湖泊科学动态

2018 年　　第 **2** 期(总第 **20** 期)

[4-6] 月

目录

摘要精选

科技热点

业界动态

热点文章

Global lake evaporation accelerated by changes in surface energy allocation in a warmer climate

Wei Wang; Xuhui Lee; Wei Xiao; et al.

Lake evaporation is a sensitive indicator of the hydrological response to climate change. Variability in annual lake evaporation has been assumed to be controlled primarily by the incoming surface solar radiation. Here we report simulations with a numerical model of lake surface fluxes, with input data based on a high-emissions climate change scenario (Representative Concentration Pathway 8.5). In our simulations, the global annual lake evaporation increases by 16% by the end of the century, despite little change in incoming solar radiation at the surface. We attribute about half of this projected increase to two effects: periods of ice cover are shorter in a warmer climate and the ratio of sensible to latent heat flux decreases, thus channelling more energy into evaporation. At low latitudes, annual lake evaporation is further enhanced because the lake surface warms more slowly than the air, leading to more long-wave radiation energy available for evaporation. We suggest that an analogous change in the ratio of sensible to latent heat fluxes in the open ocean can help to explain some of the spread among climate models in terms of their sensitivity of precipitation to warming. We conclude that an accurate prediction of the energy balance at the Earth's surface is crucial for evaluating the hydrological response to climate change.

（来源：Nature Geoscience, 2018,11:410-414）

中文点评：

<div align="center">全球湖泊蒸发加剧与气候变化关联大</div>

人们普遍认为，湖泊的蒸发量主要是由太阳辐射来控制的。近日，耶鲁大学森林与环境学院研究人员在《自然地球科学》杂志上发表文章,他们采用建模工具证明还存在其他因素，从湖水冰冻时期的缩短到其表面热能的重新分配，正加速湖泊水分流失到大气中。

该学院气象学教授、资深论文作者李徐辉说："通常我们关注的是，大气层的上半部分会触发促进气候变暖的反应。但如果我们想对水文变化做出准确的预测，我们就需要了解大气层的底部发生了什么，包括湖泊表面的变化。因为这些变化推动了气候变化所触发的水文反应。"

世界上 25 万个湖泊中，大约有 85% 位于中高纬度地区。这些地区的湖泊常年处于冰冻状态。但随着全球变暖，这些湖泊中的大多数开始在春季解冻。湖水冰冻期的缩短导致太阳热能吸收率升高（因为湖水颜色较深，所以它的反射率较低）。变暖的温度还会导致蒸发所需的能量增加，这从本质上改变了能量的分配方式。湖泊表面温度对能量分配变化的调整进一步增加了湖水的蒸发量。研究人员利用湖泊模拟模型评估了从 2005 年到 2100 年间世界主要湖泊的湖泊-大气相互作用并发现，约有一半的蒸发量变化是由地表能量重新分配和缩短的湖水冰冻期造成的。区域层面的另一个关键因素是融雪量的变化。例如，在寒冷和极地地区，融雪量减少是导致湖泊蒸发量增加的第二大因素。这些气候变化造成的水文反应将对拥有许多湖泊的地区产生深远的影响。随着更多的水分蒸发到大气中，更强的降水事件也会随

之发生。

李教授指出，对于干旱地区来说，这些变化也可能带来淡水资源管理方面的挑战。例如，为了做出长期的管理决策，人们必须了解湖水中会有多少水分被留下；如果这种可预测性降低，人们对饮用水需求和农业需求的规划将会变得更加困难。因此，对于一些地区来说，如何节约用水可能会成为日益严峻的问题。

（来源：http://h5.scimall.net.cn/register?from=xh005 根据相关资料编译）

Cascading lake drainage on the Greenland Ice Sheet triggered by tensile shock and fracture

Poul Christoffersen; Marion Bougamont; Alun Hubbard; et al.

Supraglacial lakes on the Greenland Ice Sheet are expanding inland, but the impact on ice flow is equivocal because interior surface conditions may preclude the transfer of surface water to the bed. Here we use a well-constrained 3D model to demonstrate that supraglacial lakes in Greenland drain when tensile-stress perturbations propagate fractures in areas where fractures are normally absent or closed. These melt-induced perturbations escalate when lakes as far as 80 km apart from expansive networks and drain in rapid succession. The result is a tensile shock that establishes new surface-to-bed hydraulic pathways in areas where crevasses transiently open. We show evidence for open crevasses 135 km inland from the ice margin, which is much farther inland than previously considered possible. We hypothesise that inland expansion of lakes will deliver water and heat to isolated regions of the ice sheet's interior where the impact on ice flow is potentially large.

（来源：Nature Communications, 2018, doi:10.1038/s41467-018-03420-8）

中文点评：

格陵兰湖泊排水导致剧烈连锁反应冰盖坍塌风险巨大

随着全球变暖，格陵兰岛面积达170万平方公里冰盖正在融化。最新《自然通讯》刊登相关文章，研究表明这一过程正在加速，因为快速排水的湖泊所造成的连锁反应会加剧冰盖的衰退。这些湖泊位于冰面上，是由温度升高而形成的，它们在融化流动过程中会很快地将大量的水和热量转移到冰盖的底部，这种快速流动会导致冰盖新的裂缝产生。这种排水的连锁反应能够暂时将冰流加速到400%。一旦冰层开始出现大裂缝，整个冰盖的稳定性就会受到更大的威胁。

文章作者英国剑桥大学的保罗教授表示："这块冰盖覆盖面积达170万平方公里，25年前相对稳定。但如今，它正以每天10亿吨冰的速度流失，这导致全球海平面每年上升1毫米，该速度比几年前的预测要快得多。"因此，冰面会承受越来越大的压力，从而出现拉伸冲击和断裂，并使远离冰盖边缘的冰体暴露于水和热量中。

研究人员将数年来的实际观测资料与3D计算机模型相结合，以评估这些湖泊的潜在影响。结果发现，在某些情况下，连锁反应效应可加速其他湖泊的排水，湖水可以排到80公里

远之外。在某种条件下，仅仅五天的时间里就有124个湖泊流失。这些"融化湖泊"在内陆地区构成了绵延135公里的网络，这种规模的距离在以前来看是不可能的。它们的海拔高度也达到了2000米。保罗认为："由于连锁反应，水和热量从表面到冰盖底部的转移速度会越来越快。在某个模拟中，我们发现在59个被观察的湖泊中，有58个湖泊在单次连锁事件中流失殆尽。大部分融化的湖泊都是以这种动态的方式耗干的。"

所以限制温度上升是保护格陵兰岛的重要措施，而且比以往任何时候都更加迫切。随着大规模冰盖越来越多地融入海洋，海平面上升，沿海地区将受到严重威胁。并预测到本世纪中叶，格陵兰岛的夏季可能就不再有冰存在了。

（来源：根据相关资料编译）

摘要精选

The world's largest High Arctic lake responds rapidly to climate warming

Igor Lehnherr; Vincent L. St. Louis; Martin Sharp; et al.

Using a whole-watershed approach and a combination of historical, contemporary, modeled and paleolimnological datasets, we show that the High Arctic's largest lake by volume (Lake Hazen) has succumbed to climate warming with only a ~1 °C relative increase in summer air temperatures. This warming deepened the soil active layer and triggered large mass losses from the watershed's glaciers, resulting in a ~10 times increase in delivery of glacial meltwaters, sediment, organic carbon and legacy contaminants to Lake Hazen, a >70% decrease in lake water residence time, and near certainty of summer ice-free conditions. Concomitantly, the community assemblage of diatom primary producers in the lake shifted dramatically with declining ice cover, from shoreline benthic to open-water planktonic species, and the physiological condition of the only fish species in the lake, Arctic Char, declined significantly. Collectively, these changes place Lake Hazen in a biogeochemical, limnological and ecological regime unprecedented within the past ~300 years.

（来源：Nature Communication, 2018, 9(5):530-539）

Climate and anthropogenic contributions to the desiccation of the second largest saline lake in the twentieth century

Chaudhari, Suyog; Felfelani, Farshid; Shin, Sanghoon; et al.

Urmia Lake, once the second largest saline lake in the world, is on the verge of complete desiccation. It has been suggested that the desiccation is caused by intensified human activities, especially irrigation, and prolonged droughts in the lake basin, but there is a lack of quantitative analysis to attribute the observed water level decline to natural and anthropogenic causes. In this study, we use remote sensing data, ground observations, and a hydrological model with human impact assessment capabilities (HiGW-MAT) to investigate the natural and human-induced changes in the hydrology of Urmia Lake basin from 1980 to 2010. Based on the analysis of remote sensing data, we find a similar to 98% and

similar to 180% increase in agricultural lands and urban areas, respectively, from 1987 through 2016, with a corresponding shrinkage in lake area by similar to 86%. Further, we use model results to examine the changes in terrestrial water storage (TWS) over the basin including the lake. Results indicate that TWS declined over the lake region and the lake lost water at a faster rate than the watershed did. Comparison of river inflow to the lake from two simulations-one with and the other without human activities-suggests that human water management activities caused a reduction in streamflow of similar to 1.74 km(3)/year from 1995 to 2010, which accounts for similar to 86% of the total depletion in lake volume during the same period. It is also found that irrigation water requirement almost tripled, causing high withdrawals from rivers. These results demonstrate that the on-going depletion of Urmia Lake is not solely due to prolonged droughts but also due to direct anthropogenic alterations which caused significant changes in land use, streamflow, and water storage within the basin. This study provides important insights on the natural and human-induced changes in the hydrology of Urmia Lake and highlights the need for a high resolution regional scale modeling approach for better understanding potential future changes toward restoring the lake and putting forth a course of action to stop further desiccation and avoid a major environmental catastrophe.

（来源：JOURNAL OF HYDROLOGY, 2018, 560:342-353）

Pronounced summer warming in northwest Greenland during the Holocene and Last Interglacial

Jamie M. McFarlin; Yarrow Axford; Magdalena R. Osburn; et al.

Projections of future rates of mass loss from the Greenland Ice Sheet are highly uncertain because its sensitivity to warming is unclear. Geologic reconstructions of Quaternary interglacials can illustrate how the ice sheet responded during past warm periods, providing insights into ice sheet behavior and important tests for data-model comparisons. However, paleoclimate records from Greenland are limited: Early Holocene peak warmth has been quantified at only a few sites, and terrestrial sedimentary records of prior interglacials are exceptionally rare due to glacial erosion during the last glacial period. Here, we discuss findings from a lacustrine archive that records both the Holocene and the Last Interglacial (LIG) from Greenland, allowing for direct comparison between two interglacials. Sedimentary chironomid assemblages indicate peak July temperatures 4.0 to 7.0 °C warmer than modern during the Early Holocene maximum in summer insolation. Chaoborus and chironomids in LIG sediments indicate July temperatures at least 5.5 to 8.5 °C warmer than modern. These estimates indicate pronounced warming in northwest Greenland during both interglacials. This helps explain dramatic ice sheet thinning at Camp Century in northwest Greenland during the Early Holocene and, for the LIG, aligns with controversial estimates of Eemian warming from ice core data retrieved in northern Greenland. Converging geologic evidence for strong LIG warming is challenging to reconcile with inferred Greenland Ice Sheet extent during the LIG, and the two appear incompatible in many models of ice sheet evolution. An increase in LIG snowfall could help resolve this problem, pointing to the need for hydroclimate reconstructions from the region.

（来源：PNAS, 2018, 115 (25): 6357-6362）

Hydroclimatic changes of Lake Bosten in Northwest China during the last decades

Junqiang Yao; Yaning Chen; Yong Zhao; et al.

Bosten Lake, the largest inland freshwater lake in China, has experienced drastic change over the past five decades. Based on the lake water balance model and climate elasticity method, we identify annual changes in the lake's water components during 1961–2016 and investigate its water balance. We find a complex pattern in the lake's water: a decrease (1961–1987), a rapid increase (1988–2002), a drastic decrease (2003–2012), and a recent drastic increase (2013–2016). We also estimated the lake's water balance, finding that the drastic changes are caused by a climate-driven regime shift coupled with human disturbance. The changes in the lake accelerated after 1987, which may have been driven by regional climate wetting. During 2003 to 2012, implementation of the ecological water conveyance project (EWCP) significantly increased the lake's outflow, while a decreased precipitation led to an increased drought frequency. The glacier retreating trend accelerated by warming, and caused large variations in the observed lake's changes in recent years. Furthermore, wastewater emissions may give rise to water degradation, human activity is completely changing the natural water cycle system in the Bosten Lake. Indeed, the future of Bosten Lake is largely dependent on mankind.

（来源：Scientific Reports, 2018, doi:10.1038/s41598-018-27466-2）

Hydrological network and classification of lakes on the Third Pole

Gao, Yang; Wang, Weicai; Yao, Tandong; et al.

The intensity and form of changes in closed lakes, upstream lakes and outflow lakes on the Third Pole (TP) differ based on their drainage mode. Researchers' insufficient understanding of the hydrological networks associated with lakes hampers studies of the relationship between lakes and climate. In this study, we establish a comprehensive hydrological network for each lake (> 1 km(2)) on the TP using 106 Landsat images, 236 Chinese topographic maps, and SRTM DEM. Three-hundred-ninety-seven closed lakes, 488 upstream lakes and 317 outflow lakes totaling 3,5498.49 km(2), 7,378.82 km(2), and 3,382.29 km(2), respectively, were identified on the TP using 2010 data. Two-hundred-thirty-four closed lakes were found to not be linked to upstream lakes. The remaining 163 closed lakes were connected to and fed by the 488 upstream lakes. The object-oriented analyses within this study indicated that more rapid changes occurred in the surface extent of closed lakes than in upstream lakes or outflow lakes on the TP from 1970s to 2010. Furthermore, the water volume of the examined closed lakes was almost nine times greater than that of the upstream lakes from 2003 to 2009. All the examined closed lakes exhibited an obvious water volume change compared to the corresponding upstream lakes in the same basin. Furthermore, two case studies illustrate that the annual and seasonal dynamics associated with the changes in closed lakes may reflect climate change patterns, while the upstream lake dynamics may be more controlled by the lakeshore terrain and drainage characteristics. The lake inventory and hydrological network catalogued in this study provide a basis for developing a better understanding of lake response to climate change on the TP.

（来源：JOURNAL OF HYDROLOGY, 2018, 560: 582-594）

Exploration of an urban lake management model to simulate chlorine interference based on the ecological relationships among aquatic species

Zhiqiang Yan; Yafei Wang; Di Wu; et al.

In eutrophic lakes, algae are known to be sensitive to chlorine, but the impact of chlorine on the wider ecosystem has not been investigated. To quantitatively investigate the effects of chlorine on the urban lake ecosystem and analyze the changes in the aquatic ecosystem structure, a dynamic response model of aquatic species to chlorine was constructed based on the biomass density dynamics of aquatic species of submerged macrophytes, phytoplankton, zooplankton, periphyton, and benthos. The parameters were calibrated using data from the literature and two simulative experiments. The model was then validated using field data from an urban lake with a surface area of approximately $8000 \, m^2$ located in the downtown area of Guangzhou, South China. The correlation coefficient (R), root mean square error-observations standard deviation ratio (RSR) and index of agreement (IOA) were used to evaluate the accuracy and reliability of the model and the results were consistent with the observations (0.446 R < 0.985, RSR < 0.7, IOA > 0.6). Comparisons between the simulated and observed trends confirmed the feasibility of using this model to investigate the dynamics of aquatic species under chlorine interference. The model can help managers apply a modest amount of chlorine to control eutrophication and provides scientific support for the management of urban lakes.

