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A Monitoring and Forecast System for Drought and Flood over China

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Abstract: Hydrological monitoring and forecast are critical for disaster mitigation and water resources management. This study proposed a frame to collect near-real-time meteorological forcings from various sources, to apply land surface hydrological model to simulate hydrological states and fluxes, and to generate ensemble seasonal forecasts of river discharge and soil moisture over China. The near-real-time satellite precipitation product was adjusted at each grid to match the daily precipitation distribution with the ground observations. The adjusted satellite precipitation was used to simulate hydrological states and fluxes in a near-real-time manner and to provide initial hydrological conditions for seasonal forecast. The system has been implemented at the National Disaster Reduction Center of China, and made the drought and flood risk reduction information available for the Emergency Management Department of China.

Key words: drought, flood risk; hydrological forecasting; satellite precipitation

A Recent Trend of N:P stoichiometry in China's Freshwater Lakes and its Linkages with Shifts in Anthropogenic Sources

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Abstract: Due to different rates of change in total nitrogen (TN) and totalphosphorus (TP) concentrations in lakes, increases in TN/TPmass ratios were observed in many China’s freshwater lakes during 2008 to 2017. The growing imbalance has important implication for aquatic ecology that remains poorly consideredand understood. Here, we show that changes in municipalwastewater treatment are a major driver for increases in the lake TN/TP mass ratios, as phosphorus is more effectively removed than nitrogen from the wastewaters. Our findings

highlight the need for more efficient nitrogen reduction in addition tophosphorus reduction in wastewater treatment to reduce risk for phytoplankton blooms, toxin production and to maintain ecosystem biodiversity in downstream waterbodies.

Key words: N:P stoichiometry; freshwater ecosystem; anthropogenic discharge; wastewater management

A smart framework for urban flood and waterlogging analysis

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Abstract: It is necessary to simulate the flood and waterlogging process rapidly in response to rainstorm events. At present, Model for Flood& Waterlogging is the main method to study the characteristics of urban flood and waterlogging, but the high computational cost of flow simulation and the uncertainty of the spatial and temporal evolution of rainstorm process make it difficult to a rapid response, which is necessary for emergency decision-making. Although there are some rapid analysis methods based on terrain, such as water balance method, cellular automata method and so on, due to the uncertainty of accuracy, this kind of method is seldom used in practical work.

A smart framework for urban flood and waterlogging analysis is designed by integrating various technologies, such as model for flood& waterlogging, machine learning, case decision and fusion of multi-source spatiotemporal data, etc. The framework is developed by B/S architecture, using GIS and database technology.

Some necessary work needs to be ready: (1) based on monitoring data of stations, which are evenly distributed and the monitoring data interval is not more than 5 minutes (the precision of most stations), rainfall processes are divided according to the standard of rainfall division. and then a machine learning model is established to get the typical spatiotemporal model of rainfall process. (2) based on the design rainfall from once in one year to 100 years, Model for flood& waterlogging is used to build the rainfall-waterlogging scheme database, including the relationship between rainfall-drainage and waterlogging, for example, the waterlogging caused by annual rainfall in drainage m. Parallel computing is used for the calculation, otherwise it may take months or longer.

In case of rainstorm, firstly, based on the monitoring rainfall and meteorological forecast data (grid data of short-term forecast), the spatiotemporal model matching algorithm is used to build the spatiotemporal process of rainfall, which can increase the forecast time of rainfall. Secondly, the flood process of rivers and reservoirs is simulated by the hydrological model, reservoir operation

model and river model, which have small calculation cost; meanwhile, the waterlogging process of each drainage zone is extracted from rainfall-waterlogging scheme database by similarity matching, which is carried out in each drainage zone due to total rainfall, intensity and duration. Waterlogging of whole urban area if combined from all drainage zone by using GIS tools. finally, the flood simulation and the matching waterlogging are summarized into a report document by using the software program to form a rapid risk assessment report.

The framework is applied in Hewan District of Shenzhen, which consists of two complete basins, the Shenzhen River basin and the Shenzhen Bay basin. Hewan District is the earliest development area in Shenzhen, covering an area of 293 km^2 . the results showed that the whole process of automatic calculation and analysis takes 1-3 minutes, depending on the duration of rainstorm. the structured template greatly improves the efficiency of putting forward risk assessment report. The comparison of precision showed that the average error between the number of waterlogging locations and the length of road inundation is less than 5%, which meets the needs of emergency decision-making.

The advantages of this framework include high efficiency and precision, due to the comprehensive application of model for flood& waterlogging, machine learning algorithm and asynchronous calculation method. The disadvantage of this framework is that the analysis is not accurate for the drainage zones which are supported by rivers of tide and have complex water exchange with the adjacent zones. It needs to be further studied from two aspects: the design of the scheme database and the waterlogging model.

This framework can be applied to other cities, especially big cities.

Key words: model for flood & waterlogging; machine learning; rainfall matching

A systematic study for the ecosystem restoration of Honghu wetland

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Abstract: Honghu Lake is one of the largest wetlands in the middle reach of the Yangtze River with a surface area of around 400 square kilometers and an average water depth of less than 5 meters. The wetland provides ecological and environmental services for wildlife refugees and

support for social and economic development to local communities. It plays an important role in regulating the water balance of the Yangtze River and Han River, maintaining ecosystem health and regional ecological security. Unfortunately, massive fish farming for more than two decades inside the lake since the early 1990s, combined *with external sources of pollution from its upstream catchment area, damaged the ecological environment of Honghu wetland and degraded the ecological function of the wetland, and deteriorated the water and sediment quality in the wetland.*

With the implementation of rescue protection since 2005, significant engineering measures such as opening the embankment to the lake, ecological dredging, the connection of river and lake systems, and restoration of aquatic vegetation have been taken to restore the ecosystem of the wetland. Due to the serious damage to the ecological environment of Honghu wetland, lack of effective control of the external pollution and potential internal pollution from contaminated sediment, the limited connection of rivers and the lake, there is no significant improvement of water quality and the ecosystem. Major challenges lay greatly in the restoration of the healthy function of ecosystems to mitigate on its own.

For a better understanding of the spatial characteristics of contamination water and sediment samples were collected across the wetland for physical and chemical property and microbiological analysis. With the 16s rDNA gene sequence and multiple statistical analyses of sample results, this study was able to identify locations where sediments were mostly impacted by non-point source pollution from its surrounding agricultural areas and fish farming inside the lake. The GIS-based spatial contouring analysis of major environmental variables and microbes showed the advantage in understanding the spatial heterogeneity of microbial communities over the entire wetland area. It could help locate impacted areas and identify potential sources of pollution. This study showed hotspots with high absolute abundances of bacteria were at the centers of the east and west divisions of the lake, upstream inflow areas of the eastern and western divisions, the southwestern part of the western division, and along the side of the lake and at the outlet of the lake. It was clear the comprehensive biodiversity analysis, together with the spatial analysis, showed microbial information could serve not only as biomarkers to show the footprints of contaminations but also as indicators of environmental conditions across the lake.

To develop effective implementation plans for the protection and restoration of the wetland, we have developed the HEC-RAS model for the wetland and rivers flowing in and out of the wetland, EFDC model for the wetland to simulate its hydraulic, water quality, and vegetation processes. The HEC-RAS simulation has the advantage to simulate water level, flow, sediment load, and water quality for various hydraulic conditions for complicated river networks with flow control structures such as gates and overflow weirs. Simulated flow and water quality are used as the boundary conditions for the EFDC model for its stable simulation of hydraulics, water quality,

lake sediment, and vegetation in the wetland area. Such an integrated model will be used to assess the impact of the external source of contaminants from the wetland's upstream areas to the wetland and the potential impact of contaminants released from lake sediments. The integrated model would also help to evaluate the effectiveness of hydraulic connection of river and lake to improve the dynamic flow condition and control of external and internal sources of contaminants, therefore to develop strategic plans for the optimal management of the ecosystem in the wetland.

Key words: Honghu wetland; integrated modeling; ecosystem restoration; hydraulic modeling; water quality modeling

An Analysis of Causes of the Record-breaking Flooding in the Yangtze River in 2020 and Related Risk Assessment

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Abstract: This contribution first highlights the most recent facts about climate change and give a short perspective of how it will develop. Climate Change will impact human societies and nature through water. The talk introduces the impacts of climate change that will most affect us. It gives an overview about the challenges we will be facing based on today`s most pressing water issues. The water, energy and food nexus will be covered, including an analysis of how different regions will be impacted and how this is related to non-climate change related drivers like population growth, economic development etc. Cryosphere is an important component of the hydrological cycle that is often forgotten in analyzing options for sustainable development. The talk highlights the most important facts around water supply from snow and ice and relates this to other development challenges.

The presentation presents proposals on how to best deal with the challenge both in terms of policy development and practical action that can be taken already now.

Key words: flooding; analysis of causes; risk assessment; Yangtze River

Addressing Challenge in the Study of Tibetan Plateau Hydrologic Cycle under Climate Change

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Abstract: Hydrologists have begun to focus on science questions of increased complexity and scope in cold region hydrology. One important theme is the hydrologic change such as glacier and permafrost retreat in response to the climatic variability. These changes at global, national or regional scales might directly include alterations to ecological systems, the patterns of droughts and floods, and the availability of surface and ground water. A focal point of our research has been the integrated assessment of natural and human-induced climate impacts on hydrology system in Tibet Plateau. These studies have relied on the understanding of changing cold-region processes and application of a model, coupling both climate and hydrologic systems. It is designed specifically for interactive climate-hydrologic processes and their simulations to examine explicit responses of rivers, lakes, wetlands and water tables across various scales in response to environmental changes. Integrated approaches were used for understanding dynamic of various processes in cold regions and applications of hydrologic simulations at different scales in the headwater of Yellow river. One important science issue with a model covering such a large area is how hydrologic processes can be scaled to make the simulation problem tractable. The presentation will shed light on research directions on how best to assess the impacts of environmental changes on hydrology, and to evaluate altered hydrologic processes in Tibet Plateau. This new generation of approaches is at the nexus of related areas of field observations, geoinformatics, cyberinfastructure in watersheds and remote measurements for scientific studies and water resources assessment in hydrological science.

Key words:

Advancing theoretical studies of vegetation-hydrological relations for sustainable watershed management and restoration

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Abstract: Destabilization of the water cycle threatens human lives and livelihoods as well as watershed sustainability. A specific long-standing challenge in the analyses of vegetation-atmosphere feedbacks has been the inadequate representation of continental moisture convergence in the global models of atmospheric circulation. In the steady state, the net amount of atmospheric moisture brought to land by winds from the ocean (moisture convergence) must match the amount

of liquid water that leaves land for the ocean as gravitational runoff. While runoff R is measured directly, moisture convergence C is model-derived. They do not generally match; instead of the equality, R = C, implied by mass conservation, the discrepancy between C and R can be of the order of 100% (as it is, for example, for the Amazon basin). For the continental moisture budget, P − E = C, the underestimate of moisture convergence C implies that either precipitation P is underestimated, or evaporation E is overestimated, or both. Reliable analyses of vegetation-atmosphere feedbacks and their spatial and temporal propagation in large river basins such as the Amazon require a resolution to these inconsistencies. The concept of the biotic pump of atmospheric moisture provides a comprehensive multidisciplinary theoretical platform for the study of the biotic climate impacts, including vegetation-atmosphere interactions and drought-related tipping points. Here I report our most recent progress on this front, which is a joint work with Anastassia Makarieva, Antonio Donato Nobre, Andrei V. Nefiodov, Douglas Sheil, Paulo Nobre, Jan Pokorný, and Petra Hesslerová. A better underestimating of vegetation-hydrological relations may help to develop better practice of watershed management and restoration and measures intended to mitigate climate change.

Key words: watershed management; vegetation-atmosphere feedbacks; biotic pump; moisture convergence

Analysis on the Evolution of China's Regional Water Cycle Based on Pan Evaporation

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Abstract: Global climate change and human activities have profoundly changed the global and regional water cycle processes. Evapotranspiration is the link between the global energy balance and the water cycle, and it is one of the most critical variables for exploring changes in the water cycle. The data of pan evaporation observation has a long time series, which is important information for estimating the long-term evolution of evapotranspiration. Its indicative significance in the study of the influence of the hydrological cycle to climate change has been widely known and has become a hot issue in the field of hydrological sciences today. Based on the PenPan model, this study analyzed the temporal and spatial evolution of my country's pan evaporation (Epan) and its driving mechanism from 1960 to 2019, and estimated my country's actual annual evapotranspiration (Ea) based on Epan data and evaporation complementarity theory.

The results show that from 1960 to 2019, China's pan evapotranspiration (Epan) firstly showed a remarkable decline and then rose around the year of 2000, with trends of −2.01 and 1.07 mm a−2, respectively; wind speed decline (52.7%) and radiation decline (23.6%) were the leading factors for the decline of Epan before 2000, while temperature rise (36.4%) and relative humidity (32.1%) were the leading factors for the rise of Epan after 2000; The actual annual evapotranspiration Ea in China showed a downward trend (−0.33 mm a−2) from 1960 to 2000, and an upward trend (0.38 mm a−2) after 2000, with obvious differences in trends in different climate regions. This study shows that there are significant temporal and spatial differences in China's regional water cycle changes. The results of this study can provide references for studies on China's regional water cycle changes, water security and sustainable development, and future climate change predictions.

Key words: PenPan model; pan evaporation; actual evapotranspiration; evaporation complementarity theory; water cycle changes

Application of system dynamics model to water demand prediction and analysis of water resources supply and demand balance based on Multiple combination scenarios

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Abstract: Based on the actual situation of Yiwu, this paper determined 68 system variables, combined with the interaction among hydrology, society, economy and ecosystem, and fully considered the reuse of reclaimed water to build a system dynamics model. The water demand of the region from 2020 to 2050 is predicted by setting 48 future economy-society-environment coupling water demand scenarios. On this basis, three combination scenarios of reclaimed water reuse were added, 144 supply and demand scenarios were analyzed, and 6 combination scenarios that are most conducive to water security and sustainable development of regional ecological environment were selected, so as to provide basis and alternative scheme sets for medium and long term water resources planning and decision makers. The model can dynamically reflect the influence of future social and economic development on the characteristics of water use in Yiwu City, and comprehensively consider the water demand of domestic, industrial, agricultural and ecological sectors, so as to provide a scientific basis for the efficient development and utilization of water resources and optimal allocation in the future.

Key words: system dynamics model; water demand prediction; multiple combination scenarios; reclaimed water; water resources supply and demand balance

Applying a Regional Transport Modeling Framework to Manage Nitrate Contamination of Groundwater

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Abstract: Regional nitrate contamination in groundwater is a management challenge involving multisector benefits. There is always conflict between restricting anthropogenic activities to protect groundwater quality and prioritizing economic development, especially in productive agriculture dominated areas. To mitigate the nitrate contamination in groundwater, it is necessary to develop management alternatives that simultaneously support environmental protection and sustainable economic development. A regional transport modeling framework is applied to evaluate nitrate fate and transport in the Dagu Aquifer, a shallow sandy aquifer that supplies drinking water and irrigation water for a thriving agricultural economy in Shandong Province in east coastal China. The aquifer supports intensive high-value vegetable farms and nitrate contamination is extensive. Detailed land-use information and fertilizer use data were compiled and statistical approaches were employed to analyze nitrogen source loadings and the spatiotemporal distribution of nitrate in groundwater to support model construction and calibration. The evaluations reveal that the spatial distribution and temporal trends of nitrate contamination in the Dagu Aquifer are driven by intensive fertilization and vertical water exchange, the dominant flow pattern derived from intensive agricultural pumping and irrigation. The modeling framework is employed to assess the effectiveness of potentially applicable management alternatives. The predictive results provide quantitative comparisons for the trend and extent of groundwater quality mitigation under each scenario. Recommendations are made for measures that can both improve groundwater quality and sustain productive agricultural development.

