao-Hong; He, Yu-Hong; et al.

Increasing sulfate input has been seen as an issue in management of aquatic ecosystems, but its

influences on eutrophic freshwater lakes is not clear. In this study, it was observed that increasing sulfate concentration without additional cyanobacterial bloom biomass (CBB) addition did not have an obvious effect on element cycling during 1-year continuous flow mesocosm experiments in which water and sediments were taken from a shallow eutrophic lake with sulfate levels near 1 mM. However, following addition of CBB to mesocosms, sulfate-reducing bacteria (SRB) were observed in the water column, and increasing numbers of SRB in the water column were associated with higher sulfate input. Sulfate amendment (0-70 mg L-1) also resulted in a larger amount of total dissolved sulfide (peak values of 5.90 +/- 0.36 to 7.60 +/- 0.12 mg L-1) in the water column and acid volatile sulfide (1081.71 +/- 69.91 to 1557.98 +/- 41.72 mg kg(-1)) in 0-1 cm surface sediments due to sulfate reduction. During the period of CBB decomposition, increasing sulfate levels in the water column were positively correlated with increasing diffusive phosphate fluxes of 1.23 +/- 0.32 to 2.17 +/- 0.01 mg m(-2) d(-1) at the water-sediment interface. As increases in sulfide and phosphate release rates deteriorated the water quality/ecosystem and even spurred the occurrence of a black water problem in lakes, the control of sulfate input level should be considered for shallow eutrophic lake management, especially during cyanobacterial bloom periods.

（来源：WATER RESEARCH, 2016, 96:94-104）

Negligible effect of hypolimnetic oxygenation on the trophic state of Lake Jyvasjarvi, Finland

Kuha, Jonna K.; Palomaki, Arja H.; Keskinen, J. Tapio; et al.

Hypolimnetic oxygenation by pumping oxygen-rich surface water to the hypolimnion (HLO) is a commonly used tool for the restoration of nutrient-loaded dimictic lakes. However, in recent years its effectiveness has been questioned. In this case study we evaluated monitoring data covering a period of 23-years to show that, although experimental cessation of HLO drastically changed the lake's temperature and dissolved oxygen regimes, it did not significantly affect its trophic status. Thus, we recommend that the limited financial resources available are better directed towards further lowering the lake's external phosphorus load than continuing HLO.

（来源：LIMNOLOGICA, 2016, 58: 1-6）

Quantification of human-associated fecal indicators reveal sewage from urban watersheds as a source of pollution to Lake Michigan

Templar, Hayley A.; Dila, Deborah K.; Bootsma, Melinda J.; et al.

Sewage contamination of urban waterways from sewer overflows and failing infrastructure is a major environmental and public health concern. Fecal coliforms (FC) are commonly employed as fecal indicator bacteria, but do not distinguish between human and non-human sources of fecal contamination. Human Bacteroides and human Lachnospiraceae, two genetic markers for human-associated indicator bacteria, were used to identify sewage signals in two urban rivers and the estuary that drains to Lake Michigan. Grab samples were collected from the rivers throughout 2012 and 2013 and hourly samples were collected in the estuary across the hydrograph during summer 2013. Human Bacteroides and human Lachnospiraceae were highly correlated with each other in river samples (Pearson's r = 0.86), with average concentrations at most sites elevated during wet weather. These human indicators were found

during baseflow, indicating that sewage contamination is chronic in these waterways. FC are used for determining total maximum daily loads (TMDLs) in management plans; however, FC concentrations alone failed to prioritize river reaches with potential health risks. While 84% of samples with >1000 CFU/100 ml FC had sewage contamination, 52% of samples with moderate (200-1000 CFU/100 ml) and 46% of samples with low (<200 CFU/100 ml) FC levels also had evidence of human sewage. Load calculations in the in the Milwaukee estuary revealed storm-driven sewage contamination varied greatly among events and was highest during an event with a short duration of intense rain. This work demonstrates urban areas have unrecognized sewage inputs that may not be adequately prioritized for remediation by the TMDL process. Further analysis using these approaches could determine relationships between land use, storm characteristics, and other factors that drive sewage contamination in urban waterways.

（来源：WATER RESEARCH, 2016, 100:556-567）

Management of eutrophication in Lake De Kuil (The Netherlands) using combined flocculant - Lanthanum modified bentonite treatment

Waajen, Guido; van Oosterhout, Frank; Douglas, Grant; et al.

Eutrophication of Lake De Kuil (The Netherlands, 6.7 ha, maximum depth 9 m) has frequently caused cyanobacterial blooms resulting in swimming bans or the issue of water quality warnings during summer. The eutrophication was mainly driven by sediment phosphorus (P)-release. The external P-loading was in the range of the critical loading for phytoplankton blooms. Hence, the reduction of the internal P loading provided a promising way to reduce cyanobacterial blooms. To mitigate the cyanobacterial blooms, the combination of a low dose flocculant (iron(III)chloride; Flock) and a solid phase phosphate fixative (lanthanum modified bentonite; Lock) was applied in May 2009. This combined approach both removed cyanobacterial biomass from the water column and also intercepted P released from the bottom sediments. Immediately after treatment, the Secchi depth increased from 1.5 m up to 5 m. Sediment P release decreased from 5.2 mg P m(-2) d(-1) (2009) to 0.4 mg P m(-2) d(-1) (2010) but increased in later years. Mean summer concentrations of total P decreased from 0.05 mg L-1 (1992-2008) to 0.02 mg L-1 (2009 -2014) and chlorophyll-a from 16 mu g L-1 (1992-2008) to 6 mu g L-1 (2009-2014). Mean summer Secchi depth increased from 2.31 m (1992-2008) to 3.12 m (2009-2014). The coverage of macrophytes tripled from 2009 to 2011. In the winter of 2010/2011 Planktothrix rubescens bloomed, but cyanobacterial biomass decreased during the summers after the Flock and Lock treatment in comparison to prior years. After the Flock & Lock the bathing water requirements have been fulfilled for six consecutive summers. As the sediment P -release has gradually increased in recent years, there is a risk of a reversion from the present mesotrophic state to a eutrophic state.

（来源：WATER RESEARCH, 2016, 97(SI):83-95）

Long-term persistence of sedimentary copper contamination in Lake Orta: potential environmental risks 20 years after liming

Vignati, Davide A. L.; Bettinetti, Roberta; Marchetto, Aldo

Lake Orta, northern Italy, has suffered from severe copper pollution and human-induced acidification

between the 1920s and the 1990s because of discharges from a rayon factory and electroplating industries located in its drainage basin. Following liming operations in the late 1980s, the chemical quality of the water column has been restored and signs of, still ongoing, biological recovery observed. Two sediment cores (07/1A and 07/1B) were collected close to the main historical Cu discharge (in the southern part of the lake) and one (07/2A) in the central part of the lake. Cores 07/1A and 07/2A were analyzed for Cu content, Loss on Ignition (LOI) and water content. Diatom profiles (cores 07/1B and 07/2A) were used to confirm sediment dating and to identify alterations in the sediment sequence because, among other taxonomic groups, diatom assemblages were strongly affected by lake pollution and recovery. Copper concentrations in the uppermost layers of sediment cores (2007 AD) were above 1,000 mg kg(-1) and around 500 mg kg(-1) in cores 07/1A and 07/2A, respectively. These values were lower than the corresponding maximum ones of approx. 3500 and 4500 mg kg(-1) recorded at the end of the 1950s at both locations, but remained 10 to 40-fold higher than the pre-industrial levels of about 40 mg kg(-1) measured in both cores. Diatom profiles revealed a continuous sedimentation pattern in core 07/1A, but highlighted interruptions in sediment deposition in core 07/2A. Copper levels in 2007 were still comparable to or higher than concentrations reported to cause adverse effect on the survival, growth and reproduction of sediment-ingesting organisms. A critical comparison of measured concentrations with relevant ecotoxicological values suggests that particular attention should be given to understand the effects of dietary ingestion of sedimentary Cu which, unlike in previous ecotoxicological studies, may now represent the main route of exposure to Cu for sediment-ingesting benthic organisms.

（来源：JOURNAL OF LIMNOLOGY, 2016, 75(S2):107-119）

Responses in sediment phosphorus and lanthanum concentrations and composition across 10 lakes following applications of lanthanum modified bentonite

Dithmer, Line; Nielsen, Ulla Gro; Lurling, Miquel; et al.

A combined field and laboratory scale study of 10 European lakes treated between 2006 and 2013 with a lanthanum (La) modified bentonite (LMB) to control sediment phosphorus (P) release was conducted. The study followed the responses in sediment characteristics including La and P fractions and binding forms, P adsorption capacity of discrete sediment layers, and pore water P concentrations. Lanthanum phosphate mineral phases were confirmed by solid state P-31 MAS NMR and L-III EXAFS spectroscopy. Rhabdophane (LaPO4 center dot nH(2)O) was the major phase although indications of monazite (LaPO4) formation were also reported, in the earliest treated lake. Molar ratios between La and P in the sediments were generally above 1, demonstrating excess La relative to P. Lanthanum was vertically mixed in the sediment down to a depth of 10 cm for eight of the ten lakes, and recovery of La in excess of 100% of the theoretical aerial load indicated translocation of the LMB towards the deepest areas of the lakes. Lanthanum was generally recovered from bed sediment samples following sequential chemical extraction from the HCI fraction. Soluble reactive P (SRP) release experiments on intact sediment cores indicated conditions of P retention (with the exception of two lakes) by sediments, indicating effective control of sediment P release, i.e. between two and nine years after treatment.