Demonstration project of eutrophic water purification by a multicomponent system

R Jia; X Wang.

Non-point source pollution from tea plantations in the upstream of West Lake caused severe eutrophication in the Longhong stream. Therefore, an in-stream treatment system combining biological purification technologies and engineering measures was devised to treat the water and to serve as a demonstration project for the purification of eutrophic landscape water bodies. Considering the characteristics of the stream channel, a treatment system combining an ecological corridor, bio-zeolite, and ecological floating beds, was used, which significantly improved the water quality. On the one hand, the multi-stage ecological corridor prolonged the flow path and prevented the formation of dead water zones and hydraulic short-circuiting. On the other hand, the bio-zeolite showed a physical interception effect, which also maintained long-term and stable removal of pollutants from the eutrophic waters by the biofilm formed on its surface. Moreover, the multi-layered three-dimensional ecological floating bed, which served as the carrier of ceramic particles and suspended elastic packing, ensured ecological restoration of the water body through the joint action of plants and microorganisms. Overall, the demonstration project exhibited good pollutants removal efficiencies of COD of 24%, TP of 46%, TN of 31%, NH_4^+-N of 24%, and NO_3^--N of 31%. Furthermore, a higher treatment efficiency was achieved in the summer than the winter. So, the project has a good application prospect.

Experimental evidence for rapid genomic adaptation to a new niche in an adaptive radiation

David A. Marques, Felicity C. Jones, Federica Di Palma; et al.

A substantial part of biodiversity is thought to have arisen from adaptive radiations in which one lineage rapidly diversified into multiple lineages specialized to many different niches. However, selection and drift reduce genetic variation during adaptation to new niches and may thus prevent or slow down further niche shifts. We tested whether rapid adaptation is still possible from a highly derived ecotype in the adaptive radiation of threespine stickleback on the Haida Gwaii archipelago, Western Canada. In a 19-year selection experiment, we let giant sticklebacks from a large blackwater lake evolve in a small clearwater pond without vertebrate predators. A total of 56 whole genomes from the experiment and 26 natural populations revealed that adaptive genomic change was rapid in many small genomic regions and encompassed 75% of the change between 12,000-year-old ecotypes. Genomic change was as fast as phenotypic change in defence and trophic morphology, and both were largely parallel between the short-term selection experiment and long-term natural adaptive radiation. Our results show that functionally relevant standing genetic variation can persist in derived radiation members, allowing adaptive radiations to unfold very rapidly.

（来源：Nature Ecology & Evolution, 2018, 2:1130-1140）

Global hidden harvest of freshwater fish revealed by household surveys

Etienne Fluet-Chouinard; Simon Funge-Smith; Peter B. McIntyre.

Consumption of wild-caught freshwater fish is concentrated in low-income countries, where it makes a critical contribution to food security and livelihoods. Underestimation of inland harvests in official statistics has long been suspected due to unmonitored subsistence fisheries. To overcome the lack of data from extensive small-scale harvests, we used household consumption surveys to estimate freshwater fish catches in 42 low- and middle-income countries between 1997 and 2014. After accounting for trade and aquaculture, these countries collectively consumed 3.6 MT (CI, 1.5–5.8) more wild-caught freshwater fish than officially reported, reflecting a net underreporting of 64.8% (CI, 27.1–103.9%). Individual countries were more likely to underestimate (n = 31) than overestimate (n = 11) catches, despite conservative assumptions in our calculations. Extrapolating our findings suggests that the global inland catch reported as 10.3 MT in 2008 was more likely 16.6 MT (CI, 2.3–30.9), which accords with recent independent predictions for rivers and lakes. In human terms, these hidden harvests are equivalent to the total animal protein consumption of 36.9 (CI, 30.8–43.4) million people, including many who rely upon wild fish to achieve even minimal protein intake. The widespread underreporting uncovered by household consumption surveys indicates that inland fisheries contribute far more to global food security than has been recognized previously. Our findings also amplify concerns about the sustainability of intensive fishery exploitation as degradation of rivers, lakes, and wetlands continues apace.

（来源：PNAS, 2018, doi:10.1073/pnas.1721097115）

Genetic and developmental origins of a unique foraging adaptation in a Lake Malawi cichlid genus

Moira R. Conith; Yinan Hu; Andrew J. Conith; et al.

Phenotypic novelties are an important but poorly understood category of morphological diversity. They can provide insights into the origins of phenotypic variation, but we know relatively little about their genetic origins. Cichlid fishes display remarkable diversity in craniofacial anatomy, including several novelties. One aspect of this variation is a conspicuous, exaggerated snout that has evolved in a single Malawi cichlid lineage and is associated with foraging specialization and increased ecological success. We examined the developmental and genetic origins for this phenotype and found that the snout is composed of two hypertrophied tissues: the intermaxillary ligament (IML), which connects the right and left sides of the upper jaw, and the overlying loose connective tissue. The IML is present in all cichlids, but in its exaggerated form it interdigitates with the more superficial connective tissue and anchors to the epithelium, forming a unique ligament–epithelial complex. We examined the Transforming growth factor β (Tgfβ) → Scleraxis (Scx) candidate pathway and confirmed a role for these factors in snout development. We demonstrate further that experimental up-regulation of Tgfβ is sufficient to produce an expansion of scx expression and concomitant changes in snout morphology. Genetic and genomic mapping show that core members of canonical Tgfβ signaling segregate with quantitative trait loci (QTL) for snout variation. These data also implicate a candidate for ligament development, adam12, which we confirm using the zebrafish model. Collectively, these data provide insights into ligament morphogenesis, as well as how an ecologically relevant novelty can arise at the molecular level.

Distinct patterns and processes of abundant and rare eukaryotic plankton communities following a reservoir cyanobacterial bloom

Yuanyuan Xue; Huihuang Chen; Jun R. Yang; et al.

Plankton communities normally consist of few abundant and many rare species, yet little is known about the ecological role of rare planktonic eukaryotes. Here we used a 18S ribosomal DNA sequencing approach to investigate the dynamics of rare planktonic eukaryotes, and to explore the co-occurrence patterns of abundant and rare eukaryotic plankton in a subtropical reservoir following a cyanobacterial bloom event. Our results showed that the bloom event significantly altered the eukaryotic plankton community composition and rare plankton diversity without affecting the diversity of abundant plankton. The similarities of both abundant and rare eukaryotic plankton subcommunities significantly declined with the increase in time-lag, but stronger temporal turnover was observed in rare taxa. Further, species turnover of both subcommunities explained a higher percentage of the community variation than species richness. Both deterministic and stochastic processes significantly influenced eukaryotic plankton community assembly, and the stochastic pattern (e.g., ecological drift) was particularly pronounced for rare taxa. Co-occurrence network analysis revealed that keystone taxa mainly belonged to rare species, which may play fundamental roles in network persistence. Importantly, covariations between rare and non-rare taxa were predominantly positive, implying multispecies cooperation might contribute to the stability and resilience of the microbial community. Overall, these findings expand current understanding of the ecological mechanisms and microbial interactions underlying plankton dynamics in changing aquatic ecosystems.

The relationships between structural and functional diversity within and among macrophyte communities in lakes

Chmara, Rafal; Szmeja, Jozef; Banas, Krzysztof

We studied the relationships between structural and functional diversity within and among macrophyte communities of softwater lakes. Diversity was assessed based on Simpson's diversity index (SD), species richness (S), Rao's functional diversity (FDQ) and shared plant traits along a gradient of pH. A total of 10,800 cover-plant samples (area=0.1 m(2)) were analysed, collected from 241 sections of the bottom (with a depth resolution of 1.0 m) of 38 lakes in Poland. We identified 59 species of macrophytes and recognized four communities. Along a gradient of increasing pH we found i) an increase of species richness; ii) a uniformity of abundance in communities; and iii) an increase in the quantitative contribution of life history traits such as perennials, submerged anchoring, leaf placement along an orthotropic shoot and generative reproduction. On the other hand, there was a decrease in unanchored and evergreen perennials. In our study, we found that the variety of these traits within communities is greater than that between them. Within lakes, structural diversity was low, whereas it was high between lakes. Functional diversity exhibited an opposite pattern; it was high at lake scale, and low between lakes. A combination of partitioning diversity and utilizing environmental variables significantly improves the prediction of community structure and the conservation of lakes.

The influence of acid mine drainage on the phyto- and zooplankton communities in a clay pit lake in the Luk Muzakowa Geopark (western Poland)

Sienkiewicz, Elwira; Gasiorowski, Michal.

The lake LK-41 is located within an acid mine drainage (AMD) area in the Luk Muzakowa Geopark (western Poland). Usually, AMD has a negative influence on the surrounding aquatic ecosystems because it is characterized by high heavy metal concentrations and very acidic water. The lake LK-41 is a young lake that was formed after the exploitation of ceramic clays ended. When the pit was filled with water, it was colonized by phyto- and zooplankton. The numerous lakes with extremely acidic water and AMD near LK-41 can impact the water quality of the lake through the leaching of chemical compounds caused by ground water migration and surface runoff. Due to the high adsorption and water holding capacities of clay minerals, AMD did not negatively influence the diatom and Cladocera communities over the entire sediment record. The lake was dominated by planktonic diatoms, such as Cyclotella comensis, C. distinguenda var. unipunctata and Lindavia nadiosa, and their frequencies were relatively stable. Among the Cladocera remains, the lake was initially dominated by Bosmina longirostris and Chydorus sphaericus. Beginning in the second half of the 1990s, planktonic Bosmina longirostris reached their maximum occurrence levels in the lake (above 50 %). The reconstruction of the water pH based on diatoms (DI-pH) indicates that the water of the lake was alkaline throughout the studied period. The values of the 01 that were inferred from the cladoceran species (CI-pH) underestimate actual values to some extent in relation to both the DI-pH and the pH water measurements collected in 1986.

Effect of a total solar eclipse on the surface crowding of zooplankton in a freshwater lake ecosystem

Adhikari, Shuvadip; Goswami, Abhishek Roy; Roy, Utpal Singha; et al.
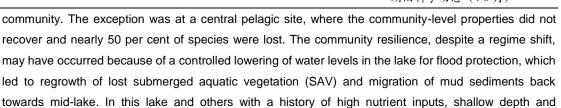
Zooplankton surface crowding in a freshwater lake ecosystem during a total solar eclipse (maximum eclipse at 06:28:43 Indian Standard Time, 22 July 2009) was studied in relation to ambient physicochemical conditions and compared with the crowding that occurred during pre- and post-eclipse days. Rapid light attenuation on the eclipse day led to changes in zooplankton surface crowding, which manifested as alterations to community structure and statistical parameters. Zooplankton diversity and density varied depending on the day (either the pre-eclipse day, the eclipse day, or the post-eclipse day) and the sampling time considered. A total of 20 zooplankton species were recorded during the study. On the day of the eclipse, the highest zooplankton density in the surface water was recorded just after the end of totality at 06:30 IST. The populations of two adult cladoceran species (Alona rectangula rectangula and Chydorus sphaericus) were particularly prominent in the zooplankton, whereas rotifers were almost absent from the surface water during the eclipse. Rather than decreasing, the primary production of the phytoplankton increased on the day of the TSE compared to that seen on the control days. Comparatively high Lindeman's efficiency values were observed during the eclipse, indicating particularly efficient utilization of photons in photosynthesis.

Recovery of plankton from hurricane impacts in a large shallow lake

Ji, Gaohua; Havens, Karl E.; Beaver, John R.; et al.

We quantified recovery of plankton in a large subtropical shallow lake from the catastrophic impacts of three successive major hurricanes. This assessment was possible because hurricanes passed directly over the lake amid an ongoing long-term sampling programme that included nearly all components of the plankton, from bacteria to crustacean zooplankton. We compared attributes of plankton 5years after the hurricanes to a pre-hurricane period and to a period immediately after the storms. We evaluated both community-level properties (biomass, biomass ratios, diversity, and dominance of major plankton groups) and species-level properties (species absolute and relative biomass) at four sites in the lake representing different ecological zones. The hurricanes strongly affected water quality and plankton community structure. The lake experienced a regime shift, losing its submerged aquatic vegetation and becoming homogenous and turbid at all sampled sites. Five years after the storms, chemical and physical conditions recovered across the lake, with a few exceptions. Between 35 and 93 plankton species were lost at the sampling sites, with greatest losses in the phytoplankton. Relative species biomass displayed substantive changes too. Daphnia ambigua did not recover at three of the sites, Polyarthra vulgaris greatly increased lake-wide, and at a central pelagic site, there was a total loss of heterotrophic nano-flagellates and a much higher biomass of diatoms than before the hurricanes, despite recovery of irradiance, depth, nutrient levels and other attributes. Most community-level properties were resilient, returning to pre-hurricane conditions of total biomass, ratios of autotrophs to heterotrophs and ratios of protozoa to metazoa. This likely happened because of species compensation in the biodiverse

community. The exception was at a central pelagic site, where the community-level properties did not recover and nearly 50 per cent of species were lost. The community resilience, despite a regime shift, may have occurred because of a controlled lowering of water levels in the lake for flood protection, which led to regrowth of lost submerged aquatic vegetation (SAV) and migration of mud sediments back towards mid-lake. In this lake and others with a history of high nutrient inputs, shallow depth and flocculent sediments, resilience may be low unless counter-acting forces are able to push the system back after a regime shift.

（来源：FRESHWATER BIOLOGY, 2018, 63(4): 366-379）

Primary producers or consumers? Increasing phytoplankton bacterivory along a gradient of lake warming and browning

Wilken, Susanne; Soares, Margarida; Urrutia-Cordero, Pablo; et al.

Eukaryotic phytoplankton form the basis of aquatic food webs and play a key role in the global carbon cycle. Many of these evolutionarily diverse microalgae are also capable of feeding on other microbes, and hence simultaneously act both as primary producers and consumers. The net ecosystem impact of such mixotrophs depends on their nutritional strategy which is likely to alter with environmental change. Many temperate lakes are currently warming at unprecedented rates and are simultaneously increasing in water color (browning) due to increased run-off of humic substances. We hypothesized that the resulting reduction in light intensity and increased bacterial abundances would favor mixotrophic phytoplankton over obligate autotrophs, while higher temperatures might boost their rates of bacterivory. We tested these hypotheses in a mesocosm experiment simulating a gradient of increasing temperature and water color in temperate shallow lakes as expected to occur over the coming century. Mixotrophs showed a faster increase in abundance under the climate change scenario during spring, when they dominated the phytoplankton community. Furthermore, both bacterial abundances and rates of phytoplankton bacterivory increased under future climate conditions. Bacterivory contributed significantly to phytoplankton resource acquisition under future climate conditions, while remaining negligible throughout most of the season in treatments resembling today's conditions. Hence, to our knowledge, we here provide the first evidence for an increasing importance of bacterivory by phytoplankton in future temperate shallow lakes. Such a change in phytoplankton nutritional strategies will likely impact biogeochemical cycles and highlights the need to conceptually integrate mixotrophy into current ecosystem models.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2018, 63 SI (1): S142-S155）

Applying multi-criteria analysis for preliminary assessment of the properties of alginate immobilized Myriophyllum spicatum in lake water samples

Milojkovic, Jelena V; Popovic-Djordjevic, Jelena B; Pezo, Lato L; et al.