Keywords: Regional Transport Modeling; Groundwater Drinking Source; Nitrate Contamination

Assessing Climate Impact on Forest Cover and Runoff Change in a Humid Subtropical Basin Dominated by Forest

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Abstract: This presentation covers two parts. In the first part, we assess climate impact on forest cover (represented by EVI) at multiple scales in area undergoing substantial land cover change (the Qingliu River basin, east China), using Landsat imagery with human-induced land cover change effect excluded. In the second part, we quantitatively attribute runoff change in a humid subtropical basin (the Qingliu River basin, East China) to climate variability, land-use change, and human activity on multiple scales over different periods by using the Soil and Water Assessment Tool (SWAT) model.

Key words: climate change, land use change, forest cover, runoff change, attribution

Boost the Water Security of the Yangtze River with the Two-Wing Strategy

Mingshan Lei

China Three Gorges Corporation

Abstract: China Three Gorges Corporation has become the largest hydropower development and operation enterprise in the world and the largest clean energy group in China after the rapid and high-quality development over the past 27 successive years. It is originated from the Three Gorges Project, and the construction of the Three Gorges Project is a national strategy and a national action. The Three Gorges Project produces its integrated beneficial effects in flood control, shipping, power generation and water resources utilization, etc. continuously and comprehensively, guaranteeing the water security of the Yangtze River and promoting the prosperity and development of the economy and society in the Yangtze River Basin. In the trunk stream of the Yangtze River and the tributaries of the Qingjiang River, China Three Gorges Corporation has 9 hydropower stations completed and in construction, with a total installed capacity of 75 million kilowatts, equivalent to 3 Three Gorges power stations. China Three Gorges Corporation actively develops wind power and solar energy and other new energy businesses, and strives to develop new energy business as its second main business, and is committed to becoming a leader in the area of offshore wind power. Closely following the national “Belt and Road” construction, China

Three Gorges Corporation has accelerated “heading overseas”, and made efforts to develop an upgraded version of “heading overseas” for China’s hydropower industry chain. It is a glorious mission the CPC Central Committee has entrusted to China Three Gorges Corporation in the new era to play a basic guarantee role in promoting the development of the Yangtze River Economic Belt, and play a backbone and main force role in general protection of the Yangtze River. China Three Gorges Corporation is working hard to fulfill the strategic objective requirements of the “world-class” demonstrative enterprises, and actively implementing the “Two-Wing” development idea for the clean energy and the ecological protection of the Yangtze River. While fulfilling the national strategic objectives and mission, China Three Gorges Corporation has realized its high-quality development.

China Three Gorges Corporation, in its development process, has always attached great importance to the measures for the basin management and water security guarantee, and worked on security in four aspects, that is, water quantity security, water quality security, ecological security and low carbon security. The first is water quantity security. All the six world-class water conservancy and hydropower projects developed and operated by China Three Gorges Corporation in the trunk stream of the Yangtze River are major basic projects related to state security, national economy and the people's livelihood. Through the joint operation and dispatching of cascade reservoirs, they have given full play to beneficial effects in flood control, drought resistance and water replenishing, and have played an irreplaceable role in ensuring the water security of the basin. In 2020, the six projects retained 38.8 billion cubic meters of flood accumulatively, accounting for more than 60% of the total flood retention by the reservoirs in the middle and upper reaches of the Yangtze River. The second is water quality security. China Three Gorges Corporation earnestly implements its responsibility and mission to play a backbone and main force role in the general protection of the Yangtze River, and actively develops the sector of ecological and environmental protection business. Taking the urban sewage treatment as incision point, it develops investment, construction and operation under the modes of “integration of factory network and river (lake) bank”, “equal emphasis on sludge and water”, resources and energy recycling, and full-cycle construction and maintenance, etc. to promote full collection of urban sewage, full treatment of the collected sewage, full up-to-standard and comprehensive utilization of the treated sewage, effectively guaranteeing the urban water quality security. The third is ecological security. China Three Gorges Corporation has set up Chinese Sturgeon Research Institute and Yangtze River Rare Plant Research Institute, developed work to protect the diversity of aquatic animals and plants in the basin for long term, and actively explored new ways for guaranteeing ecological security. China Three Gorges Corporation has carried out ecological dispatching experiments for the natural reproduction of the "four major Chinese carps" in the middle reaches of the Yangtze River for a decade successively to create hydrological conditions

suitable for fish reproduction. The monitoring results show that the effect of ecological scheduling is obvious. The fourth is low carbon security. China Three Gorges Corporation will give play to its advantages in terms of clean energy continuously to consolidate the foundation of large hydropower, strengthen and accelerate the development of wind power, PV and other new energy, actively cope with climatic changes, follow the green and low carbon development road, strive to take the lead in realizing peak carbon dioxide emissions in 2023 and carbon neutrality in 2040.

Currently, China Three Gorges Corporation is deeply studying and carrying out the spirit of the Fifth Plenary Session of the 19th CPC Central Committee and the spirit of General Secretary Xi Jinping's speech at the Forum on Comprehensively Promoting the Development of the Yangtze River Economic Belt, and systematically designing the plan for high-quality development and ecological & environmental protection during the "14th Five-Year Plan" period. China Three Gorges Corporation will, as always, cooperate with all parties, stick to the concept of Ecology First and Green Development, further play its role as basic guarantee for the development of the Yangtze River Economic Belt, further play the backbone and main force role in the general protection of the Yangtze River, and make new greater contributions to guaranteeing the water security in the basin and composing a new chapter of ecology first and green development.

Key words: Three-Gorges Corporation; water security; ecology; green economy

Challenges and Opportunities of Water Resources Management Facing in the Guangdong-Hong Kong-Macao Greater Bay Area, China

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Abstract: Coastal cities are often densely populated and economically developed, but also vulnerable to the shortage of freshwater resources. In Hong Kong, a typical coastal city, more than 70% of its freshwater supply comes from external sources-Dongjiang. The Guangdong-Hong Kong-Macao Greater Bay Area (short for the Gerater Bay Area or GBA) has a dense river-network and relative abundance of surface water resources, water supply security is still vulnerable due to the rapid population growth in the past several decades and frequent drought occurrences. Historically, there have been many serious water shortage incidents in the GBA. It is projected that the population in the region will be almost doubled in 2050. Therefore, it is likely in the very near future during drought periods, most cities in the GBA (e.g. Shenzhen, Guangzhou, Hong Kong, Macau, Zhuhai and Dongguan) will face serious water resources security problems. Thus,

it is of great significance to carry out research on the theories and key technologies of unconventional water resources utilization for the region. On the other hand, many new methods in the field of unconventional water utilization have achieved breakthroughs: such as seawater desalination and atmospheric water resources utilization. In this report, some new technologies and engineering projects will be introduced.

Key words: coastal cities; water resources management; GBA area; challenges

Changes of Eco-hydrology process of Poyang Lake to river-lake relation: from 2003 to 2030

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Abstract: Poyang Lake, is located at the south bank of the middle reaches of the Yangtze River. It is the largest freshwater lake in China, one of the two lakes that are freely connected with Yangtze River, and is of global importance for migratory waterbirds conservation of the East Asian- Australasian Flyway. From 1956-2018, the annual mean water level and its variation are 13.3m and 11.1m, respectively. The significant difference in water level shapes the distinct landscapes between wet summer and dry winter seasons.

After 2003, the "river-lake" relation between Poyang Lake and Yangtze River has been changed significantly. For the Poyang Lake, the time when the water level decline to 10m is one month earlier before 2003.The water level was lower than that of the same period before 2003, especially during the autumn. Following hydrology change, elevation for wetland plants distribution has been lowering in recent years. And the lower limit was found to be 10 m from 11m along elevation.

We started our research from river-lake relation between Yangtze river and Poyang Lake, and then focused on the coupling among water level, wetland plants distribution, and habitats for migratory waterbirds. For a continuous hydrological process, a 2 D hydro-dynamic model was established using EFDC software. On the other hand, we made a field investigation on wetland distribution and migratory waterbirds habitats at the whole lake scale, and the surface area of dominated wetland species and dominated migratory waterbirds were quantified. Based on the modelling and field investigation, three scenarios including past scenario, representing 1956-2002; the present scenario, representing 2003-2018, the future scenario, representing 2030 were compared among each other.

The results demonstrated that inundation duration, which was defined as sum of the days with water above 0m during a year was a key hydrologic factor determining wetland plants distribution and surface area of habitats for migratory waterbirds. Based on analysis we can realize that: (1) Inundation duration of 2003-2015 was relatively shorter than that of 1956-2002. (2) Averagely, for each elevation gradient, inundation duration was one month less than that before 2003. (3) The situation is getting worse in 2030 scenario, the area hardly inundated during the year would have been more than 100km2. The fitted curve demonstrated that gaussian curve can be used to explain the response of wetland plants distributions to inundation duration, and with the parameters u and t, the ecological requirements for inundation can be quantified. In order to illustrate the ecological demands of wetland plants for inundation duration, the response curve has been established by the coupling between hydrodynamic model and statistical model, and the ecological thresholds of the six dominant wetland plants of Poyang Lake are quantified, respectively.

The inundation duration for the wetlands is obviously shorter than that before 2003, and it is hard to guarantee the ecological demands of wetland plants, this may indicate that shorter duration was the main cause for expansion of the wetland plants for the inundation requirements can't be satisfied, so they have been expanding lower and lower along elevation gradient.

Changes of hydrology and wetland plants distribution may also affect migratory waterbirds. For more convenient analysis, we classified more than 40 species into 6 guilds based on different habitat requirements and the results showed that although the total number of migratory waterbirds are relatively stable from 1998, the community structure changed obviously. The number of geese living in the grassy marshland increased gradually, while the number of cranes and storks living in shallow water decreased relatively due to changes of habitat characteristics followed by the river-lake relation changes. This phenomenon will be more distinct as time goes on.

On the basis of these analysis we can conclude that changes of river-lake relation after 2003 has been caused obvious changes on eco-hydrology process of Poyang Lake, the wetland plants distribution and migratory waterbirds habitat characteristics showed significant responses to hydrological process, and some early warning signals for wetland degradation were found to be the effects of the changed eco-hydrology process after 2003. Our results indicated that it is worth further study on wetland degradation status as changing river-lake relation until 2030

Key words: Poyang Lake; "river-lake" relation; eco-hydrology process; wetland plants; migratory waterbirds

Centennial Trends of Water-Sand Evolution and Balance in Yellow River Basin

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Abstract: Yellow River, mother river of the Chinese nation, is famous for its salient features: less water and more sand. Since the mid-1980s, water and sand situation of Yellow River basin has undergone huge changes due to water conservancy, water conservation projects and other human activities as well as climate change and other factors. The sand volume of Tongguan hydrologic station changed from 1.6 billion tons during the period of 1919-1959 to about 170 million tons since 2010. The sand volume reduced about 90% and water volume decreased about 45%. The water and sand situation of Yellow River experienced rapid and tremendous changes. Which direction will the trend lead to ? Should strategic planning decisions of Yellow River management and development be readjusted accordingly? These questions become major scientific and technological issues of Yellow River Management in a new era. The situation of water and sand is the most basic boundary condition for ecological protection and high-quality development of the basin, which directly affects the management pattern of soil erosion on the Loess Plateau, the construction of the Yellow River water-sand control system, and the direction of downstream beach area management. The scientific knowledge of the changing characteristics and development trends of the water-sand situation in the Yellow River, and the proposed critical threshold and management degree of water-sand control in the Yellow River basin under the new water-sand pattern, are of great significance for the formulation of future management strategies.

The report presents the latest research results in the following aspects: firstly, it analyzes the evolution of water and sand in the Yellow River on a 100-year scale; secondly, it analyzes the changes of sediment in the Yellow River in extreme years; thirdly, it predicts the trends of water and sand in the Yellow River for the next 30-50 years by using the pooled assessment technique of water and sand trends in the Yellow River basin; fourthly, it proposes the threshold of water and sand balance and the degree of management in the Yellow River basin. The results of the study show that: in the past 20 years, the amount and process of water and sand into the Yellow River have undergone significant variation, and in the future, with the continuous improvement of the basin substrate, various soil and water conservation measures on the Loess Plateau can still play a huge role in sand reduction in case of extreme rainfall; the amount of sand in the Yellow River will be stabilized at about 300 million ton/a and the amount of water at about 24 billion m^3/a in the next 30-50 years, and the changes in the pattern of water and sand in the Yellow River provide

new boundary conditions for the great protection of the Yellow River. Under the new water-sand pattern, the original balance of erosion and siltation and ecological balance of the Yellow River channel will be broken, and a new balance will be formed gradually. The critical threshold of equilibrium sand transport in the main channel of the Yellow River will enter a new stage (60% lower than before 1986). The strategy of ecological protection and development of the Yellow River will be readjusted accordingly. There are group effects and critical effects of various measures for the management of soil erosion on the Loess Plateau. The degree of watershed management should be scientifically determined and the pattern of soil erosion management on the Loess Plateau should be adjusted to achieve a balance between water and sand in the Yellow River basin and the river, so as to provide a basic guarantee for ecological protection and high-quality development in the Yellow River basin.

Key words: Yellow River; sedimentation; trends

Climate Change and associated water risks – the global picture

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Abstract: This contribution first highlights the most recent facts about climate change and give a short perspective of how it will develop.

Climate Change will impact human societies and nature through water. The talk introduces the impacts of climate change that will most affect us. It gives an overview about the challenges we will be facing based on today`s most pressing water issues. The water, energy and food nexus will be covered, including an analysis of how different regions will be impacted and how this is related to non climate change related drivers like population growth, economic development etc.

Cryosphere is an important component of the hydrological cycle that is often forgotten in analysing options for sustainable development. The talk highlights the most important facts around water supply from snow and ice and relates this to other development challenges.

The presentation presents proposals on how to best deal with the challenge both in terms of policy development and practical action that can be taken already now.

Key words: climate change; water risks; global perspective

Combined Dispatching of Flood and Reservoirs in the Yangtze River in 2020

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Abstract: The Three Gorges Project is the backbone project of the Yangtze River flood control system, and it can greatly enhance the capacity of the Yangtze River to guarantee the flood control through the combined dispatching with other controlling reservoirs. In 2020, the most serious watershed flood since 1998 occurred in the Yangtze River Basin, and numbered flood occurred for five times here successively. Facing the austere situation of flood control, and the strong leadership of the Ministry of Water Resources, the Yangtze River Water Conservancy Commission took the combined dispatching of reservoirs as an important means of flood prevention, gave full play to the role of reservoirs in flood retention, peak clipping and staggering peak, strengthened the combined dispatching of water projects, effectively defended the severe flood in the Yangtze River Basin, and achieved great effects of flood control and disaster reduction in 2020. Zhiyu Zhong, Chief Engineer of the Yangtze River Water Conservancy Commission, has been engaged in the research on the Yangtze River Basin and the planning and design of major water conservancy projects for long term. He is the technical principal of the integrated planning, flood control planning, and water resources planning for the Yangtze River Basin, and also, he in charge of the Technology for Multi-objective Combined Dispatching of Cascade Reservoirs in the Upper Reaches of the Yangtze River, a project under the national key research and development program during the 13th Five-Year Plan period. In the flood season of 2020, he always participated in the decision making on and scientific dispatching of reservoirs in the forefront of command for flood prevention, and went to the forefront to Jiangxi, Hunan and Sichuan to provide instructions for flood prevention, so he has a deep understanding of Yangtze River flood and reservoirs dispatching in 2020.