（来源：WATER RESEARCH, 2016, 97(SI):101-110）

Impact of trophic state on the distribution of intact polar lipids in surface waters of lakes

Bale, Nicole J.; Hopmans, Ellen C.; Schoon, Petra L.; et al.

We characterized the intact polar lipid (IPL) composition in the surface waters of 22 lakes from Minnesota and Iowa, ranging in trophic state between eutrophic and oligo-mesotrophic, to investigate the impact of trophic state on IPL composition. A high diversity of IPL classes was detected. Most IPL classes were detected in all lakes, but the eutrophic lakes contained a significantly higher relative abundance of lysophosphatidylcholine (PC) than the oligo-mesotrophic lakes, which in turn were characterized by significantly higher relative abundance of hydroxymethyltrimethyl-alanine/trimethyl-homoserine (DGTA/DGTS) betaines, ornithine lipids and the recently discovered trimethyl ornithine (TMO) lipids. The higher relative abundance of ornithines and TMOs may relate to a higher contribution of heterotrophic bacteria relative to phytoplankton while the higher abundance of the DGTA/DGTS betaines may relate to substitution by microorganisms of these non-P lipids for PC under P-stress, as has been observed in other environments. We also detected a variety of heterocyst glycolipids (HGs) derived from N-2-fixing heterocystous Cyanobacteria in all lakes, suggesting the presence of these Cyanobacteria in the full range of trophic conditions. Correlation of HG abundance with environmental data showed that high productivity lakes have high HG abundances, while other distributional differences in HGs, which did not correlate with environmental parameters, are likely due to differences in species composition. We conclude that the significant differences in IPL composition between the eutrophic and oligo-mesotrophic lakes are either due to adaptation of the membrane composition to nutrient conditions or due to general divergences in microbial composition under the different conditions.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2016, 61(3):1065-1077）

Ecotoxicological assessment of flocculant modified soil for lake restoration using an integrated biotic toxicity index

Wang, Zhibin; Zhang, Honggang; Pan, Gang

Flocculant modified soils/clays are being increasingly studied as geo-engineering materials for lake restoration and harmful algal bloom control. However, the potential impacts of adding these materials in aquatic ecological systems remain unclear. This study investigated the potential effects of chitosan, cationic starch, chitosan modified soils (MS-C) and cationic starch modified soils (MS-S) on the aquatic organisms by using a bioassay battery. The toxicity potential of these four fiocculants was quantitatively assessed using an integrated biotic toxicity index (BTI). The test system includes four aquatic species, namely Chlorella vulgaris, Daphnia magna, Cyprinus carpio and Limnodrilus hoffmeisteri, which represent four trophic levels in the freshwater ecosystem. Results showed that median effect concentrations (EC50) of the MS-C and MS-S were 31-124 times higher than chitosan and cationic starch, respectively. D. magna was the most sensitive species to the four fiocculants. Histological examination of C carpio showed that significant pathological changes were found in gills. Different from chitosan and cationic starch, MS-C and MS-S significantly alleviated the acute toxicities of chitosan and cationic starch. The toxicity order of the four fiocculants based on BTI were cationic starch > chitosan > MS-S > MS-C. The results suggested that BTI can be used as a quantitative and comparable indicator to assess biotic toxicity for aquatic geo-engineering materials. Chitosan or cationic starch modified soil/clay materials can be used at their optimal dosage without causing substantial adverse effects to the bioassay

battery in aquatic ecosystem.

（来源：WATER RESEARCH, 2016, 97(SI):133-141）

A meta-analysis of water quality and aquatic macrophyte responses in 18 lakes treated with lanthanum modified bentonite (Phoslock (R))

Spears, Bryan M.; Mackay, Eleanor B.; Yasseri, Said; et al.

Lanthanum (La) modified bentonite is being increasingly used as a geo-engineering tool for the control of phosphorus (P) release from lake bed sediments to overlying waters. However, little is known about its effectiveness in controlling P across a wide range of lake conditions or of its potential to promote rapid ecological recovery. We combined data from 18 treated lakes to examine the lake population responses in the 24 months following La-bentonite application (range of La-bentonite loads: 1.4-6.7 tonnes ha(-1)) in concentrations of surface water total phosphorus (TP; data available from 15 lakes), soluble reactive phosphorus (SRP; 14 lakes), and chlorophyll a (15 lakes), and in Secchi disk depths (15 lakes), aquatic macrophyte species numbers (6 lakes) and aquatic macrophyte maximum colonisation depths (4 lakes) across the treated lakes. Data availability varied across the lakes and variables, and in general monitoring was more frequent closer to the application dates. Median annual TP concentrations decreased significantly across the lakes, following the La-bentonite applications (from 0.08 mg L-1 in the 24 months pre application to 0.03 mg L-1 in the 24 months post-application), particularly in autumn (0.08 mg L-1 to 0.03 mg L-1) and winter (0.08 mg L-1 to 0.02 mg L-1). Significant decreases in SRP concentrations over annual (0.019 mg L-1 to 0.005 mg L-1), summer (0.018 mg L-1 to 0.004 mg L-1), autumn (0.019 mg L-1 to 0.005 mg L-1) and winter (0.033 mg L-1 to 0.005 mg L-1) periods were also reported. P concentrations following La-bentonite application varied across the lakes and were correlated positively with dissolved organic carbon concentrations. Relatively weak, but significant responses were reported for summer chlorophyll a concentrations and Secchi disk depths following La-bentonite applications, the 75th percentile values decreasing from 119 mu g L-1 to 74 mu g L-1 and increasing from 398 cm to 506 cm, respectively. Aquatic macrophyte species numbers and maximum colonisation depths increased following La-bentonite application from a median of 5.5 species to 7.0 species and a median of 1.8 m to 2.5 m, respectively. The aquatic macrophyte responses varied significantly between lakes. La-bentonite application resulted in a general improvement in water quality leading to an improvement in the aquatic macrophyte community within 24 months. However, because, the responses were highly site-specific, we stress the need for comprehensive pre- and post-application assessments of processes driving ecological structure and function in candidate lakes to inform future use of this and similar products.

（来源：WATER RESEARCH, 2016, 97(SI):111-121）

研究热点

Science 文章模拟地下水和蒸腾作用之间的联系

2016年7月22日，*Science*期刊在线发表题为《揭示地下水和蒸腾作用之间的联系》（Connections between groundwater flow and transpiration partitioning）的文章指出，在地球系统模型中忽略了水循环过程中影响大规模的土壤蒸发和植物蒸腾的重要因素。该项研究结果为目前无法确认复杂水循环相互作用的方法提供了线索。蒸发蒸腾量（ET）是土壤蒸发（E）和植物蒸腾（T）的总和，它代表了地球水循环的一个关键部分。然而，因为T取决于植物的过程，而E依赖于浅表土壤的湿度，因此这两种过程对物理驱动因子会做出不同反应。

科研人员就T和E如何受到各种变量的独特影响进行了分析：通过地表下的水向河流或其他排放水体的运动（也被称作横向地下水流动）。Reed Maxwell和Laura Condon在此利用了一个将地下水和地表水流动偶联来模拟对比分析横向地下水流动时的水通量模型，该研究涵盖了北美大陆大部分主要的流域。在一年的时间中，科研人员每小时会运行一次模型模拟。最终的模拟结果表明，横向地下水为蒸腾提供了一个独特的关键性额外水源。实际上，在某些情况中，它所引起的蒸腾比土壤蒸发要高30倍以上。

研究人员提出，能接触较深层地下水的植物促使它们能在浅层土壤干燥时从地下深部汲水。这项研究的结果强调了在地球系统模型中需要纳入横向地下水的重要性，尤其是在地下水位变化明显的地区进行模型模拟。同时，该研究将有助于进一步量化全球水循环过程。

原文来源：http://science.sciencemag.org/content/353/6297/377

（来源：科学研究动态监测快报 2016-08-01，第15期总第284期）

PNAS 文章揭示加州深层地下水储量较丰但难利用

美国加利福尼亚州正经历着 1000 多年来最严重干旱的第 5 个年头，目前已造成森林大火、农作物歉收、水价飙升 10 倍，让农民不堪重负。目前的研究对于加利福尼亚州 300 米之下可能储存水源的体积或质量知之甚少。

2016 年 6 月 17 日，PNAS 期刊在线发表了题为《美国加利福尼亚州深层地下水盐度研究：水资源的数量、质量及保护》（*Salinity of deep groundwater in California: Water quantity, quality, and protection*）的文章指出，该州中央山谷 305～3000m 处蓄水层含有大量的地下水，总量可达到 2700 km^3，相当于超过密歇根湖一半的水量且大多分布在不超过地下 1000m 的地方。