The preliminary assessment of the properties of alginate immobilized aquatic weed Myriophyllum spicatum beads-MsAlg in a multi-element system of nine Serbian lakes water samples was done. Herein, the results obtained in the biosorption experiment with MsAlg contents of twenty-two elements analysed by inductively coupled plasma-optical emission spectrometry, biosorption capacity, element removal

efficiency, total hardness (TH) and quality index of water (WQI) are presented. Scanning electron microscopy with energy dispersive X-ray spectroscopy was used for the characterization of M.spicatum and its beads. The study showed that aluminium, magnesium and strontium were adsorbed by MsAlg in the water samples from all examined lakes; barium and iron in the water samples from six lakes. The overall average efficiency of MsAlg in biosorption of elements was in the following order: Al > Ba > Sr > Fe > Mg (58.6, 51.7, 48.2, 23.9 and 17.7%, respectively). The increase of TH and WQI values after the biosorption was noticed in all studied lake water samples. The most significant correlations for pH were regarding the contents of B, Mg and Ca, whereas WQI was highly correlated to the contents of B and Mg, and pH. The complexity of the obtained data was explained by Cluster Analysis and Principal Component Analysis, which showed good discrimination capabilities between the water samples taken from different locations. Considering that the invasive M.spicatum is natural, widespread and that its immobilization is cheap and eco-friendly, presented findings could be helpful in further assessment of MsAlg beads for its potential use as biofilter.

（来源：Water research, 2018, 141: 163-171）

Trophodynamics of Emerging Brominated Flame Retardants in the Aquatic Food Web of Lake Taihu: Relationship with Organism Metabolism across Trophic Levels

Zheng, Guomao; Wan, Yi; Shi, Sainan; et al.

Despite the increasing use and discharge of novel brominated flame retardants, little information is available about their trophodynamics in the aquatic food web, and their subsequent relationships to compound metabolism. In this study, concentrations of 2,4,6-tribromophenyl allyl ether (ATE), 1,2-dibromo-4-(1,2-dibromoethyl)cyclohexane (TBECH), tetrabromo-o-chlorotoluene (TBCT), pentabromobenzyl acrylate (PBBA), 1,2-bis(2,4,6-tribromophenoxy)ethane (BTBPE), bis(2-ethylhexyl)-3,4,5,6-tetrabromo-phthalate (TBPH), and decabromodiphenyl ethane (DBDPE) were measured in 17 species, including plankton, invertebrates, and fish from Lake Taihu, South China. Trophodynamics of the compounds were assessed, and metabolic rates were measured in the liver microsomes of crucian (trophic level [TL]: 2.93), catfish (TL: 3.86), and yellow-head catfish (TL: 4.3). Significantly positive relationships were found between trophic levels and lipid-normalized concentrations of ATE, BTBPE, and TBPH; their trophic magnification factors (TMFs) were 2.85, 2.83, and 2.42, respectively. Consistently, the three chemicals were resistant to metabolism in all fish microsomes. No significant relationship was observed for beta TBECH (p = 0.116), and DBDPE underwent trophic dilution in the food web (TMFs = 0.37, p = 0.021). Moreover, these two chemicals showed steady metabolism with incubation time in all fish microsomes. TBCT and PBBA exhibited significant trophic magnifications in the food web (TMF = 4.56, 2.01). Though different metabolic rates were observed for the two compounds among the tested fish species, TBCT and PBBA both showed metabolic resistance in high-trophic-level fish. These results indicated that metabolism of organisms at high trophic levels plays an important role in the assessment of trophic magnification potentials of these flame retardant chemicals.

（来源：Environmental science & technology, 2018, 52(8): 4632-4640）

Bioaccumulation and Spatiotemporal Trends of Polyhalogenated Carbazoles in Great Lakes Fish from 2004 to 2016

Wu, Yan; Tan, Hongli; Zhou, Chuanlong; et al.

Polyhalogenated carbazoles (PHCZs) were recently discovered in Great Lakes sediment and other aquatic systems. However, knowledge about their bioaccumulation and potential risks to fish and wildlife remains very limited. The present study investigated PHCZs in Great Lakes lake trout (Salvelinus namaycush) and walleye (Sander vitreus; Lake Erie only) composites collected between 2004 and 2016. Median concentrations of Sigma PHCZs by lake ranged from 54.7 to 154 ng/g lipid weight or lw (6.8-28.0 ng/g wet weight). Dominant congeners included 3,6-dichlorocarbazole, 1,3,6-tribromocarbazole, and 1,3,6,8-tetrachlorocarbazole. The highest Sigma PHCZs concentrations were found in Lakes Michigan and Ontario fish, followed by Lake Huron, whereas Lakes Erie and Superior fish contained the lowest concentrations. Congener profiles of PHCZs also exhibited spatial variations. After age normalization to minimize fish age influence on bioaccumulation rates, fish Sigma PHCZs' concentrations declined significantly over time in all lakes except Lake Erie, with slopes ranging from -10.24% to -3.8S% per year. The median toxic equivalent (TEQ) of PHCZs due to their dioxin-like activity was determined to range from 8.7 to 25.7 pg/g lw in Great Lakes fish. This study provides the first insight into the bioaccumulation and spatiotemporal trends of PHCZs in Great Lakes and suggests the need for further research on this group of chemicals.

（来源：Environmental science & technology, 2018, 52(8): 4536-4545）

Isomer-Specific Hexabromocyclododecane (HBCDD) Levels in Top Predator Fish from Across Canada and 36-Year Temporal Trends in Lake Ontario

Su, Guanyong; McGoldrick, Daryl J; Clark, Mandi G; et al.

Hexabromocyclododecane (HBCDD) is a high concern environmental pollutant due to its persistent, bioaccumulative, and toxic properties. The spatial distribution of HBCDD was investigated in top predator fish (lake trout, walleye, or brook trout) collected in 2013 (n = 165) from 19 sampling sites and in 2015 (n = 145) from 20 sites across Canada. HBCDD was measurable in at least one sample at each sampling site regardless of sampling year with the exception of walleye from the south basin of Lake Winnipeg (2013). Sampling sites in or near the Laurentian Great Lakes had greater SigmaHBCDD concentrations compared to locations to the west or east. The greatest mean SigmaHBCDD concentration was 72.6 ng/g lw in fish from Lake Huron-Goderich (2015). Regardless of the sampling sites, alpha-HBCDD was the dominant congener followed by gamma-HBCDD, whereas beta-HBCDD was barely detectable. In fish from the same waterbody there were comparable alpha/gamma isomer concentration ratios. The greatest ratio was 20.8 in fish from Lake Ontario, whereas the lowest ratio was 6.3 for fish from Lac Memphremagog (Quebec) likely related to more recent emissions of a technical HBCDD mixture. Temporal trends of HBCDD in lake trout from Lake Ontario showed a significant decreasing trend for gamma-HBCDD with a half-life estimate of 10 years over a 36-year period (1979-2015), and for alpha-HBCDD with a half-life of 11 years over the years of 2008 to 2015. The proportion of alpha-HBCDD to SigmaHBCDD increased significantly during 1979 to 2015. The present study provided novel information on the isomer-specific HBCDDs in Canada freshwater fish.

（来源：Environmental science & technology, 2018, 52(11): 6197-6207）

Review: Cyanobacterial blooms

Jef Huisman; Geoffrey A. Codd; Hans W. Paerl; et al.

Cyanobacteria can form dense and sometimes toxic blooms in freshwater and marine environments, which threaten ecosystem functioning and degrade water quality for recreation,drinking water, fisheries and human health. Here, we review evidence indicating that cyanobacterial blooms are increasing in frequency magnitude and duration globally. We highlight species traits and environmental conditions that enable cyanobacteria to thrive and explain why eutrophication and climate change catalyse the global expansion of cyanobacterial blooms. Finally, we discuss management strategies, including nutrient load reductions, changes in hydrodynamics and chemical and biological controls, that can help to prevent or mitigate the proliferation of cyanobacterial blooms.

（来源：Nature Reviews Microbiology, 2018, doi:10.1038/s41579-018-0040-1）

Characterization, origin and aggregation behavior of colloids in eutrophic shallow lake

Xu, Huacheng; Xu, Mengwen; Li, Yani; et al.

Stability of colloidal particles contributes to the turbidity in the water column, which significantly influences water quality and ecological functions in aquatic environments especially shallow lakes. Here we report characterization, origin and aggregation behavior of aquatic colloids, including natural colloidal particles (NCPs) and total inorganic colloidal particles (TICPs), in a highly turbid shallow lake, via field observations, simulation experiments, ultrafiltration, spectral and microscopic, and light scattering techniques. The colloidal particles were characterized with various shapes (spherical, polygonal and elliptical) and aluminum-, silicon-, and ferric-containing mineralogical structures, with a size range of 20-200 nm. The process of sediment re-suspension under environmentally relevant conditions contributed 78-80% of TICPs and 54-55% of NCPs in Lake Taihu, representing an important source of colloids in the water column. Both mono- and divalent electrolytes enhanced colloidal aggregation, while a reverse trend was observed in the presence of natural organic matter (NOM). The influence of NOM on colloidal stability was highly related to molecular weight (MW) properties with the high MW fraction exhibiting higher stability efficiency than the low MW counterparts. However, the MW-dependent aggregation behavior for NCPs was less significant than that for TICPs, implying that previous results on colloidal behavior using model inorganic colloids alone should be reevaluated. Further studies are needed to better understand the mobility/stability and transformation of aquatic colloids and their role in governing the fate and transport of pollutants in natural waters.

（来源：WATER RESEARCH, 2018, 142:176-186）

Observations on the dynamics and fate of dissolved organic phosphorus in lake water and a new model of eplimnetic P cycling

Taylor, William D.; Lean, David R. S.

Phosphorus (P) in lake water is commonly partitioned into particulate P and dissolved P by membrane filtration, and dissolved P is then fractionated into soluble reactive P (SRP, reactive with molybdate) and dissolved unreactive or organic P (DOP). Much of what is known about DOP is derived from radiotracer

studies using gel chromatography, and summarized by a kinetic model (Lean, Science 179: 678-680, 1973a; Lean, J Fish Res Board Can 30: 1525-1536, 1973b). Since this work, several relevant discoveries have been made on the role of enzymes, viruses and zooplankton in regenerating dissolved P, and the role of filtration damage in generating dissolved P in filtrates. Herein we present the results of new radiotracer experiments on the fate of DOP in lake water filtrates, consistent with the hypothesis that some of the high molecular weight organic P breaks down spontaneously to smaller molecules, which in turn break down to PO43-. We use inhibitors, including competitive inhibitors of phosphatases and a commercial product (RNA-later (R)) to support the hypothesis that the larger molecules include nucleic acids, and that the smaller molecules are substrates for alkaline phosphatase. We also find that colloidal P (i.e., P > 5000 MW according to gel filtration) includes some virus-sized material that can be collected on 0.02 or 0.03 mu m filters. Finally, we provide a new model of the cycling of epilimnetic P that is consistent with these and earlier observations.

（来源：AQUATIC SCIENCES, 2018, 80(2): UNSP 13）

Determining major factors controlling phosphorus removal by promising adsorbents used for lake restoration: A linear mixed model approach

Funes, A; Martinez, F J; Alvarez-Manzaneda, I; et al.

Phosphorus (P) removal from lake/drainage waters by novel adsorbents may be affected by competitive substances naturally present in the aqueous media. Up to date, the effect of interfering substances has been studied basically on simple matrices (single-factor effects) or by applying basic statistical approaches when using natural lake water. In this study, we determined major factors controlling P removal efficiency in 20 aquatic ecosystems in the southeast Spain by using linear mixed models (LMMs). Two non-magnetic -CFH-12 and Phoslock- and two magnetic materials -hydrous lanthanum oxide loaded silica-coated magnetite (Fe-Si-La) and commercial zero-valent iron particles (FeHQ)- were tested to remove P at two adsorbent dosages. Results showed that the type of adsorbent, the adsorbent dosage and color of water (indicative of humic substances) are major factors controlling P removal efficiency. Differences in physico-chemical properties (i.e. surface charge or specific surface), composition and structure explain differences in maximum P adsorption capacity and performance of the adsorbents when competitive ions are present. The highest P removal efficiency, independently on whether the adsorbent dosage was low or high, were 85-100% for Phoslock and CFH-12, 70-100% for Fe-Si-La and 0-15% for FeHQ. The low dosage of FeHQ, compared to previous studies, explained its low P removal efficiency. Although non-magnetic materials were the most efficient, magnetic adsorbents (especially Fe-Si-La) could be proposed for P removal as they can be recovered along with P and be reused, potentially making them more profitable in a long-term period.

（来源：WATER RESEARCH, 2018, 141:377-386）

Evidence for regional nitrogen stress on chlorophyll a in lakes across large landscape and climate gradients

Filstrup, Christopher T.; Wagner, Tyler; Oliver, Samantha K.; et al.

Nitrogen (N) and phosphorus (P) commonly stimulate phytoplankton production in lakes, but recent

observations from lakes from an agricultural region suggest that nitrate may have a subsidy-stress effect on chlorophyll a (Chl a). It is unclear, however, how generalizable this effect might be. Here, we analyzed a large water quality dataset of 2385 lakes spanning 60 regions across 17 states in the Northeastern and Midwestern U.S. to determine if N subsidy-stress effects on phytoplankton are common and to identify regional landscape characteristics promoting N stress effects in lakes. We used a Bayesian hierarchical modeling framework to test our hypothesis that Chl a-total N (TN) threshold relationships would be common across the central agricultural region of the U.S. ("the Corn Belt"), where lake N and P concentrations are high. Data aggregated across all regions indicated that high TN concentrations had a negative effect on Chl a in lakes with concurrent high total P. This large-scale pattern was driven by relationships within only a subset of regions, however. Eight regions were identified as having Chl a-TN threshold relationships, but only two of these regions located within the Corn Belt clearly demonstrated this subsidy-stress relationship. N stress effects were not consistent across other intense agricultural regions, as we hypothesized. These findings suggest that interactions among regional land use and land cover, climate, and hydrogeology may be important in determining the synergistic conditions leading to N subsidy-stress effects on lake phytoplankton.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2018, 63 SI (1) : S324-S339）

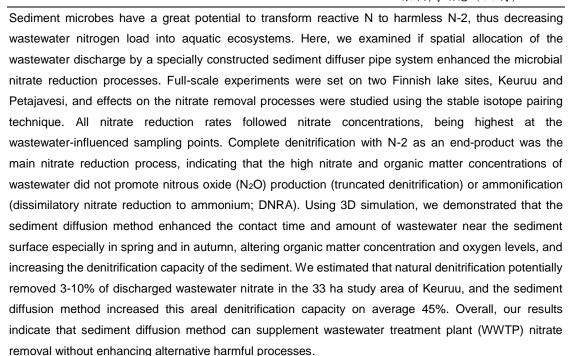# Weak response of greenhouse gas emissions to whole lake N enrichment

Klaus, Marcus; Bergstrom, Ann-Kristin; Jonsson, Anders; et al.