Comparing CMIP5 and CMIP6 Climate Change Simulations and Projections over the Pan Third Pole Environment (PTPE) Region

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Abstract: The Tibetan Plateau and its surrounding region (i.e., Pan Third Pole Environment – PTPE) are very sensitive to climate change. Over the last 50 years, temperature increase in PTPE is twice the global average. How do global climate models perform in simulating the climate change over the region? What will happen when global warming is expected to continue or even

accelerate in the future? This study aims to address those questions. CMIP5 and CMIP6 surface air temperature data from historical simulations and different future scenarios were collected and analyzed to understand if improved understanding of climate change in PTPE has been achieved in CMIP6 experiments over that of CMIP5. Spatial and temporal skill scores were used in the analysis. Our results showed that the uncertainties persist from CMIP5 to CMIP6 in most metrics, with some improvement in spatial pattern skill scores in CMIP6 over CMIP6 outputs.

Key words: Pan Third Pole Environment; climate change; CMIP5; CMIP6

Coupled Human-Natural Systems Analysis of Water Security and Sustainability: From Transboundary Competition to Climate Change in Jordan

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Abstract: In arid regions throughout the world, freshwater system are at the confluence of drivers that include severely limited water supplies, rapid population growth and demographic shifts, transboundary competition for shared freshwater resources, climate change and variability, and institutional dysfunction. We present our results for Jordan, which is one of the water-poorest countries in the world. We adopt a multi-agent modeling framework to allow for the incorporation of institutional complexity in evaluation of policy instruments aimed at improving Jordan's freshwater situation. The model employs a modular approach, integrating biophysical modules that simulate natural and engineered phenomena with human modules that represent behavior at multiple scales of decision making. The human modules in turn adopt a multi-agent simulation approach, defining agents as autonomous decision makers at the government, administrative, organizational, and user levels. Our approach evaluates policy interventions under a suite of scenarios that enable comparison of future freshwater options.

Key words: climate change; human-natural systems; transboundary water management; arid region

Discussion on the Protection Scope and Utilization Efficiency Evaluation of the Yangtze River Shoreline

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Abstract: In January 2016, General Secretary Xi Jinping proposed at the Symposium on Promoting the Development of Yangtze River Economic Belt that we should "step up conservation of the Yangtze River and stop its over development" and "prioritize ecological conservation and boost green development". Shoreline protection and efficient utilization are the core issues to ensure the security of the Yangtze River basin ecosystem and high-quality development. The Yangtze River Protection Law points out that "define the protection scope of the river and lake shoreline, formulate the protection plan for the river and lake shoreline, strictly control the development and construction of the shoreline, to promote the rational and efficient utilization of the shoreline." However, there is no unified definition of the Yangtze River shoreline. Different departments have different statistical standards on shoreline utilization. There is still a lack of systematic and science-based definition of the shoreline protection scope, and there is no objective evaluation standard for the utilization efficiency of the shoreline, which is not conducive to the implementation and promotion of the Yangtze River protection requirements. Based on the above problems, through extensive research and systematic study, the concept of "river shoreline - riparian zone - buffer zone" is proposed to protect the Yangtze River shoreline, and the definition and statistical methods of shoreline, shoreline utilization rate, and shoreline utilization efficiency are clarified. A reasonable evaluation index of shoreline utilization is proposed by considering the water depth, rear land area, and shoreline stability comprehensively. On this basis, a cost-based pricing method for shoreline utilization based on the benchmark price of water depth, shoreline utilization efficiency, shoreline grade, and shoreline functional use as indicators is proposed. By doing this, we provide a basis for establishing access and exit mechanism for shoreline utilization units, promoting shoreline protection and restoration, and improving the efficiency of shoreline resource utilization.

Ecohydrological modeling and water resources management: from field scale to basin scale

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Abstract: It remains a great challenge to represent field-scale (e.g., meters to tens of meters) heterogeneity in the ecohydrological modeling of large river basins due to the tradeoff between spatial resolution and computational cost, resulting in a deep gap between field-scale scientific understandings and basin-scale water resources management. This presentation introduces our efforts to bridge this gap with methodology innovations. First, we developed an integrated ecohydrological model which can account for subgrid structure of land cover, multilayer soil water simulation and accurate spatial coverage of irrigation within the grid, aiming to provide reliable simulations over a wide spectrum of spatial scales, from the field scale to the large-basin scale (i.e., 10^4 to 10^5 km^2). Second, we defined a new basin-scale irrigation efficiency (IE) index to factor in groundwater contributions to crop evapotranspiration and irrigation return flow. A novel approach to calculate the new index based on integrated ecohydrological modeling was also proposed. The new model and basin-scale IE evaluation method were implemented in the Heihe River Basin, the second largest endorheic river basin in China. The major study findings include the following. First, in arid areas with sparse vegetation, ignoring the subgrid characteristics of land surfaces will lead to significant errors that may be further propagated when the modeling results are used to support management or scaled up for larger-scale climate modeling. Second, the multilayer soil structure can improve ecohydrological simulations in terms of temporal variations, and it is necessary to separate a thin surface layer from the soil zone in arid areas. Third, considering the accurate spatial coverage of irrigation within the grid cell is critical for successful simulations of ecohydrological processes in arid areas. Fourth, the basin-scale IE exhibits different spatiotemporal patterns from the traditional field-scale IE, and it provides a methodological foundation for overcoming misunderstandings about the famous irrigation efficiency paradox.

Key words: Ecohydrological modeling; water resources management; field-scale; basin scale

Effects of Permafrost Change in the Tibetan Plateau on Regional Water Resources and Carbon Budget

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Abstract: The Tibetan Plateau is known as the Asian Water Tower. Changes in the water storage and its transition from solid to liquid phase influence the hydrological processes of these headwater regions, thus affecting the water resources security in the midstream and downstream regions. In addition to the large amount of ground ice stored in the permafrost region, there also exists a large

quantity of soil organic carbon. The greenhouse gas emissions due to permafrost thawing could alter the regional carbon budget and impact the climate. This study employed a physically-based distributed permafrost-hydrological model to simulate changes in frozen ground and hydrological processes on the Tibetan Plateau. Impacts of frozen ground changes on hydrological processes and regional carbon budget were assessed based on the simulation results.

During 1980~2019, the Tibetan Plateau experienced a warming and wetting trend. The mean annual air temperature increased at a rate of 0.045 ℃/a, and the annual precipitation increased at a rate of 1.09 mm/a. The permafrost area decreased from 1.205 million km^2 to 1.109 million km^2, indicating a 7.9% decline. Annual evapotranspiration and annual runoff increased significantly, the ground ice storage decreased by 282 km^3 (7.7%), and the total ground water storage showed an increasing trend. It estimated that contribution of ground ice melt to runoff was of 5.7%~20.9%, which is close to the contribution of excess glacier melt to runoff. By 2040s or 2090s, 25.9% or 43.9% of permafrost is projected to disappear under RCP 4.5 scenario. The cumulative amount of organic carbon vulnerable to decomposition due to permafrost thawing is projected to be 1.86 ± 0.49 Pg (RCP 4.5) or 3.80 ±0.76 Pg (RCP 8.5) from the baseline period (2006~2015) to the 2090s, and the thawed organic carbon from deeper layers is predicted to increase quickly. The carbon release due to permafrost degradation could possibly turn the Tibetan Plateau from a net carbon sink into a net carbon source.

Keywords: permafrost; runoff; carbon budget; climate change; Tibetan plateau

Effectiveness and Development Direction of Green Development of Yangtze River Water Transport

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Abstract: The Yangtze River, a major waterway transport corridor running through the east, middle and west regions of China, is the busiest waterway for transportation. After nearly 20 years of construction and development, the navigation conditions of the Yangtze River mainline channel have been significantly improved, the trend of standardization of large transport vessels is obvious, and the cargo volume continues to grow rapidly. It plays an important role in promoting regional economic development, improving the comprehensive transportation system, and promoting the implementation of national strategies. At the same time, the transport industry has formulated and implemented a series of ecological and environmental protection policies, including strictly managing port shoreline, strengthening port ship pollution control, promoting the construction of

ecological waterways, and improving the level of environmental supervision, to promote the green development of water transport on the Yangtze River.

The issuance of the 14th Five-Year Plan for National Economic and Social Development and the Long-Range Objectives Through the Year 2035, the Outline of National Comprehensive Three-Dimensional Transportation Network Planning, and the implementation of the Yangtze River Protection Law require further enhancement of the function and green development of the Yangtze River Waterway. This shows that the Yangtze River water transport has ushered in new development opportunities. To respond to climate change, the transport system along the river is required to pay more attention to low-carbon development and promote "road transport to waterway transport" and water transport energy saving and carbon reduction, achieving green and high-quality development of Yangtze River water transport.

In the future, the Yangtze River water transport needs to make efforts in five areas to promote green development. First, to give full play to the environment-friendly advantages of water transport in the comprehensive transportation system, strengthen the function of the Yangtze River Waterway, leading the low-carbon development of transport along the river. Second, to construct ecological water transport infrastructure, enhance the ecological protection and restoration of the port-channel in an all-round way. Third, to strengthen the prevention of air and water pollution of ships, reduce carbon emission intensity, thus enhancing cleanliness. Fourth, to set " zero emissions" "zero-carbon" as the ultimate goal, and promote port pollution prevention and energy-saving carbon reduction; fifth, to improve the overall green governance of the Yangtze River water transport capacity in terms of development planning, management methods, monitoring capacity, and regulatory system.

Efforts to Learn and Use Yangtze River Protection Law

Yong Jiao

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Abstract: Omitted.

Environmental behaviors and effects of natural organic matters in aquatic environments

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Abstract: Natural dissolved organic matters (DOM) usually refer to the fraction of organic matters that can permeate through a filter with given pore sizes (e.g., 0.45 or 0.7μm). DOM was characterized by continuous size distribution and multiple functional groups, with different concentrations and organic compositions in each size fraction. In aquatic ecosystems, DOM exhibits generally the transformation processes such as self-aggregation/disaggregation under different environmental conditions such as pH, cations, and heavy metals, etc. In addition, due to the richness of functional groups and binding sites, DOMs exhibited different environmental effects such as colloid stabilization, interface adsorption, heavy metal binding, and contaminant degradation etc., and these different environmental effects were found to be molecular weight-dependent.

Key words: natural dissolved organic matters; colloidal organic matters; molecular weight fraction; environmental behaviors and effects

Environmental Intelligence: large-scale ecosystem management in an increasingly complex and dynamic environment

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Abstract: Many of the world's river basins are severely stressed due to population growth, water quality and quantity problems, emerging contaminants, vulnerability to flood and drought, and the loss of native species and cultural resources. Consequences of climate change further increase uncertainties about the future. There has been an increasing interest in balancing water supply reliability, protecting communities and existing infrastructure, fostering economic development while ensuring a healthy earth system.

Major advances in sensor technologies, visualization, data synthesis and data mining to assess water resources are facilitating cost-effective management of the water cycle and accelerating our experiences with traditional and nature-based solutions. However, severe challenges persist since scientific studies rarely occur on the same timeframe as management actions, policy decisions or at the pace sometimes expected by government officials responsible for the management outcomes. Common challenges include the need to make decisions in the face of considerable uncertainty, ensuring research results are actionable and engaging effectively with the communities impacted

by large infrastructure projects. The presentation will explore large ecosystems in the US with a specific focus on the San Francisco Bay and Chesapeake Bay watersheds.

Science plays a critical role in helping define possible alternative futures that could be achieved and the possible consequences to economic development, quality of life, and sustainability of ecosystem services. These major societal challenges must be addressed through innovations in governance, policy, ways of implementing management strategies and graduate education that prepares the future workforce to operate across traditional scientific boundaries. The talk will conclude with one model for graduate education that prepares engineers and scientists to work effectively in this transdisciplinary problem-solving requisite.

Key words: environmental intelligence; large-scale ecosystem management; global changes

Evolution of Hydrological Cycle and Attribution Analysis of Runoff Variation in the Yarlung Zangbo River Basin

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Abstract: Variation of runoff and evolution mechanism of hydrological cycle under climate changes has being an important field of research in hydrological science. The Yarlung Zangbo River basin (YZB), located in the heartland of the Qinghai-Tibet Plateau, is extremely sensitive to climate change due to the unique terrain and climate, complex hydrological processes and fragile ecological environment. In this study, the YZB was selected as the study area, and a comprehensive hydrological analysis method was employed to identify the evolution rule of hydrological cycle and causes of runoff variation. On the basis of multi-source data from gauging data, remoting sensing and reanalysis data, the characteristics of runoff variation on spatial and temporal multi-scale and its response to rainfall were identified, the spatio-temporal variation of actual evapotranspiration and its driving factors were analyzed, and the spatio-temporal changes of hydrological budget and its correlations were investigated. The spatio-temporal evolution of runoff and its driving factors in the YZB were analyzed in the perspective of hydrological budget, and the driving factors and its contribution to runoff variation are systematically identified in different periods and regions. The results provide a basic but significant understanding on evolution mechanism of hydrological cycle and its response to changing environment in the YZB and the Qinghai-Tibet Plateau.

Key words: runoff; precipitation; evapotranspiration; evolution; driving factors

Greenhouse gas emission mechanism and global importance of rivers on the Tibetan Plateau

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Abstract: Gas exchange at the water-gas interface drives climate-related gas fluxes, that is a process which is critical to biogeochemical cycles in aquatic ecosystems and global climate change. Accurate assessments of greenhouse gas emissions from inland waterways are crucial to predicting the extent and pace of climate change. However, most of the researches on inland water system focus on the aquatic ecosystem in plain lowland, and few pay attention to the ecological ecosystem in high mountains and rivers. Although mountains cover 25-39% of the world's land area and alpine rivers account for more than 1/3 of global runoff, the lack of research on greenhouse gas emissions from alpine rivers has greatly increased the uncertainty in estimating greenhouse gas emissions from inland rivers. We took the Yangtze river, the Yellow River, the Lancang River and the Nujiang River in the eastern part of the Qinghai-Tibet Plateau as the research object, according to the direct observation across rivers and seasons to soluble deposit concentration and water interface emission flux of greenhouse gases of CO2, CH4 and N2O in these big four rivers source regions for three years, to study the rule of seasonal change of three kinds of greenhouse gases and spatial distribution characteristics, explore the emission mechanism and analyze the influence of key environmental factors (such as physical and chemical properties of rivers, meteorology, hydrology, topography and geomorphology, microorganisms, etc.) on greenhouse gas emission. It was found that CH4 was mainly released in the form of bubbling in high altitude rivers with low air pressure, and the average bubbling rate of CH4 (11.9 mmol m-2 d-1) was 6 times that of the average of all rivers in the world (1.96 mmol m-2 d-1). Based on the warming potential, the CH4 emission of rivers on the Qinghai-Tibet Plateau is much higher than that of CO2 emission. The CH4 emission mechanism and its variation with river level in the eastern Tibetan Plateau were further analyzed. It was found that the CH4 bubbling flux decreased exponentially with river level while the CH4 diffusion flux decreased linearly with river level. The rivers of the Qinghai-Tibet Plateau account for 0.7% of the world's river area, and their CH4 emissions make a disproportionate contribution to the world's rivers (2.2-6.8%), indicating that the alpine permafrost rivers of the Qinghai-Tibet Plateau are the hot source of atmospheric CH4 emissions due to the intense emission of CH4 in the form of bubbles. However, it was found that rivers in the permafrost region of the Qinghai-Tibet Plateau are weak sources of atmospheric N2O and CO2. The results revealed the complex feedback mechanism of ongoing permafrost thawing and greenhouse gas emissions on climate change.