通过卫星图像可以揭示加州地下水如何迅速地运移，但无法表征出这些多孔介质（岩层、沙，淤泥和粘土）蕴含的水量。为了进行精确的测量，科学家们需要直接获取深部含水层（可达数千米深）的水和岩石的样本。但获得这些样本的成本较为昂贵，同时也面临着技术上的挑战。因此，研究小组决定利用不同的数据源：公共记录。

加州环保部门的石油、天然气和地热资源分部收集了来自该州油、气、矿藏中水的含盐量和总溶解颗粒物的数据。通过分析 360 个油、气井的数据，并将其与相应区域的岩石特性数据进行对比，例如孔隙度等，据此来推断该州 8 个县地下深达 5000 米的含水层的面积、体积和水质。与之前的地下水储量估计值相比，该研究所发现的“可用水”数量多达 3 倍，尽管这些水没有洁净到可以饮用的程度，但基本上可用于灌溉作物。

虽然，加州地下水储量比预想的更为丰富。但是，大部分的水源位于易受到石油和天然气开发污染的地区。以克恩县（Kern County）为例，该地区的石油和天然气开采活动，19%都集中于最新研究的淡水储存区，而 35%的石油和天然气开采活动活跃在饮用水区域。研究人员指出，在加州和美国其他地区需要加大对地下水的监测，特别是在油气钻探频繁、废水注入和水力压裂的地区。

此外，这种地下水即便容易被抽取出来，暂时也难以利用。其中，水质问题值得关注，比如高浓度的矿物盐和其他类型的污染物。在未来几十年后，可以通过对环境影响最小的提取和处理技术，使得这些苦咸水将来成为重要的水源地。然而，目前大部分地下水资源还是太深并且质量太差。

从政策角度来看，对于加州来说，防止过度使用浅层水比抽取深层水更为重要。当人们可以从 1/4 英里处抽水时，没有人会从 1 英里外抽取地下水。根据加州 2014 年新出台的地下水管理条例来看，如果深钻会对周围环境产生较大的影响，那么这种深钻也是违法的。

此外，长期抽取地下水还会产生地面沉降的风险，特别是在地下水较深的地区。如抽取地下水造成的下陷、岩石和粘土层崩溃等。在加州局部地区，地层下陷已造成土层以惊人的速度下沉。需要进一步地研究、监测这些深层地下水源，在某些情况下还需要做好保护措施。

原文来源：http://www.pnas.org/content/early/2016/06/21/1600400113

（来源：科学研究动态监测快报 2016-07-15，第 14 期总第 283 期）

GRACE 卫星首次揭示青藏高原及周边多地区地下水增加

2016年06月16日，《地球与行星科学通讯》（Earth and Planetary Science Letters，EPSL）在线发表了《从GRACE卫星重力数据揭示青藏高原及周边地下水储量的变

化》（Groundwater storage changes in the Tibetan Plateau and adjacent areas revealed from GRACE satellite gravity data）文章，该文由中国科学院测量与地球物理研究所汪汉胜研究员首席负责的“地球表层物质平衡的定量评估”团队、瑞典国土测量局、香港大学地球科学系的科学家合作完成。

了解青藏高原地下水储量的变化，对高原生态恢复、农牧业发展、地质灾害防治、工程设计和地热开发等具有重要价值，同时对水文循环和全球气候变化研究具有重要意义，但是，长期以来在青藏高原广阔的地区，由于可利用的水井水位测量数据极少，对地下水状况知之甚少。该团队采用卫星称量法，能大范围连续监测地下水的变化，即GRACE卫星在500km空中感受地下水增减变化的重力信号，再根据重力信号计算地下水储量的变化。该团队不仅利用了国际最新的GRACE重力场数据，还利用了多种水文模型提供的土壤湿度和积雪数据、冰川湖泊的ICESat-1卫星测高结果、冻土模型和最新的冰川均衡调整模型，揭示了青藏高原及周边2003-2009年期间的地下水的变化趋势，在高原东部河源地区、柴达木盆地、羌塘自然保护区中部、印度河上游流域和阿克苏河流域，首次发现了地下水呈现增加趋势，每年总增加量为186±48亿km^3，相当于三峡水库175m水位时近一半的库容量。

分析表明，地下水增加与流域或盆地周边地区的冰/雪、冻土融水和或降水增加所产生的径流补给有关；对于三江（澜沧江、长江和黄河）源地区，2005年来中国政府实施生态保护和重建工程，所采取的生态移民、限制放牧、森林湿地保护和人工降雨等措施，有利于地下水的储积，反过来地下水的增加也有利于生态恢复；地下水增加还与西部的内流盆地地下水沿北西-南东向活动断层的可能渗漏有关。

原文来源：http://www.sciencedirect.com/science/article/pii/S0012821X16302898

（来源：科学研究动态监测快报 2016-06-15，第12期总第234期）

基于影像分析测定河水表面流速的新技术

2016年4月27日，日本神户大学声明开发了一款名为“神户大学时空影像速度测量系统（KU-STIV）”的软件，可以通过河流影像测定河水表面的流速，该技术可以简易准确地获取河水流速，有助于制定有效应对洪水风险的对策。

日本几乎每年都遭遇洪水灾害，洪水对当地造成了很大的损失。准确的降水量和河水流量是创建洪水风险处理对策的关键因素。由于雷达技术的发展，降雨量测定已经具有很高的精度，然而，河水径流量的测定依然采用在河流表面放置棍形漂浮物，通过漂浮物的行进速度测定河水表面流速的这种老式方法。大洪水发生时由于危险等缘故，采用该方法就很难准确测定流速，而且，在洪水高峰期等诸多情况下无法采用此方法进行流速的测定。

KU-STIV系统采用相机和无人机拍摄的影像测定河水流速。该系统叠加影像片段中的“引线”（searching lines）（10~20 m）作为测定标准，通过河水表面水流特征和漂浮物交错轨迹的流动时间计算流动速度，然后分析其分布并间接地计算水流速度。采用该系统测定的流速和采用声学多普勒（ADCPs）方法测得的数据十分接近，而且与既定的方法相比，具有更快更安全的优点。

KU-STIV系统已经被日本国土、设施、交通和旅游等领域的众多河流专家和管理局所采用，并在兵库县开始部署影像河流监测系统。该系统的英文版也已经上市。近期，受加纳研究人员邀请，日本国际合作机构（JICA）将开展对该技术使用方法的培训。该系统的开发人员指出，通过升级系统将实现对水流速度的实时计算和监测，同时该技术有望成为日本及海外国家测定河水水流速度的标准方法。

原文来源：http://www.kobe-u.ac.jp/en/NEWS/research/2016_04_22_01.html

（来源：科学研究动态监测快报 2016-05-15，第10期总第279期）

基于云平台的水质监测系统问世

中国航天科工二院23所下属北京航天微电科技有限公司（以下简称微电公司）近日自主研发出基于云平台的水质监测系统，可快速、准确、长时间地获取局部水域的水质数据。

长期以来，我国水污染问题难以改善。城市水质污染的成因主要包括污染企业偷排、不良餐饮业丢弃废物、河流附近居民丢弃生活废品等。对城市内部河流进行实时水质监测，是解决该问题有效手段，然而传统水质监测站点造价昂贵，维护成本较高，且无法实时在线工作。

该系统将水质传感器安装在浮标平台上，可监测河流水域中的溶解氧、pH、总磷、总氮、氨氮、电导率、温度等参数，并通过通用分组无线服务技术，将采集到的数据及监测点的定位信息，实时传输到云端服务器数据库。系统依靠太阳能供电，传感器精度高、时间分辨率高、稳定性强，且监测点造价仅为国内外同类产品的五分之一。可以实时对某水域进行长时间监测，并对污染过程进行跟踪，能为市政服务提供数据，公众也可以通过网页或APP查询身边的水质环境。

（来源：《科技日报》2016-05-27）

CO_2 浓度升高将促进农产品水消耗量的降低

2016年4月18日，《自然·气候变化》（*Nature Climate Change*）杂志发表题为《CO_2浓度升高对不同地区作物水分生产率的有利影响存在差异》（*Regional Disparities in the Beneficial Effects of Rising CO_2 Concentrations on Crop Water*

Productivity）的文章指出，全球CO_2浓度升高可以大大减缓全球产量损失，同时降低农产品的水消耗量（4%~17%）。

美国芝加哥大学（University of Chicago）、美国哥伦比亚大学（Columbia University）、英国东英吉利大学（University of East Anglia）等多所大学的研究人员联合使用田间试验网和全球作物模型，模拟CO_2浓度升高对小麦、玉米、水稻和大豆几种农作物产量及其耗水量的影响，展示了全球作物水分生产率1（Crop Water Productivity，CWP）的空间变化。研究结果显示，21世纪80年代，全球CO_2效应使CWP提高了10%~27%。作物品种不同和区域差异均将对CWP造成影响，届时，干旱地区旱作小麦的CWP将提高至48%。大田试验网的研究结果表明，CO_2浓度升高可以大大减缓全球产量损失，同时减少农业水消费量（4%~17%）。该研究结果表明，不同区域为作物提供了差异化的生长条件，这为农业生态系统在不影响用水安全的前提下提高粮食产量创造了有利条件。该研究建议进一步开展长时间的田间试验，并改进模型，以逐步缩小模拟结果与田间试验之间的差距。

