# LANCANG-MEKONG NEWSLETTER

## June 2020, No. 4

**Project Title:**
Climate Change and Water Resources in Great Rivers Region in Southeast and South Asia

**Principal Investigator:**

Deliang CHEN, University of Gothenburg, Sweden
Junguo LIU, Southern University of Science and Technology, China

**Participating Institutions:**

Southern University of Science and Technology
Institute of Tibetan Plateau Research, CAS
Institute of Atmospheric Physics, CAS
Institute of Geographic Sciences and Natural Resources Research, CAS
Beijing Normal University
University of Gothenburg

**Project Period:**

March 2018 – February 2023

**"Climate Change and Water Resources in Great Rivers Region in Southeast and South Asia"**

**Project Office**

# NEWS

## A brief guide for young scientist: online lecture “Navigating an academic career”



On 23rd June 2020, Prof. Junguo Liu, one of the project PIs and Chair Professor in Southern University of Science and Technology, invited Prof. Jeffrey McDonnell, a member of the International Advisory Board of the present project, to give a lecture to guide the early career for young scientist. Prof. Jeffrey McDonnell has been professor of hydrology and Associate Director of the Global Institute for Water Security at the University of Saskatchewan since 2012, and he is a fellow of the Royal Society of Canada. His work focuses on new ways to measure, understand and model streamflow generation processes. He has co-authored more than 300 articles on watershed hydrology and co-edited the Elsevier textbook “Isotope Tracers in Catchment Hydrology”. The online lecture focuses on the traits of successful scientists, e.g. how to communicate one’s work and how to navigate the first few years as a faculty member. It builds on a number of McDonnel’s recent working life articles in Science magazine and his Wiley book Navigating an Academic Career: A brief Guide for PhD Students, Postdocs and New Faculty. The lecture has attracted great attentions and aroused widespread concern.

His talk is available at

https://us02web.zoom.us/rec/share/y5VaHYnCrFJOHZ3k-k77ZrAhM6b-T6a803Uf-fclyBmbeOG5_2dxkvmAA11skGLF

# NEWS

## Teleconference of Water Diplomacy of the Mekong Basin: Toward a Shared Basin for Prosperity

A teleconference of the Water Diplomacy Project was held on May 22nd, 2020. Prof. Junguo Liu and two other group members Dr. Ganquan Mao and Dr. Kai Wang were invited to join. This project aims to promote collaborative research on water diplomacy with regional case studies and support decision-making in the Mekong River Basin. Partners will work together to publish working papers, articles, and book chapters that focus on typical case studies about water diplomacy platforms as well as the relationship between science and water. Revised structure of the project teams and schedules due to the impact of COVID-19 were approved during the conference. The online workshop and data-collection using the literature review will be adopted for further research methods, and many issues such as the format of the report and regional levels of case studies were clarified. Dr. PECH Sokhem and Dr. Lonn Pich Dara from CDRI, Dr. Watt Bottkosal from CNMC, Dr. Trond from PUC, Dr. Chem Phalla from NiDiR, Professor Carl from Chulalongkorn University, Mrs. Le Thi Huong from VNMC, and other research partners attended the conference.

SUSTech