Key words:

Global river runoff change induced by human activities and climate change

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Abstract: Global warming has been a global environmental issue which is challenging water security by accelerating hydrological cycle. Meanwhile, the increasing intensive human activities induced by rapid social economy development are influencing streamflow from different ways of storing water in reservoir, pumping water from river for agriculture irrigation and water supply to support industry and domestic uses, etc. Based the measured stream flow discharge at 1840 hydrometric stations on global major rivers, variation of recorded runoff during 1950-2010 were analyzed and attribution of runoff change were investigated by using hydrological simulation approach. Runoff data sources in this study are from Global Runoff Data Center (https://www.bafg.de/GRDC/EN/Home/homepage_node.html), SO-HYBAM Amazon Water Resources Observation Services ((https://hybam.obs-mip.fr), and USGS Water Data (https://waterdata.usgs.gov/nwis), etc.

Results show that 54.4% of hydrometric stations has increasing trend in annual runoff, among which 15.9% are significant. 45.6% of hydrometric stations presented increasing trends in annual runoff with 16.2% being significant decreasing. Spatially, runoff decreasing mainly occurred in Oceania, Africa, and some rivers in Asia and North America. Runoff increasing mainly occurred in South America, North Asia, and most rivers in Europe. Human activities play a principal role in runoff decreasing for dry areas while global climate change is a main driver to runoff increasing, particularly for rivers in cold region. For the Yellow River case, the recorded runoff from 1980-2010 decreased by 34.6% as comparing to annual runoff in previous period from 1956 to 1979. Human activities contributed approximately 65% of the total runoff reduction and climate change contribution is about 35%.

Key words: global river runoff; climate change; human activities; impacts

Global Water Security and Sustainability Integrated Hydro-epidemiological Management

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Abstract: The effects of climate change, population growth and increasing urbanisation, together with the United Nations Sustainable Development Goals (UN SDGs) and legislative drivers (such as the European Union Water Framework Directive), have led to increasing global concern about the sustainable supply and management of good quality water for all. Epidemiological standards in river and coastal basins (i.e., from source to sea) have often increasingly deteriorated, rather than improved, despite improved water treatment technologies and global aspirations for higher standards of public health and improved freshwater and coastal ecosystems. Such concerns form a major part of the targets of the UN SDGs and particularly Goal 6. Furthermore, in many countries worldwide ecosystems services have not been included in the pricing of water which, together with the increasing frequency of both floods and droughts, has necessitated a more integrated water resources management approach in addressing the growing challenges of water security from source to sea. For example, E. coli (Escherichia coli) and enterococci bacteria levels in rivers and coastal waters are often found to exceed freshwater and bathing water compliance standards, leading to unsafe bacteria levels for recreational swimming, shellfish harvesting etc. The relationship between faecal bacteria (or Faecal Indicator Organism – FIO) levels in catchments (urban and rural), rivers and bathing or shellfish waters are complex, since multiple processes and driving factors affect the transport and fate of FIOs from source to sea. To obtain improved FIO level predictions and better management of river and coastal water compliance, for a changing environment and more stringent standards, it is therefore desirable to build integrated modelling systems which include dynamic FIO kinetic processes etc. through catchments, gullies, pipes and storage tanks into river networks, estuaries and, finally, coastal waters.

The presentation will therefore first introduce some of the general challenges of water security and highlight the anticipated impact of climate change, population growth and cultural changes on water security. The nexus between water, food and energy will be introduced, along with the concept of virtual water and the impact that one country can have on another country's water security. The desirability for society, industry and governments to become more engaged in sustainable water management necessitates an improved appreciation of the water footprint and the impact of virtual water on the security of supply of good quality water. Various practical solutions to enhancing the security of supply will be introduced, particularly the need to address the pricing of water in developed countries. The need for better education on water security will also be highlighted, particularly with the need to raise the profile of water security at all levels of

society and through international organisations, for the worldwide benefit of people and the natural environment.

Brief details will also be given of the development and application of a related integrated hydro-epidemiological data monitoring and modelling study, for simulating the transport and dynamic processes of FIOs from catchments, through river networks, to the coast. An outline will be given of an extensive field data acquisition and modelling study, with the objective being to predict the distribution of FIO levels in the Ribble River Basin and along the Fylde Coast in the UK. The estuary includes shellfish harvesting sites and the coast includes the bathing waters around Blackpool, which is one of the most popular bathing resorts in the UK. The extensive measured and statistical data from the catchments, CSOs, WwTWs and river networks discharging into the estuary have been collected, for both wet and dry weather conditions, to determine various model parameters for calibration and validation of the integrated modelling system. Model predictions have been used to assess the concentrations and locations of FIOs on the bathing and shellfish water quality, with the aim being to provide information for delivering more effective management strategies to meet the EU Water Framework Directive standards, as implemented from 2015. Several key limitations of existing hydro-epidemiological modelling systems remain, particularly with regard to predicting bacterial levels in rivers, estuaries and coastal waters, and research opportunities for the future will be outlined, including the need to include sediment transport as a key transport mechanism of bacteria in river and coastal basins.

Key words: water security; hydro-epidemiological management; sustainability

Groundwater Lens Development in Small Islands

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Abstract: Groundwater resources are important freshwater supplies to small island inhabitants. Groundwater in surficial coastal aquifers is stored in the form of freshwater lens floating on the seawater due to density difference. The shape and volume of a groundwater lens are sensitive to changing environmental and climate conditions, including precipitation, extreme weather events, and sea-level rise. This presentation discusses dynamic spatiotemporal behavior of a groundwater lens under a changing climate, groundwater pumping strategies, and engineering techniques for sustainable management of groundwater resources in small islands.

Keywords: groundwater lens; small island; climate change; seawater intrusion

How to reconcile climate and hydrological attributions for extremes?

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Abstract: Detection and attribution are widely used in climate community, with focus on understanding the effect of anthropogenic climate change, natural climate change and internal climate variability on the climate extremes including heatwaves, extreme rainfall and droughts. While in the hydrological community, attributions are carried out to unravel the role of land cover change and human water use in altering the hydrological extremes including floods and hydrological droughts. Here, we use high-resolution land surface hydrological modeling to reconcile the climate and hydrological attributions for flooding events and changes in flash droughts.

Key words: Extreme; detection and attribution; climate change; land cover change

Hydropower generation and ecological operation under climate change: a case study of the downstream cascade of Lancang River hydropower plants

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Abstract: Climate change has intensified the conflict between economic and ecological water demands, and brought challenges to the ecological operation of hydropower plants. This study examined the effect of climate change on hydropower generation and ecological operation of hydropower plants, and investigated the response of the interactions between power generation and ecological water demand to climate change. The hydropower operation model and the future streamflow projections modeled by climate projections of several global climate models are used. The downstream cascade of Lancang River hydropower plants was used as a case study. Results show that the overall streamflow and hydrological variability were predicted to increase under climate change, and the ecological flow destruction rate was also predicted to increase. The benefit

of hydropower generation and its ecological effects varied more among different operational schemes than among different climate change scenarios, indicating that future conflicts between hydropower generation and ecological water demand are largely inevitable. The increase in hydrological variability caused by climate change can exacerbate the conflict between hydropower generation and ecological water demand, causing larger costs of ecological degradation when retaining the current hydropower benefits.

Keywords: climate change; cascade hydropower plants; ecological operation; multi-objective optimization; Lancang River hydropower base

ICT technologies and innovation in sustainable water management and improving water productivity

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Abstract: Information and communication technologies (ICTs) are increasingly being used in water management to help stakeholders at multiple scales make better and faster decisions in water resources planning and development including smallholders farmers in many regions. However, in MENA region is still at its early stage that could be related to its cost and accessibility. While ICT is no panacea, advancements in technologies now allow remote sensing measurements to be integrated with a large number of geo-specific and field variables such as soil and crop types and water quality. These innovations make it much easier to estimate water needs and availability and, consequently, improve water productivity and application in the field.

With scarce water resources and drought during the summer growing season, irrigation is a necessity for agricultural production in most parts of the world. In addition, local ET stations are very limited, or recently installed, resulting in a lack of historical data. This lack of data has traditionally been considered a hindering factor in the development of ICT based applications targeted at improving agricultural productivity. However, with the advancement in the remote sensing, in combination with online accessible weather data offering a great solutions. These data are providing the basis to estimate the soil-water relationship and crop water requirement and to assist agricultural communities in managing their farm practices and available resources more efficiently. It offer information on “how much water is required so that farmers can decide when and how much to irrigate and how healthy is the crop and predicted yield during the season. Two approaches were tested and discussed to answer on who are the right actors, when they need to be involved and how to achieve sustainability of the solution.

These two approaches applied in two countries (Lebanon and Egypt). In Lebanon-using existing App to further development has proven challenges in developments as limited by its original platform that resulted in a design that did not meet 100% of farmers need. However, as the app was owned by Public institute, that assured the sustainability of the regular updates and continuation of the information to reach farmers. Also, the end-users (farmers) were known the App and that helped in reaching farmers quickly. However, in Egypt-co-design and co-develop a new App in collaboration with public institutions, farmers and private (startups). That resulted in a great outcomes: i) an app that well accepted by farmers and easy to use and navigate information as they were involved from the beginning; ii) a public institute that taken ownership for hosting and continuation of upgrade plus setting the vision of the APP that assured the sustainability beyond the project and also mapped into their strategy and budget; and iii) empower private and bring innovation from startups where state of the art technologies used for less cost and less challenge in design where added flexibility of the App to continue its developments and upgrade

Key words:

Impacts of vegetation changes on regional and global evapotranspiration and related ecohydrological effects

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Abstract: Evapotranspiration is a key variable and key process in global terrestrial cycle, and is crucial for understanding how anthropogenic and climate change impacts on terrestrial water cycle. In the last two decades, global vegetation changes dramatically, reflected by land use and land cover changes and increase in leaf area index (or so-called greening). It remains unclear how these changes influence terrestrial evapotranspiration processes. This study uses a coupled evapotranspiration and gross primary product model (PML-V2) that is run at 500 m and 8-day resolutions across globe to investigate the impacts of vegetation changes on spatial pattern and dynamics of evapotranspiration in last two decades. We found that evapotranspiration across globe has increased noticeably because of vegetation changes, which is characterized by clearly regional and non-regional patterns. Transpiration has strongly increased in central and northern parts of Northern America, Europe, eastern China, southern Africa, and eastern and northern parts of Australia. Under different land cover types, shrubs and cropland have been influenced strongly, and their impact is stronger in the post-2012 period than the pre-2012 period. This kind of change has strong ecohydrological effects, reflected by changes in regional water storage. Taking Yellow

River Basin (YRB) for an example, the vegetation change has resulted in noticeable decrease in water storage in the YRB. The water storage has decreased strongly in middle and lower reaches especially in the regions where a significant increase in the leaf area index was observed. The water storage has decreased by 5.1 mm a-2 in the YRB, for which vegetation change contributed 1.5 mm a-2 (about 29%). Our results can help understanding how vegetation changes caused by recent land use and land cover changes influence terrestrial water cycle and the potential local and regional climate change.

Key words: vegetation changes; evapotranspiration; ecohydrological effects

Influences of climate change and human activities on terrestrial water storage variations across the Yellow River Basin

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Abstract: Terrestrial water storage change has been recognized as one of the components of the hydrological cycle because it can reflect the net effect of all hydrological flux variables such as precipitation, runoff and evapotranspiration. In addition, it can be viewed as a key hydrological indicator to evaluate the water resources across the study regions. In recent years, climate change and extensive anthropogenic activities not only have profoundly influenced the stability of regional water circulation, water systems and social development but led to obvious changes in the spatial and temporal distributions of terrestrial water storage over regions. Therefore, investigating the impact on climate change and human activities on terrestrial water storage change is of great significance to understand the mechanism about how climate change influences the hydrological cycle, to predict extreme weather disasters, to make rational arrangement for agricultural production and to improve the utilization efficiency of water resources. Based on the water balance equation, this report firstly reveals the important role of water storage change in the hydrological cycle process of the Yellow River Basin. Then, based on GRACE satellite data, the temporal and spatial changes of water storage in the Yellow River Basin in recent years were estimated and the trend analysis was carried out. Combined with hydro-meteorological data and human activity statistics data, the contribution of human activities and climate change to water storage in the Yellow River Basin was quantitatively analyzed. Finally, Xiaolangdi Reservoir and Longyangxia Reservoir in the Yellow River Basin are selected as the research objects,

and the influence of human activities, especially reservoir operation, on the interannual variation of water storage in the surrounding areas and their sub-basins is deeply analyzed.

Key words: climate change; human activities; water storage; GRACE satellite; reservoir operation; the Yellow River Basin

Integrated Management Strategy for the Yellow River Delta and its Ambient Sea Area

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Abstract: The strategy is intended to address the following four critical problems with the Yellow River delta (YRD) and its ambient sea.

1) The rapid elongation of the Yellow River estuarine channel, at the rates of 0.4-1.4 km/a, pushes the immediately upstream channel to rise via head(retro-) deposition mechanism. In the past 20 years the river mouth has been extending seawards at 0.4km/a averagely despite the low sediment concentration of 8 kg/m3 with as little as 0.12 billion tons of incoming sediment load per year averagely. It is forecast there will be 0.1-0.6 billion tons of sediment load to come to the estuary, which will make the river mouth running at the rate of about 0.4-1.4 km /a if the estuarine pathway is to be maintained as a single one as the current one, instead of multiple ones.

2) The coast, about 20 km far away from the active river mouth and beyond, suffers severe erosion, which, in turns, leads to the deltaic sea dike collapsing, consequently threatening the security of the people and economy on the delta. Besides, it will cost a lot to maintain and rebuild the sea dikes.

3) Low economic yields from the deltaic agro-farming is due to the fact that 16% and 74% of the deltaic land of about 5500 km^2 are mildly and heavily saline respectively, which makes the local farmers have to draw more fresh water from the Yellow River to decline soil salinity. The method, unfortunately, is strongly limited by the river water volumes availability due to the strict regulation policies on water volumes allocation in the Yellow River Basin. Other methods such as building more rainfall-collecting ponds, using underground tubes and wells to discharge the ground water out so as to lower the groundwater tables to decline salinity, and planting salt-tolerant crops/plants, have been

tried but found no effective or cost-efficient, therefore the methods have not been applied in large scales on the delta.

4) The ecological system in the ambient deltaic sea is found to be in sub-healthy category, which means that although it can maintain its natural properties for the time being, the local system faces high pressure due to environmental pollution and damage by the human activities. The bad situation is evidenced by the decline of fish catch yields from 103 kg per net per hour in 1982 down to 12 kg per net per hour in 2007.

In response to the problems, a new strategy has been formulated for creating an integrated management system for the delta and its interconnected bodies of waters. The strategy advocates:

a) ensuring relatively even distribution of the Yellow River water, sediment and nutrients along the deltaic coast, via multiple transport channels and scientific management of the flow and sediment processes;

b) making good use of the Yellow River sediment to raise the height of the delta and increase the groundwater table depth to the values ranging from 2.5-3.5m, hopefully to reduce soil salinity;

c) building seepage-stoppings on the walls and bottoms of the fresh water-storing gullies, reservoirs and rainfall collecting ponds; and

d) implementing land-sea integration policies on the western coast of the Bohai Sea and its upper area to manage the whole region's environmental resources and reduce pollution in the deltaic waters.