原文来源：http://www.nature.com/nclimate/journal/vaop/ncurrent/full/nclimate2995.html

（来源：科学研究动态监测快报 2016-05-15，第 10 期总第 196 期）

NOAA 指出美国水问题面临的科学挑战

2016年7月11日，美国国家海洋与大气管理局（NOAA）局长Kathryn Sullivan博士针对美国水资源面临的挑战进行了分析，发表了分析评论。

美国和全球范围内，水安全所造成的系统性风险持续提升，在美国，水挑战主要的形式包括：

（1）危险的洪水：每年洪水灾害造成的人员死亡数量超过其他极端气候事件，超过飓风和龙卷风。2015年山洪暴发和河流洪水造成176人死亡，远高于2014年的38人。

（2）海平面上升：整体来看，海平面继续以平均每年0.125英寸的速率上升。新奥尔良西部20英里处，水管理人员不得不通过打开泄洪道，以降低不断升高的密西西比河高度。这是1931年以来的第11次。

（3）极端干旱：2015年，美国西部的干旱是造成数十亿美元损失的天气和气候灾害中的重要方面。截止到6月底，美国有超过8170万人正在经历极端干旱造成的影响。

（4）藻类暴发：2014年，伊利湖的有毒藻类暴发，污染了托莱多市（俄亥俄州的水供应地），影响了50万人超过3天的用水。研究人员预测，2016年的藻华可能将不会那么严重，但仍然应引起注意。

原文来源：http://www.noaa.gov/blog-tackling-americas-water-challenges-science

（来源：科学研究动态监测快报 2016-08-01，第 15 期总第 284 期）

USGS：美国 25 个州的地下水具有较高的潜在腐蚀性

2016 年 7 月 12 日，美国地质调查局（USGS）发布题为《美国未处理的地下水的潜在腐蚀性》（*Potential corrosivity of untreated groundwater in the United States*）的报告，评估了美国 2 万多口井的地下水的潜在腐蚀性，指出 25 个州未经处理的地下水具有较高的潜在腐蚀性，其中，东北部、东南部和西北部州地下水的潜在腐蚀性最高。

如果不加以处理，地下水的腐蚀性能溶解管道中的铅和其他金属以及水分布系统中的其他成分。USGS 的研究人员采集了美国 2 万多口井的地下水样本，利用朗热利耶饱和指数（LSI）和潜在的促进电化学腐蚀（PPGC）两个潜在腐蚀性指标，识别了美国哪些地区家庭饮用水中更容易受金属浓度升高的影响。研究发现，基于 LSI 指标，20962 个地下水样点中约有 1/3 的样点具有潜在的腐蚀性。基于 PPGC 指标，26631 个地下水样点中约有 2/3 的样点具有中度的 PPGC；8%的地下水样样点具有高的 PPGC。

研究人员利用这两个指标绘制了全国的地下水潜在腐蚀性地图，发现美国 50 个州和哥伦比亚特区的地下水均具有不同程度的潜在腐蚀性。有 11 个州和哥伦比亚特区的地下水具有很高的潜在腐蚀性，这些州中有 800 万人口依赖于地下水供给；有 14 个州的地下水具有较高的潜在腐蚀性，这些州中有 1600 万人口依赖于地下水供给；有 19 个州的地下水具有中度的潜在腐蚀性，这些州中有 1800 万人口依赖于地下水供给；有 6 个州的地下水具有较低的潜在腐蚀性，这些州中有 100 万人口依赖于地下水供给。地下水潜在腐蚀性非常高和较高的地区主要分布在东北、中大西洋、东南和西北地区。该结果对依赖于将未处理的地下水作为饮用水的人们具有很大的影响。

原文来源：https://pubs.er.usgs.gov/publication/sir20165092

（来源：科学研究动态监测快报 2016-08-15，第 16 期总第 285 期）

研究称南亚主要流域 60%的地下水无法使用

2016年8月29日，*Nature Geoscience*期刊发表题为《原位观测反映印度恒河流域的地下水质量和损耗》（*Groundwater Quality and Depletion in the Indo-Gangetic Basin Mapped from in Situ Observations*）的文章指出，南亚主要流域——印度恒河流域6成

地下水无法使用，盐化度高和砷污染是其主要原因。

印度恒河流域冲积含水层是世界上最重要的淡水资源。印度恒河流域的地下水抽取量占到全球地下水抽取的25%，以维持巴基斯坦、印度、尼泊尔和孟加拉国的农业生产力。最近的卫星重力数据表明，当前的抽取是不可持续的，但对其原因解释缺乏政府有效管理地下水需要的时空分辨率。来自英国、孟加拉国、巴基斯坦、印度、尼泊尔、美国等国家的研究人员发现了来自高分辨率的原位地下水位、抽取量和地下水质量记录的新证据。

研究发现，印度恒河流域可持续地下水供应所面临的最大威胁是污染，而非枯竭。研究人员估计200m深处的地下水量是印度河、雅鲁藏布江和恒河年径流量总和的20倍以上。但该流域储藏的约23%地下水含盐量过高，且37%的水受到砷污染的影响。2000-2012年，地下水位实际上是稳定的，或者约70%的含水层在上升。剩下的30%，地下水位正在下降，年净枯竭量达到8.0±3.0km^3。

原文来源：http://www.nature.com/ngeo/journal/vaop/ncurrent/full/ngeo2791.html#affil-auth

（来源：科学研究动态监测快报 2016-09-15，第 18 期总第 287 期）

业界动态

UNESCO 发布《2016 年世界水资源发展报告-水与就业》

2016年3月22日，联合国教科文组织（UNESCO）发布题为《2016年世界水资源发展报告——水与就业》（*The United Nations World Water Development Report 2016–Water and Jobs*）的报告指出，通过协调政策和投资来处理水—就业纽带关系，是发展中国家和发达国家实现可持续发展的首要任务。

对于全球农业、工业、运输和能源生产来说，水资源的获取都是至关重要的，同时也是经济增长的动力。水利基础设施以及获得安全、可靠和经济的水与卫生服务可以改善人们的生活，促进地区经济发展，在全世界维持和创造就业机会，使更多的人融入社会。同时，水资源可持续管理也是实现绿色增长和可持续发展的必要推动力。

水是生命的根基，对于更包容和可持续的发展至关重要。《2030年可持续发展议程》中水资源发展目标居于核心位置，实现该目标不仅确保足量的水资源，还需要保障提供质量安全和卫生的水。目前，水资源领域的工作主要涵盖三个方面：①水资源管理，包括水资源综合管理以及生态系统修复和补偿；②修建、运行和维护水利基础设施；③提供与水相关的服务，包括供水、卫生和污水处理。

总体来说，全球劳动力或世界上78%的工作依赖于水资源。除了农业和工业，其他高度依赖水资源的行业还包括林业、内陆渔业和水产业、矿业和资源开采业、供水和卫生服务，以及大部分类型的发电企业。同时，健康护理、旅游和生态环境管理等也有与水紧密相关的工作。

（1）农业-食品行业：水量不足或不稳定会影响农业-食品行业的就业质量和数量。投资农业往往能提高产量、改善就业质量，但也可能会以减少就业为代价。在这样的情况下，需要推行适当的政策减少对失业人员的影响。

（2）能源：全球能源需求不断增加，发展中国家和新兴国家对电力的需求尤为突出。能源行业的用水量剧增，目前已占全世界耗水量的15%，并且直接创造了就业。而与此同时，全球可再生能源行业的发展使绿色的、不依赖水的行业的就业机会增加。

（3）工业：目前，工业和制造业用水量占全球的4%；预计到2050年，仅制造业的用水量就将增长400%。随着工业技术的进步，对水在经济增长中的关键作用以及水资源的环境压力的相关认知不断增加，该领域正采取措施减少单位工业生产的耗水量，尽量提高工业用水效率。未来，工业领域还在进一步加强水资源的回收再利用，改善水质满足生产需求，谋求实现更清洁的生产。

未来，各国应根据本国资源、潜能和发展重点，确定和制定特定的、协调一致的战略、计划和政策，在保证水资源和环境可持续发展的前提实现行业平衡，最大程度地创造更多相关高产的工作。国际社会也通过制定水、卫生、相关工作和可持续发展的长期目标，为各国制定发展目标行动框架指明方向。

为各经济行业分配水资源和提供水服务将很大程度上决定国家和地区层面高质量工作的增长潜能。国家或者地区能够将重点放在与环境可持续和创造就业紧密相关的经济行业将是成功的关键。实现这些目标需要水、能源、食品和环境政策的协调一致，以确保激励手段一致有效地服务于所有利益相关者。