Global warming and land use scenarios suggest increased 21st century nitrogen (N) inputs to aquatic systems. Nitrogen affects in-lake processing and, potentially, atmospheric exchange of greenhouse gases, probably being most relevant in unproductive systems. Here, we test for the first time the effect of a whole-lake experimental increase (threefold) in external nitrate loads on the atmospheric exchange of carbon dioxide (CO_2), methane (CH_4), and nitrous oxide (N_2O) from N-limited unproductive boreal lakes. Nitrate enrichment effects were assessed within a paired Before/After-Control/Impact framework based on 2-hourly to biweekly surface-water sampling of dissolved gas concentrations, and monthly whole-lake inventory surveys, carried out over 4 yrs in six lakes. Nitrate enrichment did not affect gas exchange during summer stratification and whole-lake gas inventories during summer and winter stratification. This finding specifically emphasizes the modest role of internal carbon fixation for the CO_2 dynamics of unproductive boreal lakes. A global synthesis of 52 published studies revealed a wide range of nutrient fertilization effects, both in systems similar to our experimental lakes, and other more productive systems. Effects depended mainly on the spatiotemporal scale of the study and became more pronounced when N enrichment was combined with phosphorous. Conclusively, although short-term and habitat-specific effects can occur, changes in N supply have only weak whole-ecosystem effects on greenhouse gas emissions from unproductive boreal lakes.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2018, 63 SI (1) : S340-S353）

Sediment diffusion method improves wastewater nitrogen removal in the receiving lake sediments

Aalto, Sanni L.; Saarenheimo, Jatta; Ropponen, Janne; et al.

Sediment microbes have a great potential to transform reactive N to harmless N-2, thus decreasing wastewater nitrogen load into aquatic ecosystems. Here, we examined if spatial allocation of the wastewater discharge by a specially constructed sediment diffuser pipe system enhanced the microbial nitrate reduction processes. Full-scale experiments were set on two Finnish lake sites, Keuruu and Petajavesi, and effects on the nitrate removal processes were studied using the stable isotope pairing technique. All nitrate reduction rates followed nitrate concentrations, being highest at the wastewater-influenced sampling points. Complete denitrification with N-2 as an end-product was the main nitrate reduction process, indicating that the high nitrate and organic matter concentrations of wastewater did not promote nitrous oxide (N_2O) production (truncated denitrification) or ammonification (dissimilatory nitrate reduction to ammonium; DNRA). Using 3D simulation, we demonstrated that the sediment diffusion method enhanced the contact time and amount of wastewater near the sediment surface especially in spring and in autumn, altering organic matter concentration and oxygen levels, and increasing the denitrification capacity of the sediment. We estimated that natural denitrification potentially removed 3-10% of discharged wastewater nitrate in the 33 ha study area of Keuruu, and the sediment diffusion method increased this areal denitrification capacity on average 45%. Overall, our results indicate that sediment diffusion method can supplement wastewater treatment plant (WWTP) nitrate removal without enhancing alternative harmful processes.

（来源：WATER RESEARCH, 2018, 138:312-322）

Emissions from thaw ponds largely offset the carbon sink of northern permafrost wetlands

McKenzie Kuhn; Erik J. Lundin; Reiner Giesler; et al.

Northern regions have received considerable attention not only because the effects of climate change are amplified at high latitudes but also because this region holds vast amounts of carbon (C) stored in permafrost. These carbon stocks are vulnerable to warming temperatures and increased permafrost thaw and the breakdown and release of soil C in the form of carbon dioxide (CO_2) and methane (CH_4). The majority of research has focused on quantifying and upscaling the effects of thaw on CO_2 and CH_4 emissions from terrestrial systems. However, small ponds formed in permafrost wetlands following thawing have been recognized as hotspots for C emissions. Here, we examined the importance of small ponds for C fluxes in two permafrost wetland ecosystems in northern Sweden. Detailed flux estimates of thaw ponds during the growing season show that ponds emit, on average (±SD), 279 ± 415 and 7 ± 11 mmol C m^{-2} d^{-1} of CO_2 and CH_4, respectively. Importantly, addition of pond emissions to the total C budget of the wetland decreases the C sink by ~39%. Our results emphasize the need for integrated research linking C cycling on land and in water in order to make correct assessments of contemporary C balances.

（来源：Scientific Reports, 2018, doi:10.1038/s41598-018-27770-x）

Temporal-spatial pattern of organic carbon sequestration by Chinese lakes since 1850

Wang, Mei; Wu, Jianghua; Chen, Huai; et al.

In the last century, lakes in China have been subject to forcing by climate change, intensification of

agriculture, and urban expansion, though their effects on lake OC sequestration are poorly understood. We compiled dry mass and OC burial rates from 82 Pb-210-dated lake sediment records in China. The average post-1950 focusing-corrected lake mass accumulation rate (MARFC) of 256 +/- 56 g m(-2) yr(-1) (median +/- SE) and focusing-corrected OC accumulation rate (CAR(FC)) of 8 +/- 3 g C m(-2) yr(-1) were significantly higher than the 1850-1900 rates (p<0.05). However, the magnitude of increase in CARFC was most marked in the subtropical lakes of the East Plain (EP) and on the Yunnan-Guizhou Plateau (YG), where the post-1950 CAR(FC) was about three times that of the 1850-1900 (p<0.05), due to the agricultural intensification and urban expansion in recent decades. Moreover, MARFC was significantly higher in the EP than that on the Mongolia-Xinjiang Plateau (MX) for all time periods (p< 0.05). Lake CAR(FC) in YG was significantly higher than rates in the Qinghai-Tibetan Plateau (QTP) for the post-1950 and MX for the 1850-1900 (p<0.05). Regression analyses showed that the controls on lake CAR(FC) varied among regions, with catchment climate variables the most important regulators in MX, Northeast China, and QTP, but the in-lake nutrient concentrations were more important in YG and EP (p<0.05). The results from this study show how modern limnic OC sequestration has changed with human disturbance and climate change in China.

（来源：LIMNOLOGY AND OCEANOGRAPHY, 2018, 63(3):1283-1297）

Seeking alternative stable states in a deep lake

Bruel, Rosalie; Marchetto, Aldo; Bernard, Anaelle; et al.

1. Hysteresis linked to alternative stable states may explain delays in water quality recovery despite reduced nutrient loadings in shallow lakes. Because deep lakes are assumed to be less prone to critical transitions, similar delays are attributed to the confounding effects of additional environmental disturbances, such as climate warming. Herein, we hypothesised that the lack of evidence of nutrient-driven alternative stable states in a deep lake arises from the fact that the nutrient threshold that causes the critical transition is lower than the nutrient threshold in shallow lakes. Thereby, it might have been crossed much earlier in the lake history.

2. To test this hypothesis, we focused on the palaeo-ecological trajectory of Lake Varese, which is a deep, hypereutrophicated peri-alpine lake undergoing restoration. Proxies for drivers of ecological state (i.e. total phosphorus-TP-through diatoms and pigments) and ecological responses (Cladocera), as well as a repeatable analysis, were used to identify transitions and to distinguish hysteretic delays from those of the ecosystems responding to additional constraints over the past century.

3. Our results suggest spatial heterogeneity in the ecological response. The littoral habitats changed abruptly and prematurely for a low TP threshold, causing a shift that met many criteria of a flickering-type critical transition. Soon after the littoral shift, a striking increase in the lake phosphorous concentration was recorded and drove the pelagic assemblage towards a new state. This transition was abrupt, and the pelagic communities exhibited limited evidence of recovery; however, we found no evidence of hysteresis. Therefore, the modern ecological trajectory of the pelagic communities is currently driven by climate warming.

4. This detailed analysis allowed us to go beyond the general pattern that links ecological responses to drivers and suggest that a nonlinear transition following eutrophication can take place in a deep lake synchronously with linear transitions. Instead of triggering a new regime shift, climate warming, to which

pelagic habitats are more sensitive than littoral ones, has driven the lake further from its safe operating space.

（来源：FRESHWATER BIOLOGY, 2018, 63(6): 553-568）

A Combined Field and Laboratory Study on Activated Carbon-Based Thin Layer Capping in a PCB-Contaminated Boreal Lake

Abel, Sebastian; Akkanen, Jarkko.

The in situ remediation of aquatic sediments with activated carbon (AC)-based thin layer capping is a promising alternative to traditional methods, such as sediment dredging. Applying a strong sorbent like AC directly to the sediment can greatly reduce the bioavailability of organic pollutants. To evaluate the method under realistic field conditions, a 300 m(2) plot in the PCB-contaminated Lake Kernaalanjarvi, Finland, was amended with an AC cap (1.6 kgAC/m(2)). The study lake showed highly dynamic sediment movements over the monitoring period of 14 months. This led to poor retention and rapid burial of the AC cap under a layer of contaminated sediment from adjacent sites. As a result, the measured impact of the AC amendment was low: Both the benthic community structure and PCB bioaccumulation were similar on the plot and in surrounding reference sites. Corresponding follow-up laboratory studies using Lumbriculus variegatus and Chironomus riparius showed that long-term remediation success is possible, even when an AC cap is covered with contaminated sediment, to retain a measurable effectiveness (reduction in contaminant bioaccumulation), a sufficient intensity and depth of bioturbation is required. On the other hand, the magnitude of the adverse effect induced by AC correlated positively with the measured remediation success.

（来源：Environmental science & technology, 2018, 52(8): 4702-4710）

Nontarget Mass Spectrometry Reveals New Perfluoroalkyl Substances in Fish from the Yangtze River and Tangxun Lake, China

Liu, Yanna; Qian, Manli; Ma, Xinxin; et al.

Nontarget high-resolution mass spectrometry (Nt-HRMS) has been proven useful for the identification of unknown poly- and perfluoroalkyl substances (PFASs) in commercial products and water, but applications to biological samples are limited. China is the major PFAS-manufacturing nation; thus, here, we adapted our Nt-HRMS methods to fish collected from the Yangtze River and Tangxun Lake to discover potentially bioaccumulative PFASs in aquatic organisms destined for human consumption. In addition to traditional PFASs, over 330 other fluorinated analytes belonging to 10 classes of PFASs were detected among the pooled fish livers, including 6 sulfonate classes, 2 amine classes, 1 carboxylate class, and 1 N-heterocycle class. One class was detected in samples from both locations, 8 classes were detected exclusively in Tangxun Lake fish, and 1 class was detected exclusively in Yangtze River fish, 10 km downstream of a fluorochemical manufacturing site where we first reported these substances in wastewater 3 years ago. Overall, 4 of the PFAS classes (>165 analytes) are reported for the first time here. Wider monitoring and toxicological testing should be a priority for understanding the health risks posed to people and wildlife exposed to these substances.

（来源：Environmental science & technology, 2018, 52(10): 5830-5840）

科技热点

超级净水膜诞生！薄膜上首次制造图灵结构

长期从事膜科学研究的浙江大学化学工程与生物工程学院张林教授团队把图灵结构与膜研究结合起来，第一次在薄膜上制造出了纳米尺度的图灵结构。这项首次面向应用领域构建图灵结构的研究成果，于北京时间 5 月 4 日发表在国际顶级期刊《科学》上。

纳滤膜是广泛用于深度水处理、硬水软化、苦咸水处理等领域的重要材料，它能去除水中特定的有机物、色素与盐。

制造纳滤膜主要通过界面聚合反应实现：哌嗪和均苯三甲酰氯两种小分子分别溶解于水和油中，互不相容的水油接触后，两种小分子在水油界面处发生聚合反应，可能短短的几秒钟内，一层平整致密、100 纳米左右厚的高分子薄膜就形成了。

张林表示，这种方法不仅可用于制造纳滤膜，也被广泛用于制造反渗透膜。但是，这两种膜的表面微观形貌有极大区别：纳滤膜光滑平整，而反渗透膜则粗糙不平。

纳滤是当前最先进的水处理技术之一，可降低处理成本，将在工业水回用、饮用水安全保障、雨水资源化利用以及西部苦咸水处理等领域发挥积极作用。经过核磁共振实验，发现哌嗪和均苯三甲酰氯的扩散速率差异不足以产生图灵结构，而加入聚乙烯醇后，哌嗪的扩散速率明显下降。在界面聚合过程中，哌嗪与均苯三甲酰氯"舞"出了不一样的路线，最终形成了一张具有纳米级图灵结构的纳滤膜。
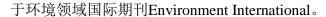
"通过调节聚乙烯醇不同的浓度，我们得到了管状、泡状等不同的图灵结构。"张林说，这项研究是第一次将图灵结构拓展到应用领域，用来指导净水膜的制备。

"我们发现了图灵结构纳滤膜的形成机理，下一步将开发性能更为优异的净水膜。"张林说。与传统制造工艺相比，这项膜制备技术不必对现有生产线做任何改造，就能生产出性能更优的净水膜，有良好的应用前景。

（来源：科技日报，2018-05-04）

中国湖泊喹诺酮类抗生素较国外有显著差异

中国科学院新疆生态与地理研究所与中国科学院武汉植物园科研人员合作，研究分析了全球湖泊中抗生素及抗性基因的类型、分布特征，影响湖泊抗生素和抗性基因分布的因素，并评估了抗生素和抗性基因对生态系统及人类健康构成的潜在风险。研究结果为湖泊抗生素污染防治提供科学依据，有助于研究干旱半干旱区内陆湖泊抗生物等有机污染物的分布特征、迁移转化及污染防治。近日，论文在线发表

于环境领域国际期刊Environment International。

湖泊是重要的淡水资源，地球表面约90%的液态淡水存储于湖泊当中。较长的水力停留时间使得湖泊中的污染物循环缓慢，从而对生态系统和人类健康构成潜在威胁。作为一类新兴污染物，抗生素及其抗性基因在湖泊生态系统中的分布特征、影响抗生素及抗性基因分布的环境因素尚不清晰。

针对上述问题，中国科学院新疆生态与地理研究所副研究员宋文娟，与中国科学院武汉植物园副研究员杨玉义等科研人员整理收集了已发表的文献资料，基于MetaWin平台对数据进行整合分析。

研究结果显示，湖泊中已研究的抗生素有57种。其中，湖泊水体和沉积物中均有较高含量的抗生素——磺胺类、四环素、红霉素及罗红霉素。对比分析中国湖泊与其他国家湖泊中的抗生素发现，磺胺类的含量无显著差异，但是喹诺酮类具有显著差异。红霉素的生态风险最高。湖泊中主要的抗生素抗性基因——磺胺类抗性基因，与河流中抗性基因的含量无显著差异。影响湖泊抗生素及抗性基因分布的因素主要有湖泊中的化学污染物、水体及沉积物的物理化学特性、水生生物区系及人类活动。