Key words: Yellow River Delta; ecology; integrated management; land-sea integrated environmental management; strategic study

Issue of the Water Security Planning During the "14th Five-Year Plan" Period

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Abstract: The "14th Five-Year Plan" period is the first five years for China, after building a well-off society in an all-round way and realizing the first centenary goal, to embark on the new journey of building a socialist modern country in an all-round way and advance towards the second centenary goal. China faces new challenges, new requirements, and new tasks in water security after stepping into a new development stage, and for carrying out new development ideas,

constructing a new development pattern, and promoting high-quality development. During the "14th Five-Year Plan" period, water security work must be done by deeply implementing the spirit of the Fifth Plenary Session of the 19th CPC Central Committee and the outline of the National 14th Five-Year Plan, practicing the water management idea of "water saving first, spatial balance, systematic management, and two-hand efforts", and accurately mastering the major issues in the water security work during "the 14th Five-Year Plan" period to promote the high-quality development of water conservancy in the new stage.

Key words: water security; 14th Five-Year plan

Lakes in a multiple-stressor world: Algal blooms on a warming planet

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Abstract: One of the greatest challenges faced by ecologists, regulators, and other environmental scientists is using appropriate time scales to assess environmental change. Due to the lack of systematic long-term monitoring data, it is often difficult to determine the nature and timing of ecosystem changes. Furthermore, as environmental assessments are typically performed *after* a problem is identified, critical data regarding pre-disturbance (or reference) conditions are rarely available. Nonetheless, the ecosystems around us have been (indirectly) archiving records of past environmental change in a wide spectrum of sources, and most notably lake sediments (the field of paleolimnology). This presentation will focus on the importance of using appropriate time scales to assess common lake management issues.

Decreasing lake ice is a common feature of warming lakes. However, the consequences of these changes are poorly understood. Paleolimnological research in the High Arctic end elsewhere have shown the striking limnological impacts of declining ice cover and a warming climate. Meanwhile, some of the most common water quality problems in temperate regions relate to algal blooms. In the 1970s, the critical role of phosphorus inputs was recognized as the main trigger for algal blooms. However, we are now experiencing blooms where nutrient levels are not increasing or are even declining. Climate warming, resulting in less ice cover and enhanced thermal stratification (i.e. the "longer summer"), may be a key factor linked to these late-summer algal (often bluegreen or cyanobacterial) blooms. With the addition of multiple stressors like global warming, we are dealing with far more complex problems than we initially suspected.

Key words: climate change; algal blooms

Lake-River interactions in the middle Yangtze River

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Abstract: Many lakes are hydraulically connected with surrounding rivers, which enables water and nutrients exchanges between lakes and rivers, maintaining a healthy aquatic system. Dongting Lake and Poyang Lake are the two large freshwater lakes that are naturally connected with the middle Yangtze River. There serve many functions including providing good quality freshwater resource, regulating Yangtze River floods, forming important habitats of many aquatic and wetland animals. Climate change and human activities have caused significant alteration of the lake-river relationship, and consequently change the lake water and mass balance. One of the apparent symptoms is the prolonged dry season of the lakes and the lowered water level. Meanwhile, water quality is becoming deteriorated, which may also be somewhat related to the changed hydrological condition. This talk presented recent research outcomes on the possible causal factors of altering lake-river relationship. In particular, the influence of the operation of the Three Gorges Reservoir (TGR) was examined. Under future climate changes, lake-river relationship may be further evolving and a new relationship may be reached in a significantly long period, which threatens water and ecological security in the middle Yangtze River.

Key words: Lake-river interaction; middle Yangtze River; Dongting Lake; Poyang Lake; Lake water and mass balance

Long-term trend of intra-annual runoff uniformity and its effects on the thermal structure in a large deep reservoir

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Abstract: Thermal stratification frequently occurs in reservoirs and significantly influences the water environment and ecology. Changes in the uniformity of intra-annual runoff have been observed in several basins, but few studies have studied these changes' effects on the thermal structures of reservoir. Based on

the measured runoff data for Sanbanxi Reservoir, China, during 1950–2015, the long-term trends of intra-annual runoff uniformity were statistically investigated and extrapolated for the 2050s and 2090s, and the relationship between these trends and the thermal structure of the reservoir were analyzed. In addition, the thermal structure was also evaluated under future climate scenarios, accounting for global warming. This study shows that: 1) for South China, the concentration degree (Cd) for the intra-annual runoff distribution of natural basins such as Sanbanxi Reservoir tended to be higher, but for rivers significantly impacted by human activities, Cd tended to be lower. 2) a higher Cd tends to increase the reservoir temperature and released water temperature, and decrease the thermal stability. For Sanbanxi Reservoir, a 10% increase in Cd will induce a change in yearly mean water temperature, thermal stability, and released water temperature of 0.036 ℃, –48.4 J m–2, and 0.153 ℃, respectively. And these changes were larger in summer than in other seasons; 3) global warming is expected to increase reservoir temperature, released water temperature and thermal stability, imposing a more significant influence on these parameters than intra-annual runoff uniformity.

Key words: intra-annual runoff uniformity; thermal regime; Sanbanxi Reservoir; CE-QUAL-W2

Managing hydrological extremes in a changing climate and the need for national water information

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Abstract: The exponential rise in demand for water to grow food, supply industries and sustain urban and rural populations has led to a growing scarcity of freshwater in many parts of the world. An increasing number of rivers now run dry before reaching the sea for substantial periods of the year. A number of major river basins around the world supporting large populations experience moderate to severe water scarcity up to 6 to 12 months, at varying inter-annual to inter-decadal time scales. The ecological and economic consequences of increasing degrees of water scarcity – as evidenced by the Rio Grande, Indus, and Murray-Darling River Basins – can include complete desiccation during dry seasons, decimation of aquatic biodiversity, and substantial economic disruption.

The Millennium Drought (1997–2009) in south-eastern Australia was the most severe on record. It decimated production in Australia's most important agricultural regions, and significantly impacted the ecological health of Australian rivers, particularly in the Murray–Darling Basin. This led to the federal Water Act 2007, which gave the Bureau of Meteorology responsibility for collating, producing and disseminating water information to enable more efficient water use and improve the health of Australian rivers. This presentation would focus on the hydrological

extremes in Australia and the role of national scale authoritative water information to support water exposed sectors with management and adaptation of the hydrological extremes.

Key words: hydrology; extremes; climate change; water information

Mitigating Harmful Cyanobacterial Blooms in a Hotter, Hydrologically More Extreme World

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Abstract: Managing and mitigating the global expansion of toxic cyanobacterial harmful blooms (CyanoHABs) is a major challenge facing researchers and water resource managers. A variety of approaches including nutrient load reduction, artificial mixing and flushing, omnivorous fish removal, algaecide applications and sediment dredging have been used to reduce bloom occurrences. However, managers now face the additional challenge of having to address the effects of climate change on watershed hydrologic and nutrient load dynamics, water temperature, mixing regime and internal nutrient cycling. Rising temperatures, increasing frequencies and magnitudes of extreme weather events, including tropical cyclones, extra-tropical storms, floods and droughts all promote CyanoHABs and influence the efficacy of ecosystem remediation measures. These climatic changes will likely require setting stricter nutrient (including both nitrogen and phosphorus) reduction targets for bloom control in impacted waters. In addition, the efficacy of currently used methods to reduce CyanoHABs will need to be re-evaluated in light of the synergistic effects of climate change with nutrient enrichment.

Key words: Cyanobacterial blooms; climate change; global changes

Numerical Simulation and Mechanism of Aeration and Cavitation in high speed flow

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Abstract: The high-speed flow is the focus problem of flood discharge safety. Aeration and cavitation are the main characteristics of high-speed flow. The research on the meso mechanism of aeration and cavitation is the basic subject to solve the problem of flood discharge safety. LBM was used to simulate the dissolution of bubble and collapse processes of cavitation bubble. Those works were realized about the detailed simulation of bubble dissolution and cavitation bubble collapse processes with high density ratio. These studies are foundation for the study of aeration and cavitation mechanism by the interaction law of among cavitation bubble and air bubble and wall.

Key words: aeration; cavitation; numerical simulation; lattice Boltzmann methods

Practice and exploration of aquatic ecology engineering in the middle and lower reaches of Yangtze River

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Abstract: The aquatic ecosystem in the middle and lower reaches of the Yangtze River is the most abundant and diverse aquatic habitat in our country, and it is an important gene bank of aquatic organisms. At the meantime, it is one of the areas where the aquatic ecosystem is most closely connected with human activities.

However, with the rapid economic and social development and the intensification of human activities in recent decades, problems such as the ecological barrier of dams in the upper reaches of the Yangtze River, the difficulty of coordination between waterway construction and ecological protection, and the degradation of the ecological relationship between rivers and lakes get more and more attention. All of those lead the aquatic ecosystem in the middle and lower reaches of the Yangtze River starts to show a degradation trend.

Responding to the call of ecological civilization construction in the new era, this report researches and proposes the scientific connotation of aquatic ecological engineering, clarifies its key research

directions and technologies that urgently need to be broken through, which provides important supports for developing the aquatic ecological protection and restoration work in the middle and lower reaches of the Yangtze River.

Rainfall-runoff Model Calibration for a Tributary of the Upper Yangtze River Using River Water Surface Width Derived from Optical Satellite Images with High Resolution

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Abstract: The potential for estimating streamflow in continental rivers from satellite observations of river hydraulic variables has been well recognized. But this has not been explored sufficiently for smaller regional rivers. In this study, for estimating long-term daily streamflow time series of data-sparse regional rivers, a method of calibrating hydrological models using river water-surface widths derived from high spatial resolution satellite images is proposed. The method is demonstrated by a case study in the upstream region of the Yangtze River of China, located in the Qinghai–Tibet Plateau. River water-surface width at the outlet in the hydrological modeling, i.e., Ganzi streamflow gauging station of the Yalongjiang River, was measured from high resolution optical remote sensing observations, such as QuickBird images. To shift the calibration objective from streamflow to river width, the hydrological model is connected with the At-a-station Hydraulic Geometry (AHG) relationship between streamflow and river width at Ganzi station. Generalized likelihood uncertainty estimation (GLUE) is used for automatic calibration and for better quantification of simulation uncertainty. After constraining the model parameter space solely to the river width observations, the Nash–Sutcliffe Efficiency values for the streamflow simulated using the calibrated model reached 64.3% in the calibration period and 55.8% in the validation period. This approach yields streamflow estimates with satisfactory accuracy, proving its reliability for application to the real world. Moreover, the promising results confirm the possibility of using high resolution satellite observations for estimating streamflow in regional river basins with river width excess of 100 meters. Higher simulation uncertainty of hydrological modelling compared with traditional calibration using streamflow data indicates that the method is only applicable to river basins where in situ observed streamflow data is unavailable. The hydrological model calibrated based solely on remote sensing observations estimated streamflow at a long temporal scale with satisfactory accuracy. Satellite observation errors caused by the

presence of riparian canopies affected the accuracy of streamflow estimates. However, the effect was not as strong as anticipated, because it was counteracted by adjustment of AHG parameters. Using more reasonable and narrower prior ranges for AHG parameters reduced simulation uncertainty associated with using remote sensing data in the model calibration. Further screening of model parameter sets using hydrological signature information following calibration was more effective in reducing uncertainty than superimposing updated prior ranges for AHG parameters. We believe that this higher uncertainty could be possibly further reduced by introducing remote sensing observations of other water cycle variables to calibration. More research in this direction is very desirable. In particular, this is the first time that the method is applied to a river with channel width around 100 meter wide at basin outlet. In addition, the investigation into how errors in satellite observations influence model performance and how to reduce simulation uncertainty are valuable for ungauged basins. This study demonstrates the potential for application of the proposed calibration method to regional ungauged basins lacking ground streamflow observation data, and provides insights into how remote sensing data can be more effectively integrated with hydrological modeling.

Key words: remote sensing; rainfall-runoff model; calibration; simulation uncertainty

Real time visual monitoring system for vibration effects on hydraulic concrete

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Abstract: Concrete is the most widely used material in hydraulic infrastructures. Its vibration consolidation quality is crucial to ensure the safety and resilience of hydraulic infrastructures. The traditional way of concrete construction is arbitrary, and it is easily influenced by construction personnel's experience and sense of responsibility. The lack of informative feedback control technology results in missing vibration, under vibration and over vibration. In addition, environmental constraints and competitive market leads to the deterioration of concrete raw materials, which will cause quality defects and safety hazards of hydraulic infrastructures.

To solve the above-mentioned problems, taking the advantage of the flexibility and convenience of manual vibration, both the intelligent wearable vibration equipment and the real-time visual feedback control system for vibration effect are developed to realize the timely control of concrete

vibration quality. The intelligent wearable vibration equipment based on GPS-RTK high precision positioning technic can locate the holding positions of construction personnel on the poker vibrator. The positioning accuracy was proved to be centimeter-level even near obstacles.

The intelligent vibrator equips with Hall sensor, and the construction personnel wear special magnetic gloves. Based on the Hall effect, the relative position between the holding positions of construction workers and the vibrator tip can be accurately obtained while workers hold the poker vibrator. Combined with the geometric relationship, the vibrated location and depth can be calculated. Based on the output change of the vibrating motor, the vibration duration is determined. These collected parameters are transmitted to the cloud database in real time through GPRS network.

The real-time visual feedback control system for vibration effect mainly consists of evaluation model and three-dimensional visualization system. In the evaluation model, radius of vibration effect and threshold value of vibration time are determined by laboratory and field tests. They are used as standards to evaluate the field concrete vibration quality calculated based on the parameters of vibration process recorded in the cloud database.

Three-dimensional visualization system establish three dimensional model based on AutoCAD/OpenGL and two-dimensional construction drawings. Vibration effect is visualized in the established three-dimensional model by different color and generates corresponding quality reports, which are convenient for gathering vibration statistics. To further help the on-site construction personnel and remote supervisor inspect the vibration quality, mobile application and remote system have been separately developed. A warning function was integrated in the application and system, which searches under-vibration cells and unvibrated cells using the recursive algorithm for multibranch tree. Once unqualified cells reach threshold, the warnings will be triggered guiding the construction personnel to timely revibrate the unvibrated or under-vibration concrete. In this way, the safety and durability of hydraulic infrastructures can be effectively improved.

The feasibility of this technology has been verified by its application in the demolition and reconstruction of Liushan North pumping station and other construction projects. The results are consistent with testing results from the third party, including Autoclam tester, impact echo detector and other non-destructive testing techniques. All hydraulic infrastructures that adopt the intelligent vibration control system have been running greatly without any safety problems so far.