原文来源：http://unesdoc.unesco.org/images/0024/002439/243938e.pdf

（来源:科学研究动态监测快报 2016-04-15,第 8 期总第 277 期）

UN-Water 解析联合国可持续发展议程“水领域目标”

2016年6月7日，联合国水机制（UN-Water）以图文并茂的方式发布了题为《基于可持续发展目标的水循环》（The water cycle in the sustainable development goals）的简明报告，详细解析了《改变我们的世界：2030年可持续发展议程》中有关水资源可持续发展的目标，指出有必要从整体、全面的角度剖析水资源可持续发展目标如何以集成的方式覆盖全球整个水循环过程。

随着时间的推移，全球水循环的可持续发展对于所有的水资源用途和用户都是

至关重要的。联合国《2030年可持续发展议程》所包括的全部17项可持续发展目标中水与卫生发展目标排名第六，具体是：①目标6.1饮用水安全目标；②目标6.2确保安全的卫生设施和卫生条件；③目标6.3改善水质和增加全球废污水处理；④目标6.4。以可持续的方式供应淡水和水安全保障；⑤目标6.5开展水资源综合管理工作；⑥目标6.6保护和恢复与水有关的生态系统；⑦目标6a加强国际合作；⑧目标6b利益相关者参与。同时，可持续发展目标11.5提出涉水灾害管理目标，该目标则包含在可持续发展目标11：建设包容、安全、有抵御灾害能力的可持续城市和人类住区。此次，可持续发展目标（SGDs）继承并完善了水与卫生千年发展目标。

从下图中可以看出，联合国2030发展议程中提出的涉水目标，涵盖了全球水循环的整个过程，所制定出的可持续发展目标、思路和方向对全球水资源开发利用和节约保护将会产生重要影响，并且将朝着解决涉水部门和区域碎片化管理迈出第一步。

图1 基于可持续发展目标的水循环

原文来源： http://www.unwater.org/news-events/news-details/en/c/417707/SDG6_targets_UN-Water highres_web.pdf

（来源：科学研究动态监测快报 2016-07-01，第13期总第282期）

高性能计算机大幅提升水资源管理决策效率

2016年8月25日，兰德公司和劳伦斯利·弗莫尔国家实验室（LLNL）高性能计算机创新中心（HPCIC）举办了联合研讨会。研讨会探讨了如何在水资源管理问题

上，将高性能计算机和新型公共政策分析结合，以更好地解决一些特别复杂的问题。

兰德公司在2012年科罗拉多河流域开展的相关前期工作的基础上，举办了本次联合研讨会。会上研究人员展示了采用高性能计算机模拟系统对一些水资源管理策略进行压力测试，近乎实时地测试了大量可能发生的情况。此前所采用的“审议-与-分析”方法，是利益相关者与专家一同用科学严谨的态度来评估复杂的问题且给出备选的解决方案，但这个方法可能需要数周的时间才能得到结果，从而拖慢决策进程。然而，利用超级计算机可以将模拟速度提高500倍，从而大大提升决策效率。

研讨会上，研究人员模拟了几千种情况，展现将来气候变化和发展模式的不确定性。以此为背景，高性能计算机测试了水资源管理的五个方面内容——水资源保护、地下水、海水淡化和水资源的再使用等。

HPCIC主任弗雷德斯特赖茨指出，本次研讨会显示了LLNL先进的计算能力如何支持兰德公司创新性分析方法的发展。两者结合可以提高我们对水资源管理问题的决策和政策制定的效率。这些相同的方法和资源可以改进决策过程，解决国家和企业面临的挑战。

原文来源：http://www.rand.org/news/press/2016/08/25.html

（来源：科学研究动态监测快报 2016-09-15，第 18 期总第 287 期）

水污染防治行动计划投资超 4300 亿

环境保护部8月8日宣布，共有4800余个项目纳入2016年度水污染防治行动计划中央储备库，总投资超过4300亿元。其中，甘肃刘家峡水库、湖南三仙湖等15个已获省级政府批复的水质较好湖泊生态环保总体实施方案作为首批项目入库，湖南湘潭市、四川广安市等103个符合中央储备库入库条件的地市水污染防治实施方案也作为首批项目入库。

环保部规划财务司有关负责人说，环保部近期联合财政部组织开展了以地级城市为申报单元的水污染防治行动计划项目储备库建设，分中央储备库和省级储备库，水污染防治相关项目实施依托储备库开展。中央财政近期已下达2016年度中央水污染防治专项资金130亿元，将首先用于省级人民政府批复的水质较好湖泊生态环境保护，集中用于城市集中式饮用水水源地保护、重点流域水污染防治、地下水污染防治等。对于未纳入中央储备库的项目，中央水污染防治专项资金原则上不予支持。

据悉，水十条项目储备库建设成效将作为项目投资安排、监督检查、绩效评价的重要参考依据。财政部、环保部加强考核，将资金安排与水环境质量改善目标挂钩，建立奖优罚劣机制等。

（来源：《科技日报》 2016-08-11）

合理的水资源管理可以缓解气候变化加剧的缺水压力

2016年5月3日，世界银行（World Band）发布题为《高温与干旱：气候变化、水与经济》（*High and Dry: Climate Change, Water, and the Economy*）的报告，评估了由气候变化和水资源需求加剧引发的水资源短缺的影响，指出水资源短缺影响经济增长，并导致人口迁移与冲突，建议通过更合理的政策引导与水资源管理缓解水资源短缺的负面影响。

气候变化加剧的水资源短缺，造成的经济影响可达某些地区GDP的6%，并导致人口迁移与冲突。人口增长、经济发展和城市扩张等带来的综合影响将造成水资源需求呈指数型增长，同时，水资源的供应变得更加不稳定和不确定。如果不立即采取行动，目前水资源充沛的地区如中非和东亚将面临缺水，而水资源短缺的地区如中东和非洲萨赫勒地区的缺水状况将进一步加剧。由于水资源短缺对农业、人体健康和收入的影响，到2050年这些地区的GDP增长将下滑6%。

报告指出，通过更好的政策引导和合理的水资源管理，能够缓解水资源短缺的负面影响，使部分地区经济增长速率提升6%。改进水资源管理能够带来高额的经济红利，如果政府通过提升水资源利用效率来应对水资源短缺，只要将25%的水资源分配用于更高效的用途，如节水农业，就能显著减少经济损失。在极端干旱地区，需要进行更长远的政策规划，避免水资源利用效率低下，通过更有力的政策和改革措施来应对气候变化压力的加剧。

为了引导各国增强水资源安全性和气候恢复力，报告提出以下政策建议：

（1）优化水资源分配规划，采取激励措施，提升水资源利用效率。①跨行业分配稀缺水资源。通过规划和规范，或者通过价格和用水许可等市场工具，跨行业合理分配和有效利用水资源，建立具有气候恢复力的经济。在此过程中需要建立信用机构、政策和法律系统，在水资源的输送过程中保证交易各方的利益。②行业内部提升用水效率。通过新型节水技术、激励措施、教育和认识，采用气候智能型农业（CSA）、可持续农业集约化（SAI）等方法提升农业产量，减少能源和水足迹。

（2） 投入基础设施建设，增强安全水资源的供应和获取。修建水库等储水设施，加强水资源循环、再利用和海水淡化，尤其在干旱地区增加水资源供应显得更加重要。相比而言，地下水补给和湿地保护等措施的风险和成本更低，回报更高。

（3）减少极端事件、气候变率和气候不确定性的影响。增加水库蓄水能力和水资源再利用有助于建立气候恢复力，更好的城市规划、风险管理和市民参与有助于减少城市面临的洪水风险。在农村地区，扩大农作物保险项目能保护农民免受暴雨袭击的风险。在沿海城市，海塘、堤坝和水库等大型设施有助于减少风暴潮和洪水灾害。

原文来源：http://www.worldbank.org/en/topic/water/publication/high-and-dry-climate-change-water-and-the-economy

（来源:科学研究动态监测快报 2016-05-15,第 10 期总第 196 期）

环保部：上半年空气改善地表水质量稳定

环境保护部 7 月 17 日发布了 2016 年上半年全国空气和地表水环境质量状况。监测表明，338 个地级及以上城市空气质量总体呈改善趋势，重点区域大气颗粒物浓度持续下降；北京主要污染物浓度持续下降，优良天数同比有所增加。全国地表水环境质量总体保持稳定。

环保部环境监测司司长罗毅说，上半年，74 个城市中空气质量相对较差的 10 个城市分别是保定、邢台、郑州、邯郸、济南、唐山、乌鲁木齐、衡水、石家庄、西安。空气质量相对较好的 10 个城市分别是：海口、惠州、厦门、深圳、珠海、中山、舟山、江门、丽水、拉萨。