此外，科研人员表示，截至目前，抗生素及抗性基因在湖泊微生物群系、水生动植物体中的分布和扩散研究较少，有待于深入研究。

（来源：http://news.sciencenet.cn，2018-05-08）

抗生素、微生物污染成水环境新挑战

随着全球抗生素使用量持续增加，各种新研发的化学品进入生态环境循环中，给传统的污水处理和中水回用、自来水处理系统提出新挑战。在30日于南京闭幕的第15届国际水协会（IWA）水与污水前沿技术大会（LET）上，抗生素、微生物等水体新型污染物引起了各国与会专家的关注。

水处理成抗生素耐药性传播潜在途径

美国弗吉尼亚州理工大学艾米·普鲁登教授说，从目前情况看，污水处理和中水回用已成为抗生素耐药性传播的"潜在关键途径"，这要求人们采取综合性的防范策略和措施。

"主要挑战是要弄清楚，在生物处理过程中，抗生素耐药性在基因水平上的转移、发生程度，这有助于开发新的耐药菌株以及优化消毒过程，从而减少下游耐药细菌的繁殖。"普鲁登说，具体而言，就是通过宏基因组学工具全面描述抗生素抗性基因（ARGs）、可移动遗传元件（MGE），并使用公开的生物信息学工具、指标来评估和比较一系列污水处理和中水回用系统，从而推进监测，缓解废水和中水

回用系统中抗生素耐药性菌的快速增长。此外，推广"污水和饮用水一体化"理念，通过对城市环境中水循环的全面监测来减轻和控制抗生素耐药性。

空气中生物气溶胶污染饮用水

污水处理和中水回用正面临着毒性控制的风险，饮用水也是如此。美国密歇根大学拉特加德·莱斯金教授表示，在过去10年，虽然生物处理工艺，尤其是生物过滤技术在饮用水处理领域得到了极大普及，"但我们尚不清楚生物过滤、消毒、管道输送等过程对自来水水质以及人体微生物群的影响"。生物滤池中大多数微生物扮演着"正面"角色——去除进水中的污染物，但有些微生物却可能导致疾病，比如在高收入国家，水传播感染的风险通常来自与嗜肺军团菌和非结核分枝杆菌等病原体的接触。

莱斯金团队的最新研究发现，消毒过程中的臭氧使用、反冲洗、氯胺暴露以及自来水输送系统中的消毒残留物仅能去除水源微生物群中部分微生物，而空气中的生物气溶胶颗粒会被带入饮用水中，这都会导致嗜肺军团菌等病原体在饮用水微生物群落中占比升高。病菌"水传播"首先会影响低免疫力人群，并在他们当中迅速扩大。

莱斯金希望能增加对饮用水生物气溶胶的关注，了解它们如何影响呼吸道微生物群，可采取哪些措施来减少感染风险，同时能维持饮用水处理达标的目的。
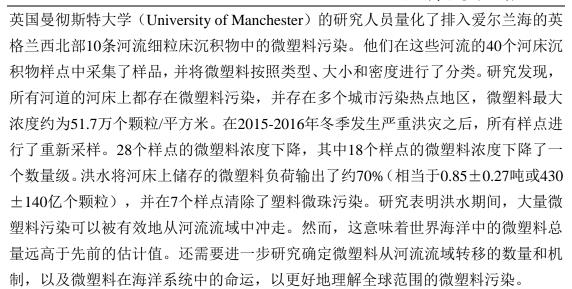
打造加速水处理前沿技术应用平台

国际水协会执行主席卡拉·维尔拉弗穆尔西教授在会上表示，当前饮用水与污水处理等前沿技术应具有三个关键特质：一是灵活性，让处理系统能更好应对各种变化；二是资源的回收与回用；三是数字化建设。对于城市化发展产生的各种新兴问题，需要采取循序渐进式的解决模式。

"目前全球仍有85%的污水没有得到妥善处理，但一项新技术从发表论文到投入实践，一般需历经35年，希望能打造一个可加速水处理的前沿新技术投入应用的平台。"维尔拉弗穆尔西说。

（来源：科技日报 2018-06-01）

洪水能减少流域内的微塑料污染

近日，《自然·地球科学》（Nature Geoscience）期刊发表题为《流域范围内的洪水显著减少河床的微塑料污染》（Microplastic Contamination of River Beds Significantly Reduced by Catchment-Wide Flooding）的文章，指出河流沉积物中普遍存在微塑料污染，洪水可以将微塑料从河流流域冲入海洋。研究表明，通过适当的管理策略控制河流流域的微塑料污染源，河流微塑料污染可以有效迅速地减少。

英国曼彻斯特大学（University of Manchester）的研究人员量化了排入爱尔兰海的英格兰西北部10条河流细粒床沉积物中的微塑料污染。他们在这些河流的40个河床沉积物样点中采集了样品，并将微塑料按照类型、大小和密度进行了分类。研究发现，所有河道的河床上都存在微塑料污染，并存在多个城市污染热点地区，微塑料最大浓度约为51.7万个颗粒/平方米。在2015-2016年冬季发生严重洪灾之后，所有样点进行了重新采样。28个样点的微塑料浓度下降，其中18个样点的微塑料浓度下降了一个数量级。洪水将河床上储存的微塑料负荷输出了约70%（相当于0.85±0.27吨或430±140亿个颗粒），并在7个样点清除了塑料微珠污染。研究表明洪水期间，大量微塑料污染可以被有效地从河流流域中冲走。然而，这意味着世界海洋中的微塑料总量远高于先前的估计值。还需要进一步研究确定微塑料从河流流域转移的数量和机制，以及微塑料在海洋系统中的命运，以更好地理解全球范围的微塑料污染。

（来源：科学研究动态监测快报 2018-04-01，第7期总第324期）

新定量模型分析预测加州水质显示地下水超采或致水源砷浓度上升

科技日报北京6月5日电，英国《自然·通讯》杂志5日发表的一项环境学模型研究显示，在2007年至2015年间，美国加利福尼亚州圣华金河谷地下水超采，可能导致该水源中砷的浓度上升了。

地下水是指埋藏在地表以下各种形式的重力水，这是水资源的重要组成部分，由于其水量稳定、水质好，是农业灌溉、工矿和城市的重要水源之一。但在一定条件下，地下水的变化也会引起沼泽化、盐渍化、滑坡、地面沉降等不利自然现象。

加州中央谷地占美国地下水取水量的20%左右，地下水也是圣华金河谷（中央谷地区）约100万人口的主要饮用水来源。而砷是地下水中的天然污染物，在含水层内黏土的孔隙水中，砷含量很高。在安全的地下水抽取水平下，砷仍留在黏土内。此次，斯坦福大学研究人员瑞恩·史密斯及其同事开发了一个定量模型，来预测地下水的砷浓度，发现圣华金河谷地下水超采引起的地面沉降速率与砷浓度存在关联。研究表明，地面沉降是黏土变形的结果，含有高浓度砷的孔隙水从黏土中释放，随后污染主要的含水层水体。

砷原本是自然界中一种微量元素，可赋存于多种天然矿物中，但在自然及人为因素的诱导下，含水介质中的砷释放进入地下水中，进而导致砷含量异常。目前，高砷地下水在世界范围内广泛分布，据2016年的统计数字，全球约70多个地区近1.5亿人口均不同程度地受到高砷地下水威胁，而长期饮用高砷地下水可导致一系列健康问题，包括皮肤癌、肺癌、肝脏和肾脏疾病等。斯坦福大学的研究小组认为，以加州为例，如能够避免在圣华金河谷超采地下水，将可以改善水质。

（来源：科技日报，2018-06-06）

气候变化将导致 2300 年全球渔业减产 20%以上

2018年3月9日，《科学》（Science）期刊发表题为《持续的气候变暖造成海洋生物生产力下降》（Sustained Climate Warming Drives Declining Marine Biological Productivity）的文章指出，在持续的气候变化影响下，海洋吸收CO_2会导致海洋生态系统中出现多米诺骨牌效应，至2300年海洋渔业产量平均下降20%，而北大西洋地区的渔业产量可能会下降近60%。

预计温室气体排放量的增加可能会抑制海洋生物生产力达一千年或更长时间。美国加利福尼亚大学（University of California）科研人员领导的研究团队，利用通用地球系统模式，预测未来几个世纪气候变化对世界海洋的影响。研究结果表明，随着气候变暖，南半球的西风将加强并向极地转移，地表水将升温，海冰消失，影响之一是海洋生物生产力的急剧下降。这种下降将是由全球范围内的营养物重新分配导致的，营养物到深海的转移将是净转移。到2300年，这可能会导致全球渔业产量下降20%以上，而北大西洋地区的渔业产量可能会下降近60%。

原文来源： http://science.sciencemag.org/content/359/6380/1139

（来源：科学研究动态监测快报 2018-04-01，第 7 期总第 241 期）

北极超咸湖泊有助寻找外星生命

科技日报北京4月12日电，据英国《独立报》11日报道，加拿大阿尔伯塔大学的研究团队在位于北极区的德文岛冰帽之下750米深处，发现了超级咸水湖。研究人员指出，这里可能是12万年前单独进化的生物的家园。由于此处环境与木卫二欧罗巴相似，因此将为在欧罗巴搜寻外星生命提供线索。

研究人员发射电磁波穿透冰层，并在电磁波弹回时对其进行测量，"看穿"了冰层并获得了冰下情形的图谱，从而发现了这些咸水湖。负责人鲁蒂肖泽女士说："雷达标志告诉我们下面有水，但我们之前以为，在温度低于零下10℃的冰层下不可能存在液态水。"

之前科学家也曾在冰帽下发现其他湖泊，但主要在南极。这是科学家首次在加拿大北极区冰盖下发现湖泊。最重要的是，这是首次发现此类充满盐水的湖，当然，也正是这种盐度使这些湖泊引人注目，因为如果它们成为微生物的家园——这种可能性是存在的，将有助于了解地球之外的生命。

鲁蒂肖泽说："我们认为，这种咸水湖能很好地模拟木卫二欧罗巴的环境。欧罗巴是木星的冰冻卫星之一，也许在其冰壳内，具有类似的咸液体条件。"

欧罗巴通常被视为最有希望发现外星生命的地方之一，美国国家航空航天局（NASA）此前曾探讨过将着陆器发往这一遥远星球，以寻找可能存在的生命。

鲁蒂肖泽指出，现在，他们需要证明在德文岛冰帽下发现的这些咸水湖里有生命存在。她说："如果湖里有微生物，那么它们可能已在此处生存了12万年，所以它可能会独立进化。若我们收集到水样，就能确定是否有微生物存在，它们如何演化，以及如何继续生活在这种没有大气层的寒冷环境中。"

鲁蒂肖泽还预测，加拿大北极区冰层下可能存在咸水系统网。

（来源：科技日报，2018-04-16）

王苏民研究员荣膺国际古湖沼学会终身成就奖

6月18日，在瑞典斯德哥尔摩召开的第14届国际古湖沼学大会上，来自中国科学院南京地理与湖泊研究所的王苏民研究员荣膺国际古湖沼学会终身成就奖(IPA Lifetime Achievement Award)。这是对王苏民研究员50余年致力于中国湖泊沉积及古湖沼学研究的肯定和表彰。王苏民研究员毕业于南京大学地理学系，上世纪八十年代初曾留学欧洲，师从国际著名湖泊沉积地质学家许靖华教授，并翻译了《湖泊的化学、地质学和物理学》专著供国内学者学习。他倡导成立了中国科学院湖泊沉积与环境重点实验室（现湖泊与环境国家重点实验室的前身），并率先领导在四川若尔盖、青藏高原错鄂、云贵高原、青海湖等地区开展湖泊深钻及全球变化研究，取得了一系列重要成果。2006年，"湖泊沉积与区域环境变化"获得国家自然科学二等奖（排名第一）。王苏民研究员学识渊博、治学严谨、学风正派、提携后学，先后出任《湖泊科学》第2、3届编辑委员会副主编和第4、5届编辑委员会主编，为《湖泊科学》的学术质量的保障和期刊发展做出了卓越贡献。

（来源：http://www.jlakes.org，2018-06-21）

业界动态

联合国发布《水行动十年计划（2018-2028）》

2018 年 3 月 16 日，联合国发布《水行动十年计划（2018—2028）》（water action decade 2018-2028），又称为"可持续发展水'十年'"，旨在进一步改善合作、伙伴关系和能力发展，以应对雄心勃勃的 2030 年议程。该十年计划从 2018 年 3 月 22 日世界水日开始，到 2028 年世界水日结束。决议指出，十年目标主要聚焦于：水资源的可持续发展和综合管理，实现社会、经济和环境目标；相关方案和项目的实施和推广；促进各层次的合作伙伴关系，实现国际商定的与水有关的目标，包括《2030 年可持续发展议程》的目标。具体如下：

目标一：推进水资源的可持续发展。让水资源的可持续发展和水资源综合管理更加集中，以"实现社会、经济和环境"良好发展的目标。加强在水相关的科学、研究和创新方面的国际合作，以促进地方、国家和区域等的水资源可持续发展，包括建立公私合作和多方利益相关方的伙伴关系，并在共同利益和共同捐助的基础上进行。

目标二：激励和实施现有的水相关方案、项目。利用十年的时间，改进合作伙伴关系和能力发展，激励所有水有关行动者的持续活动。加速和维持水相关行动动员的实现手段，鼓励发展、传播、扩散环保型技术，并把技术转移到发展中国家，充分利用现有的国际基金促进水相关目标的有效实施。

目标三：积极动员以实现 2030 议程中水相关的目标。《2030 年议程》为一个更美好、更可持续的世界提供了一个路线图。保障可持续的水资源管理是实现社会、环境和经济领域的可持续发展目标和其他相关目标的重要因素。十年计划旨在动员各层次采取行动和进一步促进对话、合作和伙伴关系，帮助实现国际商定的与水有关的目标，包括《2030 年可持续发展议程》的目标。这一目标符合 SDG6a（到 2030 年，扩大国际合作和能力建设，支持发展中国家的水和卫生相关活动和方案，包括水收集、脱盐、水效率、废水处理、回收和再用技术。）、SDG6b（支持和加强地方社区参与改善水和卫生管理。）的目标，旨在扩大国际合作和能力建设，支持发展中国家在水和卫生方面的活动和方案，并支持和加强当地社区参与改善水和环境卫生管理。

未来将会通过如下 4 项重要工作流程来实现十年计划目标对会员国的支持，即：①便利的获取水相关的知识及成功的水资源管理的经验交流；②提高水资源管理方面的知识的生成与传播，包括与水相关的可持续发展目标相关的新信息；③追求水资源综合管理及可持续发展的活动宣传，建立国际利益相关者的关系网，促进伙伴关系和行动；④加强与水相关的各类目标之间的沟通。

原文来源：http://www.wateractiondecade.org/wp-content/uploads/2018/03/UN-SG-Action-Plan_Water-Action-Decade-web.pdf

（来源：来源：科学研究动态监测快报 2018-04-15，第 8 期总第 325 期）

全球淡水可用性变化趋势出炉

科技日报北京5月17日电，据英国《自然》杂志17日发表的一篇地球科学研究，美国国家航空航天局（NASA）的科学家发布了一份全球淡水可用性的变化趋势报告。了解陆上蓄水趋势对于管理人类和生态可持续性至关重要，因此，该结果为评估水与粮食安全面临的新威胁提供了指南。