Key words: Intelligent wearable equipment; Real-time feedback control system; Concrete vibration effect; Safety of hydraulic infrastructures

Research on the Response of Global Floods to Different Temperature Rising Conditions in the Future

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Abstract: In the context of global warming, the water cycle is accelerating and extreme hydrological events are increasing. Water security has become a major challenge facing the sustainable development of human society. In response to global climate change, the "Paris Agreement" adopted in December 2015 claimed that the global average temperature rise will be controlled within 2 ℃ compared with the temperature of the pre-industrial period, and strived to limit the temperature rise to 1.5 ℃ as its temperature rise control target ; But the "2020 Emission Gap Report" pointed out that the world will still face a catastrophic temperature rise of more than 3 ℃ in this century. How will the global flood situation change under different temperature rise conditions? Can the existing flood control standards effectively cope with the increasing pressure of extreme floods in the future? Both are important questions that need to be answered urgently. This study, combined with the basin hydrological model, is based on the global climate model set of the Coupled Model Intercomparison Project Phase 6 (CMIP6). From a global perspective, it assesses the changes in the magnitude, frequency and return period of floods in 9,045 river basins around the world under the conditions of temperature rise of 1.5, 2.0, 2.5 and 3.0℃ respectively. It also combines the existing flood control standards of different countries to analyze the changes of flood control pressures in different regions. The results show that with the increase in temperature, floods will occur more frequently in most river basins around the world, and the magnitude of floods may also continue to grow, with which the data of river basins will also keep rising. Taking the once-in-50-year flood as an example, the percentage of river basins with an increase in global flood magnitude rose from 52% to 81% from a temperature increase of 1.5℃ to a temperature increase of 3.0℃. Most of the basins in Southeast Asia and Australia show a trend of increasing flood levels, while the proportion of basins in Europe showing a trend of increasing flood levels is relatively small. As far as current flood control standards are concerned, most river basins in Asia, Africa, Australia, and South America may, especially as the temperature rise increases, further increase the pressure on flood control in the future. The above research results all have uncertainties from global climate models and watershed hydrological models, of which global climate models are the main source of uncertainty.

Key words: global climate change; floods; global climate patterns; temperature rise conditions; flood control standards

Research on Transformation and Upgrading of Chemical Industry in Yangtze River Basin

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Abstract: This study analyzes the development status and problems of Jiangsu's chemical industry along the river from the three-dimensional perspectives--structure adjustment of the chemical industry chain, scale control of chemical enterprises and spacial layout optimization of chemical industry, and proposes ideas and countermeasures for the green transformation of Jiangsu's chemical industry during the 14th Five-Year Plan period. To be more specific:

1. the sustainable foundation of ensuring the ecological and environmental quality of the region is to determine the reasonable scale of chemical industry based on the upper limit of regional resource utilization and environmental carrying capacity; therefore, the regional resources and environmental carrying capacity should be regarded as constraint as well as promotion for the chemical industry along the river "to control the total amount, optimize the stock, improve quality and efficiency";

2. based on industry relevance, competitiveness and other indexes, classify different situations and implement targeted measures to promote the structural adjustment of the chemical industry along the river. First, take the elimination of backward production capacity and industry technology improvement, innovation and upgrading as the main grasp to promote the green transformation and upgrading of the chemical industry along the river. Second, step up efforts to support the incubation of emerging industries, focusing on the layout of the entire industry chain of pharmaceutical industry. Meanwhile, promote the development of high-tech industries such as electronic information, high-end equipment, energy conservation and environmental protection of new materials. Third, the government should vigorously develop a circular economy. Through the implementation of enterprise clean production and resource recycling, the society can form a circular economic development model: small cycle within the enterprise, medium cycle among enterprises and large cycle in the industrial park.

3. Make decisions based on the regional natural conditions, resource and environmental carrying capacity and economic and social development to promote the optimization of the spatial layout of the entire chemical industry in Jiangsu province. Firstly, take the water ecological carrying

capacity as a hard constraint to coordinate industrial transfer; secondly, build a green chemical industry cluster with the industrial park as a carrier; thirdly, implement a strict spatial access policy.

Research progress of Ecohydraulics

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Abstract: Among the many basic studies related to the development and protection of aquatic ecological civilization, mass transport on the water-sand interface and the response of aquatic lives driven by hydrodynamic forces are important frontier aspects. Early studies mostly combined hydraulics and ecology by rote, and deviated from the actual situation when applying empirical or semi-empirical theory to practical problems. We start from the basic theories of open channel hydraulics and river dynamics, environmental and ecological hydraulics, and use lab experiments, theoretical analysis, and numerical calculations comprehensively to try to organically combine hydraulics and ecology. Preliminary progresses have been made in transportation model of waterborne propagation of animals and plants.

Key words: eco-hydraulics; waterborne propagation; transportation model

Returning flow to the Murray Darling – How it may be affected by water saving projects and groundwater sustainable diversion limits?

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Abstract: The Water Act 2007 of Australia introduced significant policy reforms to rebalance water extracted from the Murray-Darling Basin with the needs of the environment. The 2012 Murray-Darling Basin Plan set new Sustainable Diversion Limits (SDLs) for both surface water and groundwater.

For surface water, the SDLs were set to reduce consumptive use and allocate more water for the environment. A total recovery of 2,750 GL of surface water was required. To meet the SDLs, there have been significant government investments in water recovery through direct buyback of water entitlements from irrigators and through off-farm and on-farm water saving projects. By 2018, the

Australian Government was providing $3.1 billion to purchase water entitlements, of which $2.5 billion had been spent. It was also providing more than $8 billion for modernising infrastructure and water efficiency improvements, of which over $4 billion had been spent.

For groundwater, there was low use and no extraction limit for much of the Basin prior to the Plan. To meet potential future requirements, groundwater SDLs were set much higher overall than historical use in the Basin. There are areas of the Basin, where groundwater extractions were capped at current levels or even reduced, but the reduced volume in these areas is much smaller than the increased volume in other areas. In the shallow aquifers underlying some surface water irrigation, the SDLs were intentionally set higher than historical use to give flexibility for water logging and salinity control.

Serious concerns had been raised that the investments in water saving projects would reduce irrigation return flows so much that the actual amount of water recovered for the environment would be very little or even negative. Concerns had also been raised about the potentially large negative impacts on river flows from increased groundwater use in response to Basin Plan.

In 2018, the Murray-Darling Basin Authority commissioned the authors to conduct an expert review on the potential impacts of water saving projects and increased groundwater use on river flow volume under the Murray-Darling Basin Plan. The key findings from the review are:

The government funded water saving projects recovered a total of 1179 GL/year across the Basin, of which 757 GL/year or 64% was transferred to environmental entitlements. These water saving projects were found to reduce return flow by 121 GL/year. The reduction represents 10% of the total saving, or 16% of the recovery transferred to environmental entitlements. An uncertainty range of 90 GL/year to 150 GL/year was suggested. The largest reduction is in ground return flow, making up 80% of the total reduction in return flow. Overall, while the government funded water saving projects do reduce irrigation return flow, the amount of reduction does not seriously undermine the Plan's water recovery objectives.

In relation to the Plan's groundwater SDLs, reduction in river flow due to groundwater extraction increase will depend on the extent of the increase. Under three scenarios of no growth, 2%/year growth and 4%/year growth, reduction in river flow was estimated to be between 0 and 360 GL/year. Most of the growth will be within commitments prior to the Basin Plan. The large uncertainty in potential impacts calls for close monitoring and adaptive management.

Key words: Murray Darling; Returning flow; groundwater

Satellite-observed ecohydrological changes in Qinghai-Tibetan Plateau over the past four decades

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Abstract: Qinghai-Tibetan Plateau, known as the Third Pole, is an important component of Asia's Climate System. Climate change and human activities have substantially altered ecohydrological regimes in this region. We applied satellite-based retrieval algorithms to derive the multidecadal critical information on actual evapotranspiration, land surface soil moisture, freeze-thaw dynamics, and vegetation status. We further studied the relationship between freeze-thaw dynamics and plant phenology. The results show that this region as a whole has experienced increased evapotranspiration (1.01 mm de-1; $P<0.01$), increased greeningness (0.06 de-1; $P<0.01$), and early thawing (-1.24 days de-1; $P<0.01$) over the past four decades, indicating apparent changes in ecohydrological regimes. However, these changes show large spatial variability. We also found the regulation effects of freeze-thaw on vegetation phenology in this cold region. Comparing to the end stage of the growing season, the start stage of the growing season is more sensitive to changes in the freeze-thaw cycles. Future climate change and human activities are expected to enhance these changes. However, further studies on the underlying mechanisms are necessary.

Key words: Qinghai-Tibetan Plateau; climate change; human activities; satellite; ecohydrology

Smart Lakes initiatives to ensure water security in the North American Great Lakes

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Abstract: Smart technology is changing the way we control our home environment. Self-driving cars and trucks promise to revolutionize the transportation sector. Smart and connected communities are popping up around the globe integrating intelligent technologies between the natural and built environments.

With innovation creeping into all aspects of our daily lives, should it come as a surprise that efforts to monitor the pulse of our natural environment have followed suit? Increasingly, we rely on autonomous monitoring of air and water to inform our understanding of the environment or to alert us to impending danger. And in the North American Great Lakes region, a coalition of non-profits, academic scientists and the private sector are embarking on an ambitious binational venture to create a 'Smart Lake Erie', a pilot for an even more ambitious 'Smart Great Lakes' initiative.

The 'Smart Lake Erie' concept is an information ecosystem supported by a robust sensor-driven network that will transform data into usable tools and create actionable information. These tools, in turn, will enable effective community solutions aimed at reducing public health risks such as cyanobacterial harmful algal blooms (cyanoHABs) and mitigating economic impacts resulting from climate change and direct human influence in Lake Erie and its watershed. The network will further enable adaptive management of the lake, providing real-time assessment on the success of environmental restoration efforts. Sensors can also be deployed that measure recreational access to the Lake so that the tourism sector can best respond to changes in charter boat fishing, boating and other lake-related activities.

The value of having such a network in place, reporting autonomously, is now apparent more than ever as we deal with the broad-ranging implications of the ongoing COVID-19 pandemic. While municipalities, along with state and provincial agencies continue to offer essential services to ensure the safety of our drinking water, field-based monitoring initiatives were placed on hold for much of the past 12 months. While satellites will continue to acquire data that can be used to inform the expanse of cyanoHABs in western Lake Erie and Lake St. Clair, algorithms developed to produce a cyanobacterial index require validation which is only achieved by synoptic sampling. An array of autonomous instruments deployed in key areas throughout the lake would offer continuity of monitoring during unprecedented times such as now.

Key words: North American Great Lakes; water security; Smart Lakes

Some new findings of eco-environmental effects of river damming

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Abstract: There is a long dispute worldwide on the effects of river damming on biogeochemical cycling of nutrients, emission of greenhouse gas from reservoirs, and fish habitat loss, which has become a bottleneck of sustainable hydropower development, and even jeopardizes regional

geopolitical cooperation. Here we investigated the changes of phosphorus and nitrogen concentrations and fluxes of green house gas (CO_2, CH_4 and N_2O) emissions from the cascade reservoirs along the upper Mekong River. Meanwhile, we studied the ecological flow and habitat restoration for fish spawning. We found

(1) A cascade of reservoirs along the upper Mekong River increased downstream bioavailability of nitrogen and phosphorus, despite possible interception of total nitrogen and phosphorus. The core mechanism is the synergic effect of increased hydraulic residence time and the development of hypoxic conditions due to stratification and organic matter accumulation, which results in release of nutrients from the sediment and subsequent accumulation of ammonium that are dispatched downstream from the base of the reservoirs.

(2) Although river damming could increase green house gas emission due to the deposited sediment with organic matters, enlarged hydraulic residence time and anoxic condition, frequent water level fluctuations incurred by hydropower production could enhance the materials exchange and oxic-anoxic cycles in hyporheic zones, resulting strong methane mitigation and nitrogen removal.

(3) Ecological flow can largely improve fish spawning efficiency; however, it is essential to rematch the time of reaching accumulated temperature threshold for gonad development and critical temperature threshold for egg spawning. Besides, removal of tributary low dams can well compensate the habitat loss in dammed mainstem.

The development of hydropower is a key strategy to secure national energy safety and improve energy structure to meet the treaty on carbon neutrality as well as poverty relief in mountainous regions. However, the impacts of river damming, especially in international rivers such as Lancang-Mekong, Brahmaputra, Amazon and Nile, on biogeochemical cycling and the eco-environmental consequences have received increasing concerns from public. These findings may overturn the long-term perception on the effects of hydropower development on nutrient regimes in dammed rivers, which could support the Lancang-Mekong geo-political collaborations and sustainable hydropower development worldwide.

Key words: eco-environmental effects; river damming

Spatio-Temporal Differentiation and Influencing Factors of Urban Water Supply System Resilience in the Yangtze River Delta Urban Agglomeration

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Abstract: With the increasing impacts of climate change and human activities on water resources, the urban water supply system faces multiple challenges to provide sustainable services under uncertainty. Urban water supply system resilience (UWSSR) is the water supply system's ability to maintain its functional stability and adapt to changes from the outside. A multidimensional evaluation framework of UWSSR was developed at the urban scale, which includes five dimensions with 12 indicators. The mean square deviation method was used to calculate the weight value of each indicator, and the sample additive sum method was adopted to aggregate 12 indicators to be the composite index UWSSR. Spatio-temporal differentiation, spatial correlation was analyzed by using Global Moran's I and Local Moran's I. And influencing factors were analyzed using the panel corrected standard error (PCSE) regression method to compare, narrow the gap of UWSSR among cities, and realize regional coordination further. The temporal and spatial differentiation of UWSSR and its influencing factors are analyzed in the Yangtze River Delta Urban Agglomeration (YRDUA) of China. Twelve related indicators are selected to establish the evaluation framework of UWSSR, and then the composite index is calculated according to the standardized deviation method. The spatial agglomeration and distribution characteristics of UWSSR in the YRDUA are discussed by spatial correlation analysis. PCSE estimation method is used to identify the influencing factors. The results show that: (1) the UWSSR in the YRDUA has obvious fluctuated characteristics, and the overall change is not obvious. The overall UWSSR in the YRDUA does not change much, mainly affected by the amount of water resources and reflecting noticeable inter-provincial differences and city size differences. (2) UWSSR in the YRDUA has a significant spatial correlation in most years. However, the spatial agglomeration distribution pattern is not obvious. (3) During the two successive stages (2009-2013 and 2014-2018), UWSSR is positively related to public services, negatively related to public regulation and the level of urbanization. The positive and negative sign of the variable coefficient changes during the two stages is per capita GDP, public financial resources, the level of industrialization, water supply facilities investment and the level of science and technology.

This paper provides a framework for quantitative research of UWSSR. The infrastructure level, available water resources, and management level were considered as components of UWSSR. What is different from previous studies is that we consider the public finance level and urban development as influencing factors of UWSSR. Because these factors do not affect the UWSSR directly; for example, the level of urban development will affect the UWSSR by water demand. The public finance will affect UWSSR by increasing facilities construction and investment,

strengthening the application of science and technology in water supply facilities, supporting water supply companies by certain subsidies, etc. Considering various information in the UWSSR evaluation indicator system can better show the real situation, especially the performance of water supply system under changing conditions. At the same time, we compare UWSSR among cities in different years by analyzing the panel data. So, we can get more comprehensive and extensive information by identifying spatio-temporal changes of UWSSR.

Key words: Yangtze River Delta Urban Agglomeration; urban water supply system resilience; spatial correlation analysis

Studies of the eco-hydraulics of the Taihu Lake: instruments and techniques

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Abstract: The cyanobacterial bloom problem is one of the core water environment problems faced by the Taihu Lake area. Since the water supply crisis happened in Wuxi, a city of Jiangsu province, in 2007, the state has taken a series of comprehensive measures to suppress and control algae. However, the area of cyanobacterial bloom outbreak in Taihu Lake still reached a historical peak in 2017. Under the current treatment measures and natural conditions, cyanobacterial bloom problem is still a major water safety issue that plagues the livelihood of local residents and hinders local economic and social development. Taihu Lake provides a habitat for cyanobacteria. The ecological environment of Taihu Lake and cyanobacterial bloom are limited by many factors, among which the hydrodynamic characteristic of Taihu Lake is one of the key factors that cannot be ignored. The key of solving the problem of cyanobacterial bloom in Taihu Lake is to improve the lake's hydrodynamic characteristics. At present, there are still many shortcomings in the research on the hydrodynamic characteristics of Taihu Lake, and the research on hydrodynamic characteristics lacks scientific and effective physical model simulation methods.