338 个地级及以上城市中，78 个城市空气质量达标，同比提高 6.5 个百分点；平均优良天数比例为 76.7%，同比提高 4 个百分点。PM2.5、PM10 分别浓度为 49、90 微克/立方米，分别同比下降 9.3%、6.3%。北京上半年优良天数比例为 58.8%，同比升高 10.2 个百分点。PM2.5、PM10 浓度分别为 64、88 微克/立方米，同比下降 17.9%、19.3%；臭氧浓度为 211 微克/立方米，同比上升 5.5%。

罗毅说，与去年全年水质相比，全国地表水环境质量监测网 1940 个断面中，水质优良（一—三类）断面比例为 68.8%，上升 2.8 个百分点；劣五类断面比例上升 0.8 个百分点。十大流域中，浙闽片河流、西北诸河、西南诸河水质为优，长江、珠江流域水质良好，黄河、松花江、淮河流域为轻度污染，辽河流域为中度污染，海河流域为重度污染。112 个重点湖（库）中，9 个湖（库）水质为一类、32 个二类、36 个三类、19 个四类、5 个为五类，劣五类的 11 个。滇池水质平均为五类，同比明显改善；太湖、巢湖为四类，同比有所改善。“三湖”营养状态均为轻度富营养。

（来源：《科技日报》2016-07-18）

智能水务新技术亮相国际水周

新加坡国际水周7月10日至14日在滨海湾金沙展览和会议中心举行。展会上，新加坡公用事业局展出了与合作机构共同研发的5个智能技术项目，这些项目将提高水务管理效率、改善水务领域相关服务质量。

据介绍，新加坡公用事业局与新加坡国立大学环境研究所等机构共同研发了3只“机器天鹅”——全称为“新型智能水评估网络系统”的天鹅型水样采集机器人，以帮助研究人员实时监测水质。

研究人员在“机器天鹅”身上安装了定位及感应装置，使其能在游动中实时监测蓄水池水质并回传数据，还可以抽取水样。在“机器天鹅”帮助下，实时监控数据的抽样范围比固定测量点抽样扩大了很多，同时也提高了效率。据悉，公用事业局目前已完成测试工作，正在讨论把“机器天鹅”部署在哪些地方工作。

除“机器天鹅”外，无人机也在公用事业局展示的新技术之列。从今年4月开始，该局开始探索用无人机辅助监测蓄水池状况，为此已评测了不同类型的无人机。

此外，无人机还将用于监测和即时维护深隧道型污水系统。公用事业局表示，无人机能更好地适应无光照、无定位的环境，与传统方法相比，用无人机监测和维护将更加高效。

另外，公用事业局研发的自动水表计量系统、分布在新加坡全岛的淤泥实时监测系统等也吸引了不少参观者。

（来源:《科技日报》2016-07-13）

“世界水周”关注可持续增长用水资源

8月29日第26届“世界水周”论坛29日在瑞典首都斯德哥尔摩开幕，为期5天的论坛将围绕“用于实现可持续增长目标的水资源”这一主题，探讨如何应对水资源短缺所带来的各项挑战。

主办方斯德哥尔摩国际水研究所发布的新闻公报说，“世界经济论坛”已将水危机列为未来数年全球面临的最严峻挑战之一，目前不断增长的全球人口对水资源供应造成巨大压力，因此为全球多项复杂的水资源挑战寻找解决方案正在成为研究人员、政策制定者以及社会各界急需解决的问题。

经济合作与发展组织秘书长安赫尔·古里亚在开幕致辞中指出，如今水问题已经成为国际上首要的、中心的议题，“水现在占据了它在国际首要议题中应有的地位”。

瑞典外交大臣玛戈特·瓦尔斯特伦在开幕致辞时强调，成功实现联合国2030年可持续发展议程中“为所有人提供水和环境卫生并对其进行可持续管理”的目标，将会对实现该议程的其他目标起到推动作用。

（来源：《科技日报》 2016-08-31）

新型复合材料可高效清除持久性水污染物

合肥工业大学近日成功制备出一种新型硼氮改性铁包覆碳纳米管磁性复合材料催化剂。利用新型催化氧化反应体系生成的高活性自由基基团，可高效去除有机污

染物，解决了水处理中污染物难以深度清除的难题。相关研究成果日前发表在国际学术期刊《水研究》上。

根除工业生产中产生的持久性有毒污染物，是目前水污染治理领域急需解决的关键技术难题。工业生产中产生的持久性有毒污染物在自然环境中难以降解，同时可远距离传输，并随着食物链在动物和人体中累积、放大，具有致癌、致畸、致突变以及干扰内分泌系统等危害。目前采用的混凝、沉淀、生物氧化等水处理工艺和活性炭吸附、臭氧—活性炭联用、膜处理等深度净化技术，均无法根除此类污染物。

合肥工业大学化学与化工学院副教授姚运金及其课题组创新性地构建了新型类芬顿催化氧化反应体系，以三聚氰胺等常见廉价试剂为原料制备的新型硼氮改性的铁包覆碳纳米管磁性复合材料，对持久性有毒污染物呈现出显著的去除性能。实验结果表明，针对目前广泛存在的各种有机污染物，与传统芬顿反应体系相比，这一新型材料使污染物分解速度提高了10至100倍。同时，该新型材料的制备采用一步煅烧技术，金属离子还原、金属纳米粒子碳包覆以及非金属元素掺杂改性等有机污染物的清除过程均在同一设备中实现，从而克服了传统热解法制备工艺复杂、还原处理风险较高以及非金属元素改性效果不佳等技术缺陷。

有关专家表示，由于反应体系温和、设备简单，这一成果可广泛应用于工业企业。

（来源：《科技日报》 2016-06-10）

重金属自控削污等 8 项关键技术研发成功

4月9日，国家水专项“锰锌湿法冶金行业重金属水污染物过程减排成套工艺平台”课题组在接受科技日报记者专访时表示，课题在电解锰、锌行业首次研发成功自控削污等8项关键单项技术，世界首创“电解锰行业重金属水污染物过程减排成套工艺平台”等。

我国电解锰产能、产量均占世界的98%以上，电解锌产量连续十几年居世界首位。中国工程院院士段宁认为，电解锰、锌重金属水污染严重的根本原因是生产流程工艺落后、设备简陋。其现有末端治理技术或难以稳定达标，或成本过高，更无法解决操作环境对工人身体健康的危害。

为解决重金属污染问题，国家水专项“河流水环境综合整治技术研究与综合示范”主题专门设立了“锰锌湿法冶金行业重金属水污染物过程减排成套工艺平台”课题。段宁说，经过多年科技攻关，课题在电解锰、锌行业首次研发成功8项电解车间专用智能制造、自控削污等关键单项技术，以多功能机械手、出入槽精准定位为核心的多学科、大跨度、跨领域的多项单体技术集成技术，集成建设了与1万吨电解

锌/年生产线相配套的示范工程；课题成果在世界最大电解锰企业宁夏天元锰业等企业应用，减污增效保护工人健康等效果良好。

课题还首次在湿法冶金行业成功开发硫酸盐智能识别及干法去除技术，硫酸盐结晶物回收98%以上；开发原位“刷收”技术，分别削减电解锰、电解锌电解出槽阴极板挟带液超过75%、80%。

（来源：《科技日报》 2016-04-09）

超强氧化技术实现废水达标排放

日前，“超强氧化还原废水处理装置”科技成果发布会在京举行。中国环保产业协会水污染治理委员会秘书长王家廉介绍，在国内废水治理方面，该装置取得了突破性进展，不仅效率高、成本低，而且废水处理效果显著、工艺装置占地面积小。

河南省天盛环保工程设备有限公司承担该装置主要研发工作。该装置处理后的废水达到电镀污染物排放表三标准，适用于电镀、采矿、冶炼、化工、医药、农药、电池行业、重金属等废水处理，已列入国家重点高新技术项目。

（来源：《科技日报》 2016-08-29）

仿生蕨“纳米皮草”有助清理水中油污

德国科学家近日发现，以往人们谈之色变的水生漂浮杂草具有吸油功能，仿照水生植物结构合成的人工聚合物薄膜“纳米皮草”，也像水生蕨类一样具有超级疏水和亲油性，有望为清理水中油污提供一种更便捷的手段。最新研究成果发表在《生物灵感与仿生学》杂志上。

据物理学家组织网报道，该研究由德国卡尔斯鲁厄技术学院微结构技术研究所（IMT）和波恩大学植物生物多样性尼斯研究所共同完成。研究团队将研究重点放在了一些水生蕨类植物上，包括一些长着毛茸茸叶子的槐叶苹科植物。这些毛茸茸的扩展体称为毛状体，分为四类。为了找出不同毛状体种类与吸油效果的关联性，研究人员对样品进行了精心处置。

IMT的研究人员克劳迪亚·泽格解释说：“研究发现，毛状体尾部形状决定了油／空气接触面的大小，能使吸油效果达到最大化并保留长期的吸附能力，我们据此研发出一种称为‘纳米皮草’的毛绒面合成版。这种‘纳米皮草’由热压厚板制成聚合物薄膜，当钢板回缩时，聚合物表面融化，微纳米尺度的毛发从表面拔出。”