所有陆地生命都依赖于淡水，它决定着地球上生命的分布。全球淡水可用性正在发生变化，但遗憾的是，想要在全球尺度上评估淡水可用性变化非常困难，我们对全球淡水可用性的理解主要来自于有限的、基于地面的现场观测，这些观测成本高昂，却无法提供全面的评估。

与此同时，人们又亟待了解全球水供应究竟是如何响应人类影响和气候变化的，从而才能做出正确的决策。

此次，NASA戈达德太空飞行中心科学家马修·罗戴尔及其同事，利用GRACE重力测量卫星提供的数据，分析了2002年至2016年的陆地储水记录。GRACE卫星是NASA与德国航空中心的合作项目，可以观测地球重力场变化，进而让科学家能推测出地下水的变化。

最新数据揭示了储水量增加和减少的区域，大部分地区的变化趋势与气候模型预测一致。但是，中国西北部和博茨瓦纳奥卡万戈三角洲等几处的储水量变化巨大，至今仍缺乏彻底的调查和归因。

研究结果表明，任何一个地区的变化都反映了自然气候变率与人类活动的综合影响，需要在国家内部和国家之间联合实施水资源管理方法。而基于观测来评估全球水供应如何响应人类影响和气候变化，为评估和预测水与粮食安全的新威胁提供了新指南。

（来源：科技日报 2018-05-18）

WRI：构建新型水资源利用数据库助力全球水资源管理

水资源危机是全世界目前所面临的最严峻的问题之一。作为应对该风险的手段之一，很多世界组织都通过提高全球用户对水资源知识的了解程度来减少相关资源利用的风险。关于水资源的生物物理学条件已有最为丰富的全球数据库，其中包括：水资源可利用性、水资源总量、水资源安全性、地下水水位等相关信息，并且还有

很多研究进展，例如水资源污染，如何预测气候变化对水文条件的影响等。但是，关于公共机构管理可利用水资源的能力的数据仍然相对稀缺。面对这一问题，WRI和 MIT 于 2018 年 3 月 6 日发布了名为《共享水风险信息助力水资源管理》的技术报告，试图构建创新的数据平台，通过共享区域水资源利用与管理的有效信息，实现全球水资源的有效管理。

报告指出，目前对于水资源风险的评估仍然是不完全的，并且结果也是不精确的。对于每一个水资源的使用者——工业、农业及家庭用水，水资源风险涉及三个变量：用水者对水资源的依赖性、用水者暴露于水资源压力的程度、用水者应对水资源压力的能力。水资源在不同地区不同情况下如何被管理，已成为水资源外部环境的一个重要组成部分，因此它是决定所有用水者相关"水风险"的一个至关重要的因素。此外，不同于公共用水固定的理化属性，公共用水管理政策是可以被制定及改变的。这一因素就使得水资源公共管理政策数据的可用性及可操作性变得至关重要，它有助于缓解公共用水压力，并且增加用水的安全程度。

目前，这部分缺失的数据不仅使得水资源风险评估变得不够完整，并且影响了相关缓解措施的制定与实施。当前用于衡量公共用水状况的管理政策优劣的标准分为两类：一类是通过各国具体的统计信息来综合评判全球水资源公共管理政策，另一类是通过收集多方利益的相关信息来描述某一地区具体的水资源公共管理政策，但二者都具有一定的缺陷性。基于上述，报告作者建议创建一个具有全球性、可比较性的公共水资源管理指标数据库，数据库需要明确如下内容：

（1）涉水信息指标的可用性和可获得性；

（2）区域水处理设施和水供给设施的性能与处理能力；

（3）区域水资源分配、定价等关键指标的制定与执行情况；

（4）区域应对和处理水位计的能力。

这些指标的收集与共享可以刺激水资源公共管理政策的切实改进。这个地理数据库将被多个公司提供的具有多维性的水资源风险评价数据填充。鼓励数据的提供者匿名分享水资源公共管理政策建议，以此作为降低创新实践风险的一项重要措施。

原文来源：http://www.wri.org/sites/default/files/mapping-public-water-management-harmonizing-sharing-corporate-water-risk-information.pdf

（来源：科学研究动态监测快报 2018-04-01，第 7 期总第 324 期）

联合国发布《2018 年世界水资源发展报告》

2018年3月20日，联合国发布《2018年世界水资源发展报告》（The United Nations World Water Development Report 2018，简称WWDR），这份报告强调通过基于自然的解决方案（NBS）来应对水资源的挑战，改善水的供给及水质，减少水少水多等

带来的自然灾害。

水不是一种孤立的元素，而是一种复杂自然过程的组成部分，它包括蒸发、沉淀和土壤的水分吸收等。草原、湿地和森林植被覆盖的存在影响着水循环，同时也是改善现有水数量和质量的关键。在水资源管理方面，WWDR提出需要新的解决方案，以应对人口增长和气候变化带来的水资源安全挑战，提出了基于自然的解决方案，以更好地管理水资源。

（1） 全球对水的需求、可获得性、水质及极端事件

联合国《2018年世界水资源发展报告》显示，由于人口增长、经济发展和消费方式转变等因素，全球对水资源的需求正在以每年1%的速度增长，而这一速度在未来20年还将大幅加快。尽管目前农业仍是最大的用水行业，但未来工业用水和生活用水需求量将远大于农业需水量。对水资源需求的增长将最主要来自于发展中国家和新兴经济体。气候变化正在加速全球水循环，导致湿润的地区更加多雨，干旱的地区更加干旱。目前，约有36亿人口居住在缺水地区，到2050年缺水人口可能增长到48~57亿之多。报告称，自20世纪90年代以来，在拉丁美洲、非洲和亚洲，几乎每条河流的水污染情况都进一步恶化。未来数十年，水质还将进一步恶化，对人类健康、环境和可持续发展的威胁只增不减。从全球来看，最为普遍的水质问题是水体中的营养物含量升高。据预测，低收入和中低收入国家受到污染物影响的上升趋势最为明显。水量和水质的变化趋势与洪水和干旱风险息息相关。面临洪水风险的人口数量预计将从目前的12亿增长到2050年的大约16亿。目前，受到土地退化、沙漠化以及干旱影响的人口数量大约为18亿，从死亡人数和人均GDP社会经济影响角度来看，这是最严重的一类"自然灾害"。
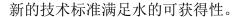
（2） 生态系统退化

生态系统退化是水资源管理面临挑战的一个主要原因。全球30%的土地覆有植被，但其中至少三分之二处于退化状态。蒸发速度变快、土地蓄水量变低、地面径流增多、土地侵蚀加剧，都将对水循环造成严重的负面影响。自1900年起，全球大约有64%~71%的自然湿地面积因人类活动因素消失殆尽。报告强调，生态系统恶化在历史上造成了诸多古代文明的消亡。现在要避免重蹈覆辙，必须实现从对抗自然到顺应自然的转变，更好地利用基于自然的解决方案。

（3） 基于自然的水问题解决方案

基于自然的解决方案，通过使用或模仿自然过程，着眼于管理水的可获得性、水质和涉水风险，致力于改善水资源的管理。

基于NBS水的可获得性主要是通过管理降水、湿度、储水、入渗和透射等方式解决供水问题，从而改善了人类生活所需要的水的来源、可供给时间和可用总量。考虑到目前世界上大多数人口都居住在城市，所以解决城市居民的用水问题也非常重要。城市绿色基础设施，包括绿色建筑，是一种新兴的现象，许多国家正在建立

新的技术标准满足水的可获得性。

基于NBS缓解水质问题。水源保护降低城市供应商水处理成本，并有助于改善农村社区饮用水安全供应。在适当管理的情况下，森林、湿地和草原以及土壤作物，在调节水质方面发挥着重要作用。在水被污染的地方，建造自然生态系统可以帮助改善水质。来自农业的非点源污染，特别是营养物质，仍然是世界范围内的一个关键问题，基于NBS可以修复生态系统服务，改善土壤养分管理，从而降低肥料需求，减少养分径流或地下水渗入。城市绿色基础设施日益被用于管理和减少城市径流污染。例如，绿墙、屋顶花园和植被渗透或排水盆地，以支持污水处理和减少雨水径流。建设城市湿地环境，以减轻受污染的雨水径流和废水对环境的影响，还会降解或固定化一系列的新污染物，包括某些药物，这种基于自然的解决方案要优于水质管理的灰色解决方案。

基于NBS的水风险管理可以通过管理水的渗透和流动性，从而改善水的滞留时间，减少洪水的损失及洪水风险。改善景观（包括土壤和地下水）的蓄水能力，缓冲水资源极度匮乏时期的干旱情况。降雨量的季节性变化为景观的蓄水提供了机会，从而为干旱期的生态系统和人们提供水。然而现实中自然蓄水（特别是地下蓄水层）减少灾害风险的潜力还远远没有实现。流域和区域尺度的存储规划应该考虑到地表和地下储存选择的组合，以达到在水资源多样性增加下对环境和经济的贡献。

原文来源：http://www.unwater.org/world-water-development-report-2018-nature-based-solutions-for-water/

（来源：科学研究动态监测快报 2018-04-01，第7期总第324期）

我国全面打响蓝天、碧水、净土三大保卫战

6月24日公布的《中共中央国务院关于全面加强生态环境保护坚决打好污染防治攻坚战的意见》提出，坚决打赢蓝天保卫战，着力打好碧水保卫战，扎实推进净土保卫战。

大气污染防治方面，意见明确，编制实施打赢蓝天保卫战三年作战计划，以京津冀及周边、长三角、汾渭平原等重点区域为主战场，调整优化产业结构、能源结构、运输结构、用地结构，强化区域联防联控和重污染天气应对，进一步明显降低PM2.5浓度，明显减少重污染天数，明显改善大气环境质量，明显增强人民的蓝天幸福感。

水污染防治方面，深入实施水污染防治行动计划，扎实推进河长制湖长制，坚持污染减排和生态扩容两手发力，加快工业、农业、生活污染源和水生态系统整治，保障饮用水安全，消除城市黑臭水体，减少污染严重水体和不达标水体。

土壤污染防治方面，全面实施土壤污染防治行动计划，突出重点区域、行业和

污染物，有效管控农用地和城市建设用地土壤环境风险。具体措施集中在强化土壤污染管控和修复、加快推进垃圾分类处理、强化固体废物污染防治等领域。

意见确定了到2020年三大保卫战具体指标：全国PM2.5未达标地级及以上城市浓度比2015年下降18%以上，地级及以上城市空气质量优良天数比率达到80%以上；全国地表水一至三类水体比例达到70%以上，劣五类水体比例控制在5%以内；近岸海域水质优良（一、二类）比例达到70%左右；二氧化硫、氮氧化物排放量比2015年减少15%以上，化学需氧量、氨氮排放量减少10%以上；受污染耕地安全利用率达到90%左右，污染地块安全利用率达到90%以上。

（来源：新华每日电讯3版 2018-06-25）

两部委打响治理城市黑臭水体"号令枪"

5 月 7 日，保卫碧水的"号令枪"已经打响。生态环境部联合住房城乡建设部启动了 2018 年城市黑臭水体整治环境保护专项行动，将分 10 个组对广东、广西、海南等 8 个省 20 个城市开展督查工作，首批督查组已抵达督查现场。

生态环境部有关负责人表示，城市黑臭水体的实质是污水、垃圾直排环境问题，根子在于城市环境基础设施不合格。专项行动是以整治黑臭水体为抓手，倒逼城市环境基础设施建设，加快补齐短板，提高城市水污染防治水平，切实改善城市水环境等。

"城市黑臭水体问题的根本是环境基础设施还没有完全建设到位，还不能满足水环境的要求。"中国人民大学环境学院副院长王洪臣教授在接受科技日报记者专访时表示，近年来，我国在黑臭水体治理方面做了很多工作，也快速地取得了成效，黑臭程度大幅缓解。

不过，王洪臣也认为，目前，离彻底解决黑臭水体的目标还有很长的路要走。"比如污水是否彻底截留和处理了？现在很多城市污水处理厂基本处于满负荷运行中，有时甚至是超负荷运行。一个必然的结果是，在污水排放高峰期或汛期时，有污水溢出或是雨水和污水混合一起排入河道。我国的排水系统欠账较多，住建部正在做提质工作，主要是提升排水管网的收集功能，尽可能地将更多污水留下来。"

按照《水污染防治行动计划》要求，直辖市、省会城市、计划单列市建成区黑臭水体消除比例达到 90%以上，各省、自治区地级及以上城市建成区黑臭水体消除比例平均达到 60%以上。

中持环保董事长许国栋说，目前城市黑臭水体治理的基本思路都是"控源截污—清淤疏浚—生态修复"，瓶颈不在技术，而在设施和管理。

生态环境部也表示，本次的实质督查包括控源截污措施是否落实。重点关注是否存在非法排污口，是否存在企业超标排污或偷排问题，是否实质性解决了城镇污

水直排环境的问题，收集的污水是否得到有效处理。垃圾清理措施是否落实。重点关注沿河垃圾收集、转运及处理处置措施是否有效落实。清淤疏浚措施是否落实。重点关注内源污染是否得到有效控制，清理的淤泥是否安全处置。生态修复措施是否落实。对于城市无排涝功能水体，重点关注是否采取了必要的生态补水等修复措施，自然水体生态基流是否得到保障等。

"在黑臭水体治理方面，各个城市都应该有一个面向未来的行业规划；在治理设施上，必须留出来盈余的系数。"王洪臣说，这样一来，可避免在突发情况下的污染问题。

据悉，今年生态环境部还要开展渤海综合治理、长江保护修复、打好水源地保护等攻坚战，此次黑臭水体整治专项行动是涉水的 5 个攻坚战的"当头炮"。"我们将连续三年开展黑臭水体整治环境保护专项行动，督促地方彻底解决城市建成区黑臭水体问题。把群众是否满意作为首要标准，公众全程参与；滚动管理，不获全胜绝不收兵。"该负责人说。

（来源：科技日报 2018-05-08）

生态环境部专项督查 1586 个水源地

科技日报北京5月20日电，生态环境部5月20日正式启动全国集中式饮用水水源地环保专项第一轮督查，并从全国抽调执法骨干力量组成273个组，对所有涉及到的212个地级市及1069个县，1586个水源地的环境问题进行督查。

经国务院批准，环境部联合水利部制订了《全国集中式饮用水水源地环境保护专项行动方案》，要求各地政府组织做好本辖区饮用水源地环境违法问题排查整治工作，确保饮用水源安全。

环境部表示，为及时发现饮用水水源地保护区内排污口、违法建设项目、交通穿越、餐饮旅游等环境问题，鼓励公众拨打举报电话：010-12369，或通过"12369环保举报"微信公众号进行举报，环境部将督促地方逐一核实，依法查处。

环境部还通报了国家地表水水质自动站建设进展情况。截至2018年5月17日，959个需要地方新建的水站中，954个已开工建设；772个站房主体工程已建成，开始进行内外装修和辅助设施建设，占80.5%。530个地方投资的已（在）建水站中，329个水站已完成仪器设备填平补齐，占62.1%。其中，江西、浙江等11个省份的仪器设备填平补齐已全部完成。