Nanjing Hydraulic Research Institute set up the world's first physical model of the whole lake area with large variability for the first time. The model has a plan view size of 140m×140m, a height of 1.1m, a horizontal scale of 1:500 and a vertical scale of 1:10, and the simulation area includes the lake area of Taihu Lake, 23 major estuaries and 49 islands. During the construction of this model, researchers proposed a similarity theory of Taihu Lake water environment and dynamic characteristics model with the method of synthesized parameter as its core. Cross-sectional wind-generated system was invented to realize the cross-sectional uniform wind field with controllable wind speed, which overcame the technical problems of simulating the natural lake wind field.

Based on the joint action of wind-generated flow, wave flow of underwater 3D PIV and large-scale surface flow field and concentration field, researchers developed the contact-less and high-precision measurement system. The physical model of the whole lake can accurately simulate the characteristics of wind-generated flowing water dynamics and pollutant migration and dispersion law in Taihu Lake under the effect of southeast and northwest winds. It can be used for basic theoretical research on hydrodynamics of shallow lakes, pollutant migration and dispersion law, cyanobacterial bloom aggregation and drift, ecological dredging and siltation of Taihu Lake, habitat restoration, optimal scheduling of water transfer and diversion, comprehensive measures to improve the hydrodynamic elements of Taihu Lake, algae suppression and control, prevention and control of lake flooding, etc. After the completion of Taihu lake physical model , we have undertaken and completed many national key reasearch and development projects, National Natural Science Foundation of China projects and provincial and ministerial key engineering consulting projects. The model has improved the basic theory of lake hydrodynamics and provided technical support for the water environment management of Taihu Lake; built an international shared open platform; cultivated high-end talents in lake research and lake management innovation team; guided the ecological river and lake action plan of Jiangsu Province and supported the effective implementation of river chief system and lake chief system.

Study on the Process and Mechanism of Long Time Series Change of the Lake Water Environment in Middle and Lower Reaches of Yangtze River based on Satellite Remote Sensing

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Abstract: The middle and lower reaches of Yangtze River has the largest freshwater lake group in China, while the lakes in this region are facing a series of water environment problems, which have seriously affected the normal ecological functions of the lakes. This report will focus on two most important problems of lake environment in the middle and lower reaches of Yangtze River : eutrophication and lake reclamation, and introduce how to use long time series multi-source satellite remote sensing data to obtain the spatial and temporal dynamic trends of lake eutrophication degree at basin scale, trace the spatial and temporal trajectories of the main forms of lake exploitation, and study the response of lake environment to human activities and climate change.

Study on water conservation ecological service function and value response of water conservancy project nested affected area

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Abstract: Water conservation function and its ecological value response mechanism are complex under the combined action of water conservancy project nested operation, regional underlying surface and hydro-meteorological changes. Under the nested operation of the Three Gorges Project and the Kaizhou Water Level Regulation Dam, and the influence of strong human disturbance in the reservoir area, the response mechanism of water conservation ecological service function to the changing environment in Pengxi River Basin is still unclear. Therefore, based on the InVEST model and spatial interpolation method, two time nodes before and after the nesting of water conservancy projects were selected, 2005 and 2018, and different water level and meteorological scenarios were set to explore the evolution mechanism of water conservation service function. The results show that: (1) The water conservation function presents a positive development trend under the nesting operation of water conservancy projects. (2) The simulation results of different precipitation and evapotranspiration scenarios show that water conservation function has a more significant response to precipitation conditions. (3) Under the dual effects of precipitation evapotranspiration, water conservation has the most significant response. In low temperature and rainy years, the water conservation presented a maximum value, especially in 2018, the water conservation exceeded 100 million m^3 under the high water level scenario. On the contrary, high temperature and low rainfall years have the lowest value, about 14 million m^3, which is reduced by 86%. The research can provide scientific basis for the protection of water conservation ecological service function in the water-level-fluctuation zone of the Three Gorges Reservoir Region and the nested operation area of related large-scale water conservancy projects, and provide data reference for the optimal allocation of regional water and soil resources.

Key words: InVEST model; Water yield; Nested area of water conservancy projects; Hydrology-weather condition; Land use change

Study on the Changing salty regimes and the strategies for preventing saltwater intrusion in the Pearl River Estuary

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Abstract: Preventing saltwater intrusion in the Pearl River Estuary is extremely important for the protection of water safety in the Guangdong-Hong Kong-Macao Greater Bay Area. At present, under the influence of factors such as low incoming water, downward cutting of river, and rising sea level, the salty regimes in the Pearl River Estuary are not optimistic. Based on the analysis of the changing salty regimes in the Pearl River Estuary, we established a comprehensive prevention strategy from the basin, delta, and estuary scales for saltwater intrusion in this study. Specifically, on the basin scale, an emergency scheme of saltwater flow guarantee in an exceptionally dry year is put forward. On the delta scale, the local water supply system of the Pearl River Delta has been improved, and the Sluice-Pump Joint Operation Technology in the Pearl River Delta has been applied to regulate and store freshwater. On the estuary scale, an early warning and forecasting system for monitoring salty regimes has been developed, and a series of measures have been taken to prevent saltwater intrusion in the Pearl River Estuary.

Key words: saltwater intrusion; salty regimes; Sluice-Pump Joint Operation; Pearl River Estuary

Sustainable Water Resources Management Under Socio-economic and Climatic Change

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Abstract: The existential threat of anthropogenic climate change looms large over the water sector globally, and there is increasing concern over the risk that it poses to water security in the coming decades. However, while climate change does indeed represent a major risk, it is not the fundamental reason why many countries are facing water crises. Developing economies, notably in the BRIC and MINT countries, have driven water demand to levels that are outstripping the available resources, leading to water deficits or gaps. According to the 2030 Water Resources Group (2030WRG), nearly 25% of the world's population face looming water crises, and by 2025

the figure is predicted to surpass 60%. The World Bank projects that water scarcity could cost some regions up to 6% of their GDP by 2050. In 2018 alone, companies reported more than $38 billion in financial losses due to water challenges.

The concept of sustainable development was introduced in the Brundtland report in 1987, and much has been written since about how this should be implemented in the water sector eg through Integrated Water Resources Management. This concept of ensuring that sufficent water is left for ecosystem needs and those of future generations can be implemented when there are ample resources available, but the emerging water crises invariably mean that ecosystem and future needs have been sacrificed to meet the imperatives of economic and social development. So how can these crises be addressed? The 2030WRG, a private sector initiative now hosted by the World Bank, has demonstrated that if sufficient investment is made in water use efficiency/demand management measures, the emerging water gaps can be closed. They have used an Integrated Economic Approach incorporating a Water Availability Cost Curve to rank preferentially by cost the different water use efficiency and supply-side options that can be used to close a country's water gap. Generally, supply-side options emerge as being more expensive in cost terms, quite apart from their impact on the environment. Moreover, through case studies implemented in multiple countries, they have shown how inclusive public-private sector partnerships can be forged to mobilise the necessary investments; multi-stakeholder platforms that include the corporate sector, the public sector and civil society are key to enabling this.

So what then of the climate risk? Long-term natural climatic variability, reflected in decadal/multidecadal fluctuations in precipitation and river flows, is present in many regions of the world, as exemplified by global mapping of the Hurst coefficient H for historical precipitation. It can be anticipated that this variability will be amplified under anthropogenic climate change, with the most severe impacts emerging later this century, so there is still time to implement major water use efficiency programmes. GCMs/RCMs provide uncertain scenarios of how the future climate may evolve as a function of the level of GHG emissions. In evaluating investment options in managing the supply demand balance under climate change risk, the concepts of robustness and resilience should be employed as part of the evaluation process. These concepts generally give preference to smaller scale incremental investments in water use efficiency measures over large scale, expensive, supply-side investment with uncertain outcomes and which do not fit with the concept of sustainable development.

Finally, it is suggested that water resources research needs to focus more on the technological and economic aspects of closing the emerging supply-demand gaps, and on how the necessary investments in the water sector can be mobilized through public/private partnerships that are used in other sectors. It needs to be recognized that water, as our most precious but also our most wasted

natural resource, has a much higher value than implied by the level of investment it invariably attracts, and that the development of new water saving technologies can provide new business opportunities and markets that can make the sector more attractive for investors. Moreover, these water saving technologies should be designed to contribute towards net zero.

Key words: climate change; sustainable water resources management; socio-economic change

Synergistic Governance of Water-Energy-Food Nexus for Basin-wide High-quality Development

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Abstract: Water, energy, and food are viewed as three strategic elementary resources for human survival and development. A sustainable provision of products from water, energy, and food systems plays a foundational role for ensuring basin-wide high-quality development. There exists a nexus relationship among these three resources at the basin level, which can be characterized as complex reciprocal feedback and mutualism. Consequently, a synergistic governance of water-energy-food nexus provides an institutional guarantee for the basin-wide high-quality development.

According to the principle of "water-constrained, ecology first", a synergistic governance paradigm of water-energy-food nexus is proposed to promote basin-wide high-quality development. The paradigm mainly consists of a database of basin-level multi-dimensional heterogeneous production input factors based on a high-precision grid, a synergistic mechanism of water-energy-food nexus, and a synergistic governance system of water-energy-food nexus from the perspectives of risk management and control, and institutional mechanism innovation. Informative decision-making can be achieved in terms of better management of land development, industrial spatial distribution, and basin-wide high-quality development.

Key words: water-energy-food; watershed; synergistic governance paradigm; decision-making

The Dedicated Protection of the Yangtze River and the Future of the Yangtze Finless Porpoise

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Abstract: The Yangtze River is the mother river of the Chinese nation, with rich and unique biodiversity. In particular, it is unique in the world to have two aquatic mammals (lipotes vexillifer and finless porpoise) inhabiting the same freshwater river at the same time. Then, in the past few decades, due to the population increase in the Yangtze River Basin, the rapid social and economic development, and the unreasonable economic structure and development model, etc., the rapid decline of the Yangtze River's biodiversity and the near collapse of the ecosystem have occured. The landmark event was the functional extinction of the lipotes vexillifer. In order to prevent the Yangtze finless porpoise from following in the footsteps of the lipotes vexillifer, it is urgent to upgrade the protection of the Yangtze finless porpoise. Since the 18th National Congress of the Communist Party of China, the strategy of "jointly protecting and no big developing" is a historical opportunity for the restoration of the Yangtze River ecosystem and biodiversity. The success or failure of the Yangtze River protection is closely related to the protection of the Yangtze finless porpoise. As an important habitat for the Yangtze finless porpoise, the Nanjing section of the Yangtze River is the only city along the Yangtze River where the Yangtze finless porpoise can be stably found in the central section of the city. The in-site conservation of the Nanjing Yangtze finless porpoise is crucial for achieving the harmony between the human and nature, and the coodination between protection and of development.

The Development of Environment-Friendly Eco-Concrete Technology

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Abstract: Given the current situation of China's environment and water ecology, this paper puts forward the functional requirements for concrete structure of buildings and introduces the classification and significance of environmentally friendly eco-concrete at home and abroad. It focuses on the introduction of the key technologies and engineering applications of water permeability, reproducibility, low-carbon, photocatalytic self-cleaning and eco-concrete, looking forward to the development trend of environmentally friendly eco-concrete technology.

The role of integrated assessment and modelling in river basin management and water security

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Abstract: It is now well recognized that effective water management requires an integrated approach that can tackle multiple issues of concern such as long=term water security, water allocation decisions, water quality protection, ecosystem maintenance, food and energy policy interactions and farmer livelihoods. It is also appreciated that this requires an interdisciplinary approach that considers all relevant parts of the water system, engages appropriate stakeholders, domain knowledge and discipline expertise. Crucial considerations are the governance and human settings.

Integrated assessment (IA) can be defined as a scientific metadiscipline that integrates knowledge about a problem domain and makes it available for societal learning and decision-making processes. A core tool of IA is modelling (M) to map out the problems of concern, structure our thinking and integrate the knowledge required for its resolution. Properly handled, an IAM process can elicit and share knowledge, generate trust and identify opportunities that reduce conflict.

The key challenge is to ensure the IAM process is fit-for-purpose. This includes not only pertinent engagement processes but also problem framing and modelling that captures the multi-sectoral issues, their socio-environmental components and interactions. Perhaps the biggest challenge is managing uncertainties, particularly about the longer-term future, and anticipating issues and opportunities to achieve robust outcomes. The presentation will use case studies to demonstrate how IAM can support integrated river basin management.

Key words: water management; Integrated Assessment Modeling; water issues; interdisciplinary

The key technology and application of hydraulic ship lift

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Abstract: In view of the problems of traditional motor-driven ship lift that can’t operate normally when the ship cabin is leaking and the docking of the ship cabin is difficult when the water level of the river changes rapidly and drastically, our team has worked on scientific and technological research for more than ten years and invented a new type of ship lift—hydraulic ship lift, which uses water energy as lifting power and security measure. On this basis, we have developed three core technologies of hydraulic drive synchronization and stability, mechanical synchronization system correction and operation control, and proposed a complete set of technologies covering

design, manufacturing, construction and operation. The hydraulic ship lift is the first in the world and an original Chinese technology. The new type of ship lift with China's completely independent intellectual property rights breaks through the technical bottleneck of traditional ship lift in principle, greatly improving the safety, reliability and adaptability of ship lift, thereby providing a new, advanced, practical and safe technical choice for the navigation field of high dam.

The hydraulic ship lift has significant advantages in adapting to the rapid change of downstream water level and coping with extreme accident conditions such as water leakage in the ship cabin, as well as in operation and maintenance. In addition, the prospect of popularization and application of this technology is very broad.

Keywords: hydraulic ship lift; original Chinese technology

Thoughts and Countermeasures on Accelerating the Establishment of the Value Realizing Mechanism of Aquatic Ecological Products in the Yangtze River Economic Belt

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Abstract: At the meeting of Comprehensively Promoting the Development of the Yangtze River Economic Belt held on November 14, 2020, General Secretary Xi Jinping pointed out that speeding up the establishment of value realizing mechanism of ecological products is quite necessary. He said that it be used to reward the action of environmental protection and restoration, as well as punishing the action of environmental destruction. Ecosystems provide material products for human beings, display significant values in natural landscapes and geological relics, and have various ecological functions such as regulating climate, conserving water and biodiversity, and preserving soil and water. Water is the foundation of ecology, and aquatic ecological products are indispensable for human survival and development. Accelerating the establishment of value realizing mechanism of aquatic ecological products in the Yangtze River Economic Belt is the key to realize the value transformation of the “Two Mountains”, and is of great significance to achieving high-level protection of the ecological environment and high-quality socio-economic development.