“纳米皮草”像水生蕨类一样具有超级疏水和亲油性，可以选择性地吸油而不吸水。该研究的一个最初目的是通过了解植物来提高“纳米皮草”的吸油能力，但

目前的研究结果也为其他研究提供了可能。

研究人员在论文中强调，水生蕨类在世界很多地区被看成杂草或有害物，利用其进行吸油或许可以同时解决两个问题——清除多余的自然植物及生产低成本的石油吸附剂材料。

（来源：《科技日报》 2016-08-19）

GFDRR 等机构总结日本水文气象服务现代化的经验教训

2016年8月25日，全球减灾和恢复基金（GFDRR）等机构联合发布题为《日本水文气象服务现代化：灾害风险管理的经验教训》（*Modernizing Japan's Hydromet Services: A Report on Lessons Learned for Disaster Risk Management*）的报告，通过研究日本的水文气象服务，结合其他拥有先进的现代服务系统的国家的相似研究，总结日本现代风险服务需求方面经验教训，旨在为决策者提供知识库，帮助政府和赞助商了解天气、气候和水文服务的基本运营，使其能更加有针对性地进行财政支持。报告的主要内容如下：

（1）水文气象服务的现代化需要长期而按部就班的努力，这一过程应该在中长期战略中加以明确规定。①水文气象战略应该把现有的科学和技术考虑在内，同时也需要考虑经济和人力因素。②制定全面的战略规划是一个持续并反复的过程；特别需要注意的是在重大灾害发生后，要重新审视和修改这些战略，因为重大灾害事件通常会提供关于水文气象系统或者水文气象服务方面的宝贵经验教训。③清晰的战略也能够促进提供支持的捐助者之间的协作。

（2）法律和监管框架应该明确规定各国气象和水文部门（NMHS）的角色和职责，还要规定提供气象、水文以及早期预警服务的公、私部门的角色和职责。①有效的早期预警系统需要角色和职责不同的利益相关者之间有良好的协调合作，还需要简化的操作程序，以确保及时向所有在风险中的居民传递有用信息，同时避免多种互相矛盾的预警。②为了推进这些有效的系统实施，国家法律应明确规定NMHS作为预警服务的唯一权威来源。③保证落实有效的监管框架和标准的运作程序。

（3）在发展中国家，水文管理框架的设计和发展应与水资源综合管理（IWRM）相一致，如果可能的话，应完全包含在IWRM里面。IWRM是联合国设计的一个可持续发展目标，并在全世界范围通过基于流域的方法得到加强。在日本，水文服务已经被归为IWRM的组成部分。

（4）可靠的气象、地震、水文观测和数据管理系统是所有相关服务的先决条件。①公开的数据政策可以为社区提供范围更广、利用价值更高的数据。②维护和运行可靠、可持续、质量有保证和面向用户的观测系统是水文气象服务成功的关键，对于气候变化适应和管理灾害风险战略也至关重要。③观测系统所使用的工具，在国

家、地区以及全球水文气象机构中都应该有很高的可追溯性，而且在质量保证、质量控制和数据归档方面有合适的维护机制。

（5）水文气象系统和服务中心的紧急备份（hot backup）对于业务连续性是很必要的。在发展中国家，至少应该有一个地理上单独的“第二”服务中心，可以用来操作最基本的应急服务。这个服务中心应该包含重复监测和信息通讯技术（ICT），以及紧急快速激活的最基本服务。

（6）与相关部门和公众密切合作，建立和改善面向用户、基于风险和无缝的早期预警服务。维护和测试制度的安排是有效服务的关键。一些灾害可能是因为多种事件的复杂结合产生，因此，这些事件的有效防范和管理，需要借助一种与各利益相关方协作的多风险综合方法，包括水利局、灾害管理机构和地方政府等。

（7）与当地一线应急人员和公众之间保持强有力的协作很必要。在地方上，公众是管理灾害风险行动的最后运作层面，通过多种方法加强地方政府和公众之间的交流很必要。原因在于，仅仅通过发布预警和相关信息，或者仅仅依靠政府部门的管理，通常无法确保早期的行动。

（8）水文气象服务的现代化应该基于用户需求。只有当用户理解和使用水文气象信息，并做出决定和采取行动的时候，水文气象信息的社会经济价值才能体现出来。用户需求决定着服务的类型和范围。在日本，水文气象服务的现代化很大程度上受用户需求的影响，这些需求包括洪水管理、水资源利用规划、导航、交通、农业、能源或者水文气象灾害的早期预警。

原文来源：http://pubdocs.worldbank.org/en/355891472179524146/DRMHubTokyo-Japan-Hydromet-Summary.pdf

（来源：科学研究动态监测快报 2016-09-15，第 18 期总第 287 期）

WRI：宁夏水资源管理的用水压力分析及政策建议

2016年8月17日世界资源研究所（WRI）发表一篇关于《宁夏水资源管理压力及应对政策建议》（*Water Stress Analysis and Recommendations for Water Resources Management in Ningxia*）的报告。该报告是由世界资源研究所与宁夏回族自治区人民政府研究室、中国水风险（China Water Risk）共同完成。报告研究的目的是为了帮助政府和企业更好地了解宁夏所面临的水压力，以及社会经济发展对宁夏水压力可能产生的影响。该研究利用世界资源研究所Aqueduct水风险地图工具评估了宁夏的基准水压力（Baseline Water Stress），在分析了宁夏水资源禀赋、水资源管理以及用水方式现状的基础上，重点分析了宁夏煤炭产业发展对水资源的潜在影响，并提出了有益的水资源管理建议。

宁夏地区水资源禀赋匮乏，降雨偏少、分布不均。可用水资源主要为当地地表

水、地下水、黄河水以及苦咸水，其中90%的用水需求来自黄河水。宁夏用水类型主要包括农业用水、工业用水、农村人畜用水和城镇生活用水，农业用水占总取水量的90%，并且用水效率相对较低。能源产业（特别是煤炭产业）是宁夏经济的重要增长极。由于煤炭上下游产业均属高耗水行业，带来经济迅速增长的同时，也给宁夏的水资源带来巨大压力。气候变化也可能加剧宁夏地区的水压力风险。随着全球气候变暖，黄河流域水资源呈现减少趋势，进一步加剧黄河水资源的供需矛盾，因此依靠黄河水为主要水资源来源的宁夏在未来用水方面存在潜在的风险。

世界资源研究所根据宁夏有关部门提供的降水量、水资源量、用水量、耗水量等数据信息，对宁夏的基准水压力进行了分析。宁夏全区70%以上的地区都面临着非常高的水压力；银川和石嘴山两个地级市属于水资源极度匮乏地区。分析宁夏现有火电厂布局发现，91.5%的煤电装机容量都分布在水资源极度匮乏的地区。根据宁夏水资源特征及用水特点，提出如下建议：①优先深入节水工作，尤其是提高农业用水效率；②将水资源作为限制性因素纳入能源、煤炭产业发展规划，促进能源、煤炭产业和水资源的可持续开发利用；③总结水权转换经验，推动建立水权交易机制；④加速水价改革，提高水资源收费标准，利用经济杠杆促进节水；⑤宁夏应建设矿山开发生态补偿机制，尝试流域水环境生态补偿机制。

原文来源：http://www.wri.org/sites/default/files/Water_Stress_Analysis_and_Recommendations_for_Water_Resources_Management_in_Ningxia.pdf

（来源：科学研究动态监测快报 2016-09-01，第 17 期总第 286 期）

专家建议水库泄洪建立分级预警机制

6 月 20 日 19 时 20 分，江西省鄱阳县古县渡镇向阳圩（位于昌江下游右岸，临近鄱阳湖）发生溃决。截至 20 日 24 时，受威胁的 5600 人已全部安全转移，其中转移至堤上 1200 人，转移至坚固楼房上 4400 人，没有人员伤亡。新华社早前报道称，因高水位急剧上升、滨田水库泄洪、昌江洪峰通过叠加作用，导致此次溃堤发生。

《水利学报》主编、防洪专家程晓陶接受记者采访时指出，如今水库紧急泄洪的风险实际比过去更高。现在许多水库功能转以城市供水为主，汛限水位调整提高，发生应急泄洪的概率随之增大。汛限水位，指的是汛期水库限制运行水位，汛限水位以上库容为防洪库容。汛限水位提高，防洪库容减少。一旦上游来水量过大，水库水位更容易攀升至需紧急泄洪的水位。

目前的通行做法是根据库区上游天气预报降雨量数据来决定是否“预泄腾库”。此时又会面临一个两难选择——如果天气预报不准，上游来水量不够，可能会出现水库蓄水量不足无法满足城市供水的尴尬。因此，水库往往要到确定降雨时才会真正开闸放水。一些中小型水库本就归属地方管辖，其库区上游缺少健全的雨水情测

报系统，只能根据水库水位的实际涨幅情况是否达到临界值来决定是否泄洪。经过向上级报告、拿到上级批示等流程后，留给下游百姓撤离的时间非常有限。“中小型水库的这一时间差可能就只有十几到几十分钟。”