（来源：科技日报 2018-05-21）

白高分五号卫星强势加盟"空天地一体化"监测绿水青山

5月9日2时28分，我国成功发射高分五号卫星。生态环境部环境监测司负责人9日表示，高分五号卫星是国际上热红外波段空间分辨率最高的民用卫星，对形成"空天地一体化"监测系统，满足环境综合监测等方面的迫切需求，掌握高光谱分辨率对地观测能力、遥感信息资源自主权等具有重要意义。

生态环境部认为，高分五号可有效探测港口/船舶大气污染等；可高精度监测叶绿素、浮游生物、溶解的有机质以及各种悬浮物、水生植物等；可用于水色遥感大气校正、水体热污染监测、湖泊蓝藻水华监测预警、核电厂温排水、湖泊富营养化评估、近海赤潮、浒苔遥感监测等；可高精度识别地物类型、植被类型，进行地表温度、土壤水分、蒸散、城市热岛效应、生物多样性、自然保护区、土地利用类型、大型工程生态环境破坏等监测。

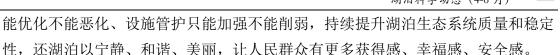到今年年底，我国将全部划定生态保护红线区域，并将实行最为严格的生态环境保护和用途管制。然而，生态保护红线区域不仅面积大、分布广，而且还多分布于偏远的深山密林和高山峡谷，人迹罕至，全靠人工去严防死守不及时也不可行。

该负责人表示，高分五号卫星的发射，有利于建立卫星、无人机和地面相结合的"空天地一体化"监测系统：卫星"拍片"记录下生态保护红线划定时的生态环境状况，这相当于生态环境"底片"，之后发生的任何生态环境变化都可通过遥感解译、反演和比对及时发现，无人机则通过分辨率超过50厘米的各种相机，对卫星发现的变化进行核实和确认，减少误判错判，最后通过地面实地核查和鉴别，完成对违法生态破坏行为的取证，从而实现及时、快速、准确的生态保护红线监测监管，第一时间发现、处置各种生态破坏行为。

（来源：科技日报，2018-05-10）

广东省率先所有湖泊全面实施湖长制

从广东省水利厅获悉，《关于在全省湖泊实施湖长制的意见》(以下简称《意见》)近日由广东省委办公厅、省政府办公厅正式印发，到本月底，全省所有湖泊将全面建立省、市、县、镇、村五级湖长体系，今后新开挖的人工湖泊也将纳入湖长制实施范围。

《意见》提出，到2018年6月底，在全省行政区域内所有湖泊全面建立湖长制，建立健全以党政领导负责制为核心的责任体系，落实属地管理责任。到2020年年底，力争实现湖泊管理范围内违法建筑物、构筑物基本拆除，违法养殖全面清，入湖排污口全面整治，湖泊富营养化和蓝藻水华得到有效控制；相较于2018年年初，要确保所有湖泊水域面积只能增加不能减少、水体水质只能变好不能变差、生态环境只

能优化不能恶化、设施管护只能加强不能削弱，持续提升湖泊生态系统质量和稳定性，还湖泊以宁静、和谐、美丽，让人民群众有更多获得感、幸福感、安全感。

在实施范围上，全省行政区域内所有湖泊和今后新开挖的人工湖泊均纳入全面推行湖长制实施范围。水库、山塘纳入河长制实施范围。

广东省河长办相关负责人介绍："2018年6月底全省要全面建立湖长制,比中央要求提前半年。"

特色——湖泊生态损害终身追责

《意见》显示，广东要全面建立省、市、县、镇、村五级湖长体系。"这是考虑到湖长体系的设置与各级河长设置充分结合。广东目前建立的河长体系是流域与区域相结合，即除了各级区域内的主要河流有流域河长外，在各级区域上有各级总河长，由区域的党政主要负责同志担任,对区域内的所有河流管理保护负总责。此次《意见》则明确，广东不再设置各级总湖长,由各级总河长对本行政区域内的湖泊管理保护负总责。"上述相关负责人说。

此外，《意见》还明确了湖长要全面落实的六大主要任务：严格湖泊水域空间管控、强化湖泊岸线和设施管理保护、加强湖泊水资源保护和水污染防治、加大湖泊水环境综合整治力度、开展湖泊生态治理与修复、健全湖泊执法监管机制。

相关负责人解释，考虑到广东水系发达、河流纵横，自然灾害较为频发等水情特点，《意见》在中央规定的"强化湖泊岸线和设施管理保护"中增加了水安全方面内容，包括"大力推进湖泊管护设施除险加固、安全检测与评价工作，加快实施流域防洪联合调度，进一步提高湖泊蓄洪、滞洪和调洪能力"。

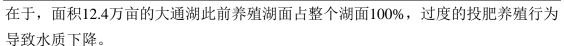同时，广东湖长考核将纳入到河长制考核，实行湖泊生态环境损害责任终身追究制，对造成湖泊面积萎缩、水体恶化、生态功能退化等生态环境损害的，严格按照有关规定追究相关单位和人员的责任。

（来源：新快报，2018-06-14）

湖南最大内陆淡水湖请水草为湖泊"疗伤"

在湖南益阳市大通湖区大通湖湖面上，120多名工人分乘20来条船将轮叶黑藻、黄丝草、穗花狐尾藻等水草苗投放到选定的湖面，一天内他们要完成25吨水草投放任务。

请来"吃"污染物的水草为湖泊"疗伤"，是大通湖区为恢复"水美大通湖"想到的好办法。大通湖是组成洞庭湖的四个较大的湖泊之一，也湖南省内最大的内陆淡水湖，如今正面临湖水富营养化严重，总氮指标尤其是总磷指标难降的难题。

大通湖在2012年还是国家良好湖泊，然而水质从2013年Ⅲ类下降到了2015年劣Ⅴ类，作为湖泊生态系统重要组成部分的水生植物覆盖率一度为零。而其根本原因

在于，面积12.4万亩的大通湖此前养殖湖面占整个湖面100%，过度的投肥养殖行为导致水质下降。

自2018年1月开始，大通湖区邀请武汉大学梁子湖湖泊生态系统国家野外科学观测研究站水生态修复团队，在大通湖进行水生植被重建研究。目前，在大通湖适种区已实施两批次植被恢复，共种植轮叶黑藻、苦草、狐尾藻等1.7万亩。这些水草在水中生长，逐步吸收和降解水体中的营养元素和污染物。

"氮、磷是水体富营养化后发臭、发绿的'元凶'。而轮叶黑藻、苦草等植物在生长过程中正好可以吸收水体里面的氮和磷。"武汉大学副研究员王力功说，恢复大面积水生植被，降低大通湖水体和底泥中的营养含量，重新构建一个稳定的生态群，对大通湖来说是一个复杂的系统，也是一个缓慢的过程，而武汉大学研究团队将在这里提供为期三年的技术服务。

大通湖渔场场长夏忠明介绍，为加快水生态植被修复，目前大通湖已实行全面禁养、退养、禁投，大通湖水生植被恢复和农业污染治理、垃圾污水防治、工业点源污染整改、疏浚活水等措施在同步进行。到2018年底，大通湖水生植被覆盖率将达到10%至15%，力争2020年底达到40%左右，水质恢复到III类。
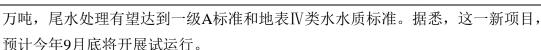
（来源：中国新闻网，2018-05-24）

湖南污水环保处理能力有望翻番

6月3日，第四十七个"世界环境日"前夕，在长沙启动湖南省科技厅主办的"世界环境日——美丽中国 我是行动者"主题环保及志愿者服务活动上，来自湖南师范大学附属小学的吴老师，给近百名学生和社会各界环保志愿者，分享了一场生动而有趣的环保科普。记者同时获悉，该省运用环保新技术，污水处理能力有望今年实现翻番。

这一场旨在提升公众对水资源与水环境保护意识的"水资源科普盛宴"中，除了环保科普专家现身说法保护河流的重要性，及水污染的危害。孩子们和环保志愿者还深入湖南省创新性示范工程、"两型"科普教育基地和水生态修复试验示范基地——洋湖再生水厂，"眼见为实"地感受了污水如何变清澈的全过程，观赏各种植物塘与人工湿地。

经了解，洋湖再生水厂在我国首次采用"MSBR+人工湿地+城市湿地公园"工艺系统，日处理污水规模可达4万吨，处理后的出水可达国家一级A标准，电耗仅0.15度/吨水。能更科学、高效、低成本地解决我国新型城镇化过程中污水处理、水资源循环利用和城市水环境保护等一系列问题。目前，再生水厂二期项目正在建设中，届时，将采用"MSBR+微絮凝过滤单元"组合工艺，日处理污水能力有望翻番到8

万吨，尾水处理有望达到一级A标准和地表Ⅳ类水水质标准。据悉，这一新项目，预计今年9月底将开展试运行。

（来源：科技日报 2018-06-04）

投资十多亿治理两年呼伦湖水质仍是最差的劣五类

呼伦湖是内蒙古第一大淡水湖，也是我国第五大淡水湖。生态环境部 6 月 26 日表示，呼伦湖生态环境治理一期工程项目实际投资 13.15 亿元，经过两年治理，总氮、高锰酸盐指数有所下降，但化学需氧量（COD）、总磷、氟化物指标却不降反升，水质仍为最差的劣五类。

呼伦湖素有"草原明珠"之称，呼伦湖及其周边水系列入《国际重要湿地名录》，其环境治理与生态保护是筑牢我国北方生态屏障的重要任务。2016 年批复的《呼伦湖流域生态与环境综合治理一期工程（2016—2017 年）实施方案》，其中含有草原生态保护、湿地生态系统恢复、水利工程、环境整治和管护能力等五大类 20 项工程，规划投资 21.08 亿元；通过上述治理工程减轻湖泊富营养化程度等，力争 2017 年底湖泊水质从劣五类提高到五类。
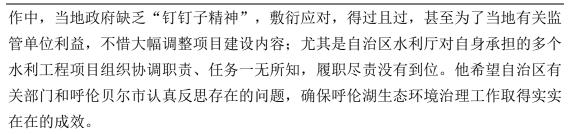
生态环境部表示，现场督察发现，呼伦湖水环境质量没有得到改善。监测数据显示，与 2015 年相比，呼伦湖水质在 2016—2017 年虽然总氮、高锰酸盐指数有所下降，但 COD、总磷、氟化物指标却不降反升。从总体看，呼伦湖水质与入湖水量密切相关，水环境质量"靠天吃饭"现状尚未改变，生态环境保护形势不容乐观。

即使投资没有达到当初批复的 21.08 亿元，但依然投资了 13.15 亿元，经过两年治理，呼伦湖水质为何没有实现好转？

据生态环境部分析，主要是治理工程随意调整变更。实施方案明确的 20 个治理工程项目，只有两个项目总体按计划执行，工程项目调整变更率达 90%。相应投资变更是大幅削减，其中，农村安全饮用水项目计划投资 1 亿元，实际仅投 640 万元；涉及旅游景区治理改造及基础设施建设等重大项目没有实施，有关管护能力建设却由规划的 1.9 亿元，调增到 4.02 亿元。工程项目实施存在避重就轻、避难就易等问题，治理效果自然大打折扣。

工程项目管理也十分混乱。生态环境部表示，从督察情况看，自治区有关部门和呼伦贝尔市在治理项目实施中，既没有有效协同推进机制，也没有有效的监督考核机制，工程项目擅自调整，任意变更，容易实施的实施，有难度的就调出实施范围；对环境治理影响较大的项目往往被延期或简化，用于管护、执法能力的项目投资增长到总投资的 32.3%。特别是工程项目研究论证不够，有的甚至仅凭某个研究单位的个别专家意见，就彻底变更技术路线，管理混乱，监督松懈。

中央第二环保督察组副组长、生态环境部副部长翟青说，在呼伦湖综合治理工

作中，当地政府缺乏"钉钉子精神"，敷衍应对，得过且过，甚至为了当地有关监管单位利益，不惜大幅调整项目建设内容；尤其是自治区水利厅对自身承担的多个水利工程项目组织协调职责、任务一无所知，履职尽责没有到位。他希望自治区有关部门和呼伦贝尔市认真反思存在的问题，确保呼伦湖生态环境治理工作取得实实在在的成效。

（来源：科技日报 2018-06-28）

洱海入湖河流治理取得初步成效

处于富营养化初期的湖泊洱海的污染负荷主要来自入湖河流，流域面源污染通过入湖河流输入湖泊主体。

2011 年，根据国家水体污染控制与治理重大专项的总体安排，洱海流域设立了"入湖河流污染治理及清水产流机制修复关键技术与工程示范"课题（课题编号 2012ZX07105-003），上海交通大学作为课题承担单位，联合中国环境科学研究院、大理大学和大理市水利水电管理总站等单位开展了课题研究工作。
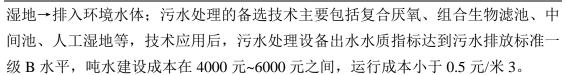
针对洱海流域入湖河流面源污染严重、自净能力下降、库塘湿地退化等造成河流水质超标的环境问题，课题选择洱海的入湖河流及其子流域为研究对象，在"十一五"研究的基础上，以永安江及其子流域为工程示范区，以洱海南部及西部不同类型入湖河流为研究对象，研发与集成入湖河流清水产流机制修复整装成套技术，编制综合修复方案，通过对河流及子流域的污染特征分析、技术研发与工程示范，实现永安江水质综合改善，形成入湖河流水污染防治的技术体系。

课题研究内容主要包括：东湖湿地生态修复及永安江水质改善技术研究及综合示范；永安江清水养护区污染防治技术研究及工程示范；洱海南部和西部典型河流清水产流机制修复技术研究和方案编制。通过本课题的研究，编制完成洱海南部及西部典型河流清水产流机制修复综合方案，形成清水养护区污染控制、湿地生态修复及沿河污染收集处理等关键技术，并建成永安江工程示范区，实现永安江水质综合提高一个等级的目标。

控源截污、优化工艺，形成面源污染控制技术体系

形成分层生物滤池污水处理工艺，控制村落面源污染

基于洱海流域农村污水收集现状，课题开发了农村污水收集与处理技术。通过对功能填料、跌水充氧与微生物氧化、潜流湿地等技术组合应用，形成了分层生物滤池污水处理工艺，优化了生物氧化、硝化和反硝化过程，达到有效去除氮磷营养物与有机物的目标。针对农村地区污水收集系统不健全、管道铺设难度大的问题，提出分类收集的解决方案，建设村落雨污合流的截污沟收集系统，实现区域污染控制。工艺单元主要包括：村落生活污水→分区收集系统→分层生物滤池→强化潜流

湿地→排入环境水体；污水处理的备选技术主要包括复合厌氧、组合生物滤池、中间池、人工湿地等，技术应用后，污水处理设备出水水质指标达到污水排放标准一级 B 水平，吨水建设成本在 4000 元~6000 元之间，运行成本小于 0.5 元/米 3。