During the “14th Five-Year Plan” period, we should fully aware of the public nature, spillover and externality of aquatic ecological products, including the indirectness and long-term effectiveness of their value, accelerate the establishment of value theory and accounting method system of aquatic ecological product, making efforts to realize the value of aquatic ecological products. First,

expand our supply capacity of high-quality aquatic ecological products. The focus of this method is to implement the “Yangtze River Protection Law”, protection and restoration of the Yangtze River need to be implemented around the idea of “three waters co-governance”; second, promote the institutional reform of the Yangtze River Water Property Right. We need to accelerate the pace of reforms on the basis of current pilot projects for water flow property rights confirmation, confirm the ownership and supervision responsibilities of governments at all levels, and protect the legitimate rights and interests of property subjects; third, improve the water rights transaction system and market mechanism. Give full play to the role of water rights in optimizing water resources allocation, improving water resources utilization efficiency, promoting the rational use of water resources and protecting the ecological environment of the Yangtze River. Meanwhile, explore ways to raise water fund and repurchase river water rights; fourth, accelerate the reform of water supply and hydropower prices. This method needs to focus on promoting non-residential water price reform, and establishing a dynamic adjustment mechanism for water and electricity prices; fifth, vigorously develop cultural service products. Protect the cultural heritage of the Yangtze River with craftsmanship spirit and vigorously develop water eco-tourism; sixth, improve the diversified water ecological compensation mechanism. Improve the water ecological compensation standard system, explore diversified financing channels, build a long-term investment mechanism for ecological compensation, implement diversified compensation methods based on “hematopoietic” compensation, and build a development pattern of win-win cooperation and mutual benefit.

United-control System technology for water environment improvement in river network area of Yangtze River Delta Plain——Taking the United-control System of CIIE as an example

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Abstract: The Yangtze River Delta Plain is the largest economic area in China with dense population and high urbanization rate, but also the most complex plain river network area in the world. The specific performance is as follows: the river network is densely distributed (2.5km per square kilometer), there are many wading projects, the connectivity is poor (more than 10000 water conservancy projects in Taihu Basin), and the pollution load into the river is strong (8-10 times of that in European and American countries).The problem of river network water environment has become the bottleneck of the sustainable development of economy and society in the Yangtze

River Delta. In order to improve the river water environment, it is very important to make rational and intelligent operation of regional river system.However, at present, the daily scheduling is still mainly dependent on manual scheduling, which is difficult to plan as a whole. The daily water diversion volume mostly uses empirical value, so it is very difficult to achieve accurate scheduling.This paper takes the comprehensive improvement project of regional water environment of China International Import Expo as an example. The study area is located in Xujing Town of Qingpu District in Shanghai City, with a research area of about 12km2, of which the core area is xiaolaigang National Convention and exhibition center section, with a length of about 2.0KM. The main problems of water quality in the study area of the fair include: 1) the control of the source is not in place, the bottom mud is not dredged to release pollutants continuously, and the pollution load of point source and non-point source into the river is heavy; 2) the water quality in the study area is poor, basically of grade V - worse grade V , SS, NH3-N and TP seriously exceed the standard, with low transparency (30-50cm); 3) the surrounding water body is turbid, the water quality is unstable (grade IV-V), and there is no clear water source; 4) the river system connectivity is poor, the water flow is not smooth, Yangjing port, planning Xinkai River, luojialangbang are not connected; 5) the surrounding regulation and control engineering system is incomplete, and the river network hydrodynamic control capacity is insufficient. Therefore, it is urgent to build a multi-objective real-time monitoring, precise simulation and intelligent feedback water environment improvement joint control and regulation system,which is based on big data and cloud platform, integrated hydrological hydrodynamic water quality coupling model as the core, real-time monitoring and prediction data as the driving force, and remote automatic control as the means.There are four construction contents including: software and hardware, internet of things, model construction and scheme preparation, model cloud and system development to realize full coverage, three-dimensional monitoring and early warning of all factors, intelligent decision-making and remote joint scheduling. The accuracy of water level scheduling is within 5cm, and the response time is upgraded from more than 20 minutes of artificial response to less than 5 minutes of intelligent response.The United-control System has improved the water environment in the Expo area, and the water quality in the Expo area has been improved to grade II and grade III, which has improved the level of regional water conservancy informatization, responded to several sudden rainfall and pollution events in time, effectively guaranteed the smooth holding of the two sessions of the Expo, and formed a good demonstration effect.
Keywords: river network area of Yangtze River Delta Plain; water environment improvement; United-control System; intelligent scheduling; China International Import Expo

Unraveling the causes of excess lead in drinking water supply systems of densely populated high-rise buildings in Hong Kong

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Abstract: Excess concentrations of lead (Pb) were found in tap water from drinking water supply systems of high-rise buildings in Public Rental Housing (PRH) estates in Hong Kong in 2015. As almost half of the population live in public housing estates, this incident poses significant threats to public health. And yet the underlying causes of the lead contamination are complex and largely unknown. Unlike other countries the water supply pipes in Hong Kong are made of copper rather than lead.

The copper supply lines are fitted with lead-soldered connections, and brass fixtures and faucets. The causes of excess lead are studied through field sampling on occupied households, experiments on prototype supply chains, and 3D numerical modeling. The tap water lead concentration of 129 households in the PRH estates was sampled using a specially-designed protocol, revealing the highly variable lead concentration variations induced by sources along the supply chain. Lead concentration variation at consumer tap and its relation with various lead sources are studied in a full scale test rig. A 3D computational fluid dynamics (CFD) model is successfully developed to interpret the time variation of lead concentrations at the consumer tap. Model predictions of the complex variation of dissolved lead are in good agreement with data, and confirm lead solder in copper pipe connections as a major cause of the ``lead water'' episode in Hong Kong. A new method for the prediction of Pb concentrations as a function of the random stagnation time, water use time, and sampling time is presented. A theory based on electro-chemical kinetics and electric potential field is developed to predict the galvanic corrosion and lead leaching process. The findings provide a basis for lead risk assessment of different water sampling strategies in densely populated high rise buildings in Megacities.

Unscented weighted ensemble Kalman filter for soil moisture assimilation

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Abstract: A new data assimilation technique, unscented weighted ensemble Kalman filter (UWEnKF) was developed based on the scaled unscented transformation and ensemble Kalman filter (EnKF). In UWEnKF, the individual members selected are unequally weighted and symmetric about the expectation. To investigate the performance of UWEnKF, nine assimilation experiments with different ensemble sizes (161, 1601, 16001) and different assimilation frequencies (every 6 h, every 12 h, every 24 h) were designed to assimilate soil surface (5 cm) moisture data observed at station HY in the upper reaches of the Yellow River, in the northeastern of Tibetan plateau, China into the Richards equation. The nine assimilation experiments were all run 100 times independently, respectively. In addition, to analyze the impact of initial value, uncertainty of precipitation and soil properties on filter performance, another five experiments with different errors on precipitation, soil properties and initial values were designed.

The root mean square error (RMSE) and mean absolute error (MAE) results of the nine assimilation experiments with 100 independent runs led to the following conclusions:

(1) The performance of the filter was greatly affected by random noise. UWEnKF improves the model simulations better than EnKF at all soil depths no matter what the ensemble size and the assimilation frequency are. At the deepest soil layer, EnKF is influenced by the initial value, but UWEnKF greatly improves soil moisture simulations. Uncertainty in precipitation and soil properties has some impact on filter performance because both impact the model performance.

(2) The filter was sensitive to ensemble size and assimilation frequency. Increasing the ensemble size (i.e., the number of randomly selected members) reduced the effects of random noise on filter performance in several independent assimilation runs (i.e., it decreased the differences between the results of the several independent assimilation runs), because the differences between the results of independent assimilation runs decrease with the increased ensemble size. Reducing the assimilation frequency (i.e., increasing the assimilation interval) also reduced the effects of random noise on filter performance.

(3) UWEnKF gave more accurate soil moisture model results than EnKF for all ensemble sizes and assimilation frequencies at all soil depths. Thus, UWEnKF is a better choice than EnKF, while

it is more computationally demanding, for improving soil moisture predictions by assimilating data from many sources, such as satellite-observed soil moisture data, at a low assimilation frequency (e.g., every 24 h).

Additionally, the results of the five uncertainty experiments show that EnKF may have different performances according to different initial conditions, but not for UWEnKF. Precipitation and soil properties uncertainties had some impact on filter performance.

Overall, the impact of the different randomly and equally-sized ensembles on filters performance is reduced in UWEnKF, and UWEnKF is an effective and practical data assimilation technique that improves soil moisture model simulations. It is benefit to obtain the high accuracy of catchment or global soil moisture estimations for different soil depths using the sparse in-situ soil observations and remote sensing data, which is helpful for rainfall proportions in watershed flood forecasting, drought warning and management of agriculture production.

Keywords: Soil moisture; Richards equation; ensemble Kalman filter (EnKF); unscented weighted ensemble Kalman filter (UWEnKF)

Urban land use impact on source water quality: Emerging challenges

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Abstract: Exploding population growth and rapid urbanizations have put severe pressure on quality of source water in many parts of the world, both because of increasing point and non-point source discharges to surface and groundwater, but also because of increasing per capita consumption of water in the growing urban centers causing concerns for public health. In the past, researchers have focused heavily on traditional contaminants such as nitrogen, phosphorus, and heavy metals etc., however the discussion recently has shifted especially because of increasing use of treated wastewater (i.e., reclaimed water) as a source. This has led to increased occurrences of new and emerging pollutants including steroidal hormones, pharmaceuticals, and personal care products (PPCPs) in urban areas. It is common to have highly prescribed pharmaceuticals, widely used antimicrobial products, and naturally occurring hormones in sewage waste. Conventional wastewater treatment plants are not designed to remove these organic compounds completely, and thus they are frequently detected at low levels (parts per billion to parts per trillion) in wastewater effluents. This presentation will review and discuss emerging contaminants problems with examples from two case studies, Lake Mead, Nevada, and Lake Taihu, China. Both water bodies

are located adjacent to heavily populated urban centers and provide as important sources of drinking water for large populations.

Water Adaptive Agriculture and Smart Agriculture with High Water Utilization Efficiency

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Abstract: The report analyzes the new challenges facing the development of modern agriculture, that is, population growth and urbanization have put forward higher requirements for food supply. The future increase in global food production will mainly depend on increasing per unit yield; while resource shortages and deterioration of the ecological environment will bring a greater challenge to agricultural production. Therefore, green development will be the main theme of future agricultural development. As cost reduction and efficiency enhancement and international competition have put forward new requirements for the transformation of agricultural production methods, increasing labor productivity becomes the key to enhancing the competitiveness of the agricultural industry in the future; industrial integration and new business entities will give birth to a new agricultural industrial revolution and, with agriculture changing from a family unit to a large-scale operation mode, family farms have gradually become a new force in my country's agricultural production. Moreover, the new green agricultural science and technology revolution will lead agriculture to a new era. Developed countries have a high degree of agricultural industrialization, organization, cooperation, and scale, and they have realized agricultural modernization in an all-around way, which features mechanization, improved varieties, chemization, electrification, informationization and so on. Besides, modern agriculture is facing globalization, marketization, and Internetization, therefore, cost reduction, high quality, high efficiency and green sustainability is the foundation for the development of agriculture.

The report points out that the development of water adaptive agriculture is a strategic choice to deal with water shortages and to ensure national food security. Water shortage is the real food crisis. The former director general of the United States FAO once said that "without water security, there is no food security." China's water resources are in short supply, especially in the northwest region, whose water resources account for only 8% of the country's total; the amount of water resources per unit area there is only 1/4 of that of the country. The excessive development and utilization of water resources has caused serious ecological and environmental problems. In addition, the per capita water resources in North China have been less than 300m3 for many years,

which is only 1/7 of the national average. The agricultural water-saving technology in this region has been promoted for more than 30 years, but it has not changed the worse situation of groundwater resources. The main reason is that the planting system has been developing towards a high water-consumption structure. As a result, the effect of water-saving technology significantly lower than that of water intensity, even leading to a strange phenomenon that "the more water is saved, the more water is lacking". Therefore, sustainable development cannot depend on increasing grain production capacity by expanding the scale of total agricultural water consumption. Under the conditions of water shortage, it is necessary to develop water adaptive agriculture, which requires that the scale, the output, and the development of agriculture should be based on the amount of water. Besides, the optimal allocation and development, utilization, conservation, and protection of surface water and groundwater will meet the needs of water utilization of cities, industry, daily life, and agriculture, thus reducing the negative impacts on the environment. The development of water adaptive agriculture is a higher-level water-saving strategy.

The study finds that the water consumption of different planting systems is significantly different from the cumulative change of groundwater. Compared with the traditional wheat-corn model, the grain-cotton-potato model, the grain-oil model, and the grain-cotton-oil model save 22.6%, 15.1% and 10.6% of water respectively. Through the comparison of different planting systems, it is found that reducing the planting area and reducing the maturation will increase the loss of ineffective soil evaporation and have a large impact on the yield, while the water saving effect is less than that of reducing the amount of irrigation water per unit area. Using limited irrigation water to expand the irrigation area has less impact on yield than increasing irrigation water per unit area. Thus, it is an option to compress irrigation volume and not compress irrigation area to develop semi-arid farming.

Smart agriculture with high water utilization efficiency is the main measure to ensure food security under the background of water shortage, whose development should tap the potential from three aspects, namely, the natural physiological water saving of crops, field irrigation water saving and regional water saving, distribution and management. Moreover, smart agriculture with high water utilization efficiency, as the future development direction of agriculture, is to rely on biotechnology, information technology and intelligent equipment to achieve intelligent perception of water and intelligent decision-making of and control over water use and crop phenotype information at different scales. It will also achieve regional water and soil adaptation and optimize the spatial and temporal pattern of water productivity, realizing precise water use and maximizing water benefits. This model of agriculture development needs to realize the adaptation of regional water and soil resources and the optimization of the spatial and temporal pattern of water

productivity. Under certain regional yield or benefit goals, the process of crop planting and water consumption should be designed from the perspective of space and time to minimize the net water consumption of regional crops and improve water productivity and water production efficiency; and under the conditions of total amount control and quota management, the regional output or water efficiency can be maximized through the optimal distribution of regional crop planting and water consumption in time and space.

Smart agriculture with high water utilization efficiency includes four key elements, namely, high-throughput intelligent perception of crop phenotype and water featuring air-ground integration, intelligent cognitive model system for water and crop production process, intelligent decision-making system for water use and agricultural production activities and intelligent control of water network system integrating intelligent control facilities and equipment. The report takes Hexi Corridor of Gansu province in Northwest China as an example to introduce the results of related research.

Water Security for the Lancang-Mekong River Basin

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Abstract: The Lancang-Mekong (LM) River is one of the most important international rivers originating from the Tibetan Plateau region. Water security is critical to support regional transboundary collaborations and sustainable development. This requires a systematic study on the evolution of river network, river flows and water resources in coupled human-natural systems at a river basin level. We have investigated the complex water systems for the LM river basin by integrating approaches of remote sensing (RS) techniques, hydrological models, and field surveys. RS-based methods are developed to detect historical evolution of river networks, lake inundation area, and water quality parameters, while a hydrological model is developed to simulate water resources within the river basin in the context of climate change and human activities. In this talk, case studies will be provided to demonstrate the evolution and driving forces for water resources of the LM river basin. One case is the detection and attribution of the evolution of the inundation area of the Tonle Sap Lake within the basin, which is also the largest lake is southeast Asia. Our results show that the inundation area was stable before 2000, followed by a significant shrinking trend between 2000 and 2018. The key driving force for this change is the precipitation in a region located in the lower basin of the Mekong River (mostly outside the drainage basin of Tonle Sap

Lake). The dams constructed in China only contributed little (6.9%) to the above change. Another case is the evolution of hydropower potential in the context of climate change. We demonstrate that global climate change will reduce hydropower potential in future with a reduction of around 10% (RCP2.6) and 20% (RCP6.0) for a warming of 1.5 ℃, and 56% (RCP6.0) for a warming of 2 ℃. Our results imply that climate change plays a key role in evolution of water resources in LM river basin. Water security policies need to explicitly take into account of climate change. In addition, integrated river basin management by involving all countries within the watershed is a key for future transboundary management and sustainability.

Key words: Lancang-Mekong River; international river; water resources; climate change