程晓陶表示，最近几年因洪水发生的人员伤亡事故，有些就和水库紧急泄洪有关。如果能建立分级预警机制，即相关部门在水库水位上涨、出现应急泄洪的可能性时，先向分洪区发送“预警报”， 以便当地百姓有较充分时间做好应急避险的准备。

“预警体系决不能仅仅是个文本，从政府到各企事业单位到普通公众，必须非常明确，接到怎样的信号，得采取怎样的行动。”程晓陶说，预警体系不是一个大而化之的概念，它应落地为可操作的实施方案。每个地区应根据自身实际情况，对洪水预警体系的各个环节进行确认和落实。程晓陶记得，有一年他去奥地利开会，到了周六中午十二点，街上所有警报器齐鸣。当地人员解释说，这是为了测试城市中的警报器能否正常工作而进行的例行演练。

在我国，预警信息主要靠传统通讯手段逐级向下通传，这对政府们的责任意识、管理水平也提出更高要求。“平日要进行演练，职责要落实到人，政府各相关部门必须协调行动，预警系统才能正常运转，最大限度避免泄洪带来的生命财产损失。”

（来源：《科技日报》 2016-06-21）

京津冀水资源衰减如何破解--国家重点研发计划项目为其保驾护航

“京津冀地区是我国乃至全世界人类活动对水循环扰动强度最大、水资源承载压力最大、水资源安全保障难度最大的地区之一，随着气候变化和人类活动的影响，京津冀地区可利用水资源量呈现显著衰减的趋势。”中国水科院水资源研究所副所长赵勇12日在接受科技日报记者专访时表示。

京津冀地区生产总值占全国11%，但多年平均水资源量不足全国1%，人均水资源量仅为全国平均值的1/9，水资源条件与经济社会布局极不相称。研究显示，京津冀地区年均水资源总量由1956-1979年的291亿立方米减少到1980-2000年的219亿立方米，2001-2010年年均总量进一步减少到166亿立方米；入境水量由上世纪50年代的100亿立方米减少到2000-2014年的24亿立方米。

为了支撑经济社会发展，京津冀地区付出了巨大的生态环境代价。赵勇举例道，目前京津冀地区重要河流主要河段年均断流260多天，湿地面积较上世纪50年代减少了75%，1980年以来海河南系几乎无水入海或仅有少量的污水入海，地下水累计超采量超过1550亿立方米，形成了3.3万平方公里浅层地下水超采区和4.8万平方公里深层地下水超采区，已经发展成为全球最大的“地下水漏斗”。

随着京津冀协同发展战略的大力实施和南水北调东中线工程的相继通水，京津冀地区水资源形势正在发生显著变化，水资源安全保障也面临着新的挑战和要求。“亟须将京津冀三地作为一个有机整体，统筹开展水资源问题剖析，集成研发水资源安全保障技术，协同制定水资源安全保障方案，整体解决区域水资源安全问题。”赵勇表示。日前，由他领衔的项目“京津冀水资源安全保障技术研发集成与示范应用”，获得国家重点研发计划“水资源高效开发利用”专项2016年度资助。

据介绍，该项目针对京津冀地区水循环显著变异、人水关系严重失衡和水资源安全保障技术短板，重点聚焦两大科学问题：一是强人类活动区的水循环演变机理与健康水循环模式，揭示京津冀地区水循环全过程演变机理、过程与规律，提出健康水循环模式与评判标准；二是强烈竞争条件下水资源多目标协同配置，开展京津冀地区多水源多目标协同配置，推动建立健康的自然—社会水循环系统。

对此，赵勇进一步解释，无论京津冀地区水资源问题的表现形式如何，均可归结为水循环过程的演化与失衡问题，而保障水资源安全所开展的各类水事活动，本质上也都是针对流域水循环过程的调控行为，因此揭示京津冀地区水循环全过程演变机理、过程与规律，是开展京津冀水资源科学调控和安全保障的科学基础。同时，水资源稀缺地区存在普遍的区域、行业、城乡、经济和生态之间用水竞争与利益冲突，如何在水资源有限而需求众多的情况下，使水资源配置最优是解决强烈竞争地区水资源调配与安全保障的关键科学问题。

“通过我们的研究，预期支撑京津冀地区水资源利用效率提升20%，地下水超采压采率超过80%，再生水利用量提高到20亿立方米以上，缓解京津冀水资源短缺压力，推动建立健康的自然—社会水循环系统，保障京津冀地区水资源安全。”赵勇介绍。

（来源：《科技日报》 2016-09-13）

美基金设置 1000 万奖项清除 Okeechobe 湖有毒藻华

削减有毒藻华暴发水体中的P对生态环境保护者而言是巨大的挑战。美国Everglades Foundation基金会拟通过设置一项1000万美金的奖项激励新的P削减技术的研发以解决这一问题。

该奖项命名为George Barley Water Prize，设置的预期技术目标是削减每公斤水体中P的花费不超过120美元。基金会的首席科学家Melodie Naja表示，要实现这个目标很有难度，但是我们相信一定有人可以做到。

该项需求十分紧迫。今年5月，美弗罗里达州最大的淡水湖Okeechobee湖藻华暴发，范围延伸至33英里。由于今年大雨频繁，为避免水源地洪水发生，只能将该区域的水提前排放至其他湖泊或河流中，导致了将水温较高富含N的水体通过St. Lucie运河排放到了Okeechobee湖。

藻华暴发通常是由农业污染和废水排放的带来的大量N和P引起的。除藻和减P是一个耗时且花费巨大的过程。该奖项（George Barley Water Prize）的设立旨在寻找更加经济有效的办法。

目前申请已正式开放，在接下来的6个月中该基金拟启动3.5万美金用于奖励若干优秀申请者。这些申请者将被要求进一步阐述他们的治理方法在特定条件下的实施效果。最终，遴选出一个研究小组开展他们的治理项目，该小组将获得1000万美金的奖励。

来自NOAA大湖环境研究实验室的生态学家Tim Davis认为，这种积极的项目引导是非常重要的，有了该项经费的资助将使得削减P的新技术和新方法得到进一步实施，从而减少有毒藻华暴发，使湖泊回归健康水平。

N也是有毒藻华暴发的诱因之一，Davis说，但是我们目前没有充足的研究N的模型和数据。他认为降P是解决问题的有效办法中重要的第一步。

（来源：http://www.sciencemag.org/news/2016/07/everglades-foundation-launches-10-million-prize-clean-toxic-algae-blooms 根据相关资料编译）

鄱阳湖“瘦身”三分之二

9月26日上午9点，江西鄱阳湖星子水文站水位为10.24米，迫近10米的枯水位。据江西省水文局预计，10月中旬，会接近8米的极枯水位。

鄱阳湖都昌印山附近水域24日的航拍图片显示，黄褐色的河床大面积干涸裸露，不少渔船也被迫停靠岸边。“目前鄱阳湖水域面积不到1000平方公里，不及丰水期的1/3，过去鄱阳湖枯水期一般发生在冬季，今年提前了近两个月，枯水期大大延长。”江西省水文局副局长李国文在接受科技日报记者采访时说道。

事实上，今年是鄱阳湖流域的丰水年，多雨多汛情。今年1月至9月上旬江西全省比多年平均雨量偏多14%。7月份，鄱阳湖还发生了新世纪以来的最大洪水。

丰水年却早早遭遇枯水，令人讶异。江西省防汛抗旱总指挥部副总指挥、水利厅副厅长朱来友在接受科技日报记者采访时表示，今年并非鄱阳湖首次遭遇枯水期提前，近年来，鄱阳湖秋季枯水屡屡发生。究其原因，主要在于长江上游水库群在汛期结束后开始蓄水，泄流减少；泥沙沉积在上游水库后，清水下泄冲刷河道，导致河床下切，长江河道与鄱阳湖地势落差增大；航道整治、河湖采砂等也加剧了河道下切；长江上游降雨少，径流量小。

朱来友解释道，鄱阳湖连年出现低枯水位，表明长江与鄱阳湖的水文情势已发生了重大变化，这种变化呈不断加重趋势。

鄱阳湖湖区水位下降，枯水位提前来临，会对当地产生哪些影响？

朱来友表示，低水位持续时间延长，对生态环境及湖区生产、生活用水影响较大。湖区枯水期用水矛盾将更加突出，容易发生取水困难，使工农业取水成本大幅增加。受鄱阳湖水位偏低影响，湖区自然保护区内的洲滩草地也提前或加快露出水面，且持续的天数也相应增加，这将直接或间接影响到湖区植被、鱼类和鸟类等资源。

“就江西而言，急需在鄱阳湖建生态闸，预防长江低水位将鄱阳湖拉空，拦蓄起来的湖水可渐次下泄，补充长江干流枯水期流量，以利下游诸省；从长江全流域的角度来看，需要调整上游水库群的汛后蓄水量，优化水库群调度，实现全长江的蓄泄安全协调。”朱来友建议。

（来源：《科技日报》 2016-09-26）