构建入湖河流缓冲带，拦截农田面源污染

基于洱海流域入湖河流受到农田径流影响较大、农田中流失的氮磷等营养物质主要通过入湖河流流入洱海的现状，课题在河道两侧建设缓冲带，大幅度减少河道两侧的高强度人为干扰，同时发挥缓冲带的氮磷拦截功能，将沿河的农田径流进一步净化，以保持与改善入湖河流水质。在此工艺中，以河道为轴心，依次向外进行不同类型功能区的布设，将近岸区（30m 范围内）强化净化空间、较远区域（30m~100m 范围内）环境友好种植空间和基本农田区生产空间顺次排列，基本形成基于空间布局的面源污染控制体系。

研发潜流/表流近自然湿地技术，改善入湖河流水质

农业与农村面源是洱海流域北部入湖河流的主要污染源，河流中总氮、总磷等水质指标超标严重，很多月份处于 V 类或劣 V 类水平，不能满足洱海流域水质目标要求。入湖河流还存在季节性水质波动较大的问题，即初期雨水带来的地表径流会造成水体浓度骤然升高；旱季污染物在岸上积存，河流水质压力较雨季明显降低。常规的污水处理工艺难以应用于浓度和水量的季节性波动河流，课题研发的潜流/表流近自然湿地通过蓄存净化等方式，可以有效降低河水中的氮磷等营养盐浓度，还可以营造自然湿地景观，为生物多样性恢复提供空间保障。工艺特点包括：以河流水质改善为目标，通过营造多级潜流/表流交错湿地，构建好氧和兼氧区域，控制出水总氮浓度，同时通过种植沉水、挺水、浮叶植物，创造良好的水生生物栖息环境，以强化填料为核心，降低出水总磷浓度和悬浮物。
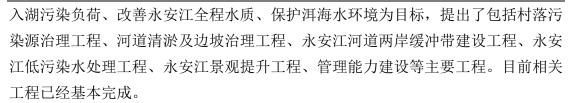
以清水入湖为核心目标，支撑地方政府治理河道

编制洱海源头万亩湿地建设工程方案

课题组接受地方委托，编制了《洱海源头万亩湿地建设工程——恢复东湖湿地建设工程实施方案》与《洱海源头"万亩湿地"建设工程—洱源县大树营生态湿地建设工程实施方案》，将课题组提出的村落污染控制及湿地生态修复技术应用在实际工程当中，两个方案分别于 2012 年 11 月 16 日和 2013 年 2 月 28 日评审通过，目前工程方案已经实施完成，为课题示范工程、依托工程和示范区水质改善提供了技术保障。

编制永安江绿色流域建设工程可研报告

在课题实施之初，永安江总氮超标较严重，一直在劣 V 类水平，具有典型的农业面源污染特征，实施永安江水环境综合治理项目对洱海流域入湖河流的全面治理具有示范意义。2016 年 1 月，课题组根据地方需求，整合研究成果，编制了可行性研究报告，为全面实现永安江水质提高提供了技术支撑。报告以削减永安江携带的

入湖污染负荷、改善永安江全程水质、保护洱海水环境为目标，提出了包括村落污染源治理工程、河道清淤及边坡治理工程、永安江河道两岸缓冲带建设工程、永安江低污染水处理工程、永安江景观提升工程、管理能力建设等主要工程。目前相关工程已经基本完成。

设计波罗江清水产流机制修复方案

课题以波罗江小流域清水产流机制修复为目标，将流域划分为清水涵养产流区、清水输送区、湖滨缓冲区三大区，并根据各区特点与环境影响因素，划分为不同亚区。根据各区不同的环境现状、污染物来源、产污方式等，采用不同的思路及技术工艺，设计相应工程方案，同时提出非工程措施，通过工程措施和非工程措施的结合，最终实现工程目标。波罗江清水产流机制方案主要包括六大工程：三哨水库及汇流山箐清水保障工程、波罗江流域农业农村复合污染控制工程、波罗江流域工业园区污染控制工程、城镇快速发展区面源污染控制工程、清水输水通道生态建设工程、清水优化调度与管理体系建设工程。
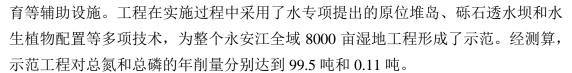
制定白鹤溪清水产流机制修复方案

针对白鹤溪小流域清水产流各功能区的主要环境问题，从流域的角度出发，以改善和提高白鹤溪入湖水质、健全流域污染治理体系和构建清水廊道为目标，以"清水产流理念"为指导，通过白鹤溪河流生态环境现状与问题分析，实施"水质、水量、水生态、水管理"四维修复思路，采用"清水产流区水源涵养保护—清水养护区控源治污与清水廊道—湖滨屏障区入湖净化与生态建设—生态环境系统管理"的水污染综合防治总体思路，全面修复清水产流机制三大功能区的生态、环境功能，改善白鹤溪水质。白鹤溪清水产流机制方案主要包括五大工程，主要有：上游清水产流区涵养修复工程、大理古城节点清水保持工程、流域农村农田污染系统控制工程、白鹤溪水系绿色生态廊道修复工程、湖滨缓冲带生态屏障建设工程、信息化机制修复监管体系建设。

发挥关键技术核心作用，进行大规模河流治理工程示范

在永安江流域 4 个自然村开展清水养护区污染防治技术示范。以洱源县永安江流域右所镇 4 个自然村的农村生活污水处理为核心示范点，根据当地条件，通过污水管道收集系统、雨水明渠排放系统、污水处理系统和环村截污沟的建设，将村落污水进行综合处理。结合项目区域的水质水量情况、地形特征及运行成本等因素，采用塘表湿地系统+模块化分层生物滴滤池工艺，出水水质达到一级 B 的排放标准，永安江流域的村落面源污染得到有效控制。

在邓北桥 II 期湿地开展永安江水质改善关键技术示范。邓北桥期湿地工程位于洱源县右所镇东湖湿地中部，处理规模 5 万吨/日，占地面积 495 亩，水力停留时间 7 天，采用"塘-砾石床-表面流"相结合的复合工艺。工程内容包括植物净化塘和多级表流湿地在内的主体设施，以及引水渠、拦水坝、拦污格栅、步行便道、宣传教

育等辅助设施。工程在实施过程中采用了水专项提出的原位堆岛、砾石透水坝和水生植物配置等多项技术，为整个永安江全域 8000 亩湿地工程形成了示范。经测算，示范工程对总氮和总磷的年削量分别达到 99.5 吨和 0.11 吨。

在大树营湿地开展湿地生态修复技术示范。大树营生态湿地处于永安江上游，位于东湖湿地最北端，是永安江的清水源头保障区。工程设计处理规模为 5 万吨/日，占地面积 1390 亩。工程建设过程中采取课题组提出的复合型人工湿地工艺，由上游至下游依次通过多级塘、表流湿地与潜流砾石床组成的复合系统，通过上述工艺进行有机组合，并重点恢复当地原有的荷花等浮叶植物，使永安江源头水质达到地表水环境质量标准III类水平。根据运行监测情况估算，每年 COD、总氮、总磷削减量分别达到 28 吨、31.4 吨和 0.89 吨。

课题成果应用及相关技术规范标准编制

本课题的关键技术——入湖河流原位及异位湿地构建技术，在洱海流域得到了广泛的推广应用，其中涵盖了河道原位治理、湖湾与地表低污染水治理、地表径流调蓄等方面，目前已经完成推广的工程包括：洱海南部波罗江综合治理工程、大理市湾桥镇古生村湖湾生境改善示范工程、大理市喜洲镇上关村污水处理设施尾水深度处理湿地工程、大理海东新城滇西商贸物流园区海绵城市示范工程、大理市北部三江的两岸缓冲带建设工程。课题成果在云南省其他地区的环保项目中也得到了应用，主要工程包括：云南省通海县杞麓湖红旗河河口湿地建设工程、云南省通海县杞麓湖中河河口湿地建设工程、云南省富宁县剥隘镇坡芽村生活污水处理工程。

根据水专项洱海项目的研究成果以及相关河流的治理经验，针对云南省高原湖泊特征，课题组开展了高原湖泊入湖河流综合治理技术规范的编制工作，为指导和规范云南省高原湖泊入湖河道净化及沿河污水的综合治理提供技术支撑。2014 年，课题组根据云南省大理州环保局的要求，向云南省质监局提出了编制《高原湖泊入湖河流综合治理技术规范》地方标准的申请，并得到正式批复同意立项。此地方标准的编制是课题考核指标的重要内容，目前已经完成征求意见稿，标准编制的主要内容包括：范围、规范性引用文件、术语和定义、高原入湖河流分类、总体设计、入湖河流调查、治理目标确定、污染负荷计算及总量控制、综合治理工艺、综合治理工程设计、监测与运行维护、附录等内容。

平台建设与地方合作

在水专项执行期间，项目承担单位上海交通大学与大理州人民政府共同建设了上海交通大学云南（大理）研究院，旨在以洱海保护为核心内容，通过政产学研的有效融合，探索洱海保护的长效模式。目前，上海交通大学云南（大理）研究院在硬件设施建设、科研人员集聚以及人才培养等方面开展了卓有成效的工作，并承担了省市多项与洱海保护相关的研究课题。

2016 年 11 月 30 日，云南省委、省政府提出"采取断然措施开启抢救模式保护

治理洱海"的要求；2017 年 1 月，大理州委、州政府启动实施了洱海保护治理"七大行动"，即实施洱海流域"两违"整治行动、村镇"两污"治理行动、面源污染减量行动、节水治水生态修复行动、截污治污工程提速行动、流域综合执法监管行动及全民保护洱海行动。大理州洱海保护治理抢救模式攻坚战全面打响。

自 2017 年洱海保护"七大行动"启动以来，上海交通大学云南（大理）研究院全力投身到行动中：

一是节假日不休进行洱海水质加密点位监测分析，针对洱海湖区 17 个采样点多频次多指标进行细化分析，实现洱海水质监测全覆盖全天候，截至目前已完成洱海加密采样监测报告 23 期；

二是进行了包括洱海典型湖湾水体生境改善示范工程、银桥镇"七大行动"应急库塘建设工程、洱海海西农业面源污染综合治理试点项目、洱海流域北部三江及西闸河两岸水生态保护核心区及缓冲区种植、大理海东滇西国际商贸物流基地海绵城市等多项工程的设计与施工，直接参与洱海保护治理工作；

三是针对洱海上游西湖、罗时江、永安江等多条河流湖泊开展湖泊水质观测、生态现状评价，并形成了多项工程治理方案，为流域面源污染控制提供技术支持；

四是协助大理州洱海流域局开展了洱海流域航拍图像数据采集工作，目前已完成洱海重点湖湾水质现状图册近 15 期，共提供近 800GB 洱海流域航拍图像数据，为洱海流域水环境大数据服务平台建设打下坚实的基础；

五是作为技术把关单位，为洱海流域实施的多项重大工程开展评估和审查工作，为洱海保护治理提供了技术支撑和数据支撑，为大理生态文明建设尽心竭力，助推沪滇科技合作和大理脱贫攻坚。

鉴于在洱海治理中所做贡献，上海交通大学云南（大理）研究院荣获 2017 年"大理州洱海保护治理先进集体"称号。

（来源：中国环境报 2018-05-30）

俄罗斯多措并举保护湖泊

新华社莫斯科 6 月 3 日电：俄罗斯湖泊的淡水存量约占全球四分之一；依据总径流量计算，其水力资源居世界第二位。面对如此丰富的自然馈赠，俄罗斯非常重视保护湖泊生态和湖区环境，并且针对问题采取相应对策。

(1) 资源丰富

俄西北部的卡累利阿地区是俄湖泊最为集中的区域，拥有欧洲第一大淡水湖拉多加湖和第二大淡水湖奥涅加湖。当地在湖泊保护方面，深受 20 世纪 70 年代"人类聚居学"理论创始人、希腊城市规划学家康斯坦丁诺斯·佐克西亚季斯主张的国土利用最佳结构图的影响。

该理论主张各国陆地领土的 40％应是自然保护区，禁止用于任何经济活动；42％的国土可在不破坏自然生态群落的基础上用于有限的林业开发和休闲旅游；10.5％的领土留作耕地；7.3％的土地用于国民居住，建设交通设施，开展轻工业生产；0.2％的国土用于重工业生产和废料堆放。

与之相对照，俄罗斯森林覆盖面积超过其国土的 50％，耕地面积仅占 7.3％。在占其领土四分之三的亚洲部分，仅在交通要道沿线零星分布着一些人口数万的小城市。该国 4 大工业区中的 3 个——莫斯科工业区、乌拉尔工业区和新西伯利亚工业区均远离大湖分布区，距离其西北部大湖区最近的圣彼得堡工业区主要生产食品、纺织品以及在海港区造船。

从总体上看，包括湖泊在内的俄生态环境在承载现有经济压力方面，有巨大先天优势。

(2) 处罚严重

在俄罗斯联邦刑法中，针对污染破坏湖泊和其他生态环境的行为有专门条款。例如，刑法规定，凡是对包括湖泊、河流等在内的地表水和地下水造成污染、破坏其水质、导致水资源枯竭或者改变其自然特征且造成该水域动植物资源严重受损的自然人，可视其违法情节轻重予以处罚。

刑法还规定，对于因污染破坏水体危害人体健康、造成动物大批死亡者，须将其接受处罚的时间期限延长 1 至 3 倍，或判处有期徒刑最多 2 年。对于因触犯这些条款、过失致人死亡者，可判处有期徒刑最多 5 年。

俄国家杜马（议会下院）议员认为上述条款没有规定如何处罚违法单位的法人，存在漏洞。因此俄正在制定刑法环保条款修正案，拟对造成水域污染的单位法人和对自然人分别予以相应的处罚。

此外，刑法还规定，对于石油严重泄漏等重大案件导致生态灾难的责任人，最高可判处有期徒刑 20 年。

(3) 措施多样

近年来，俄罗斯为保护湖泊生态采取了一系列防治措施。2013 年，贝加尔湖南端一家经营了约 50 年的造纸厂被彻底关闭，消除了对贝加尔湖造成生态危害的最大源头。厂区的废料填埋场已被浇筑水泥封存，其余厂区地表已铺上适宜种植的土壤。

在修建运输石油的管道时，当地政府将石油管道距离贝加尔湖湖岸的距离由传统法规要求的 30 米延伸到 300 米，最终又敲定为相距 800 米。专家认为在这一距离上，即使发生地震，泄漏的石油也不会在救援力量到达前污染湖水。此外，该管道的安全加固技术可使其在湖边运送石油的环保风险仅相当于铁路运输的十万分之一。

在紧邻俄第二大城市圣彼得堡的拉多加湖，当地林业公司在采伐树木后会在湖中和流入该湖的河里散放木排，让其漂到目的地。为了杜绝这一行为造成的水质富营养化和部分树木、枝叶腐烂造成的污染，当地政府不久前彻底叫停了这种已延续

多年的运输方式。

不过，也有俄专家指出，目前部分湖区分布的一些企业还存在环保技术落后，环保部门检查力度、频率不够，企业法人和自然人违法成本偏低，部分地区的垃圾污染水体问题久拖不决等难题，尚有待各方跨区域协调联动、密切协作加以解决。

（来源：新华网，2018-06-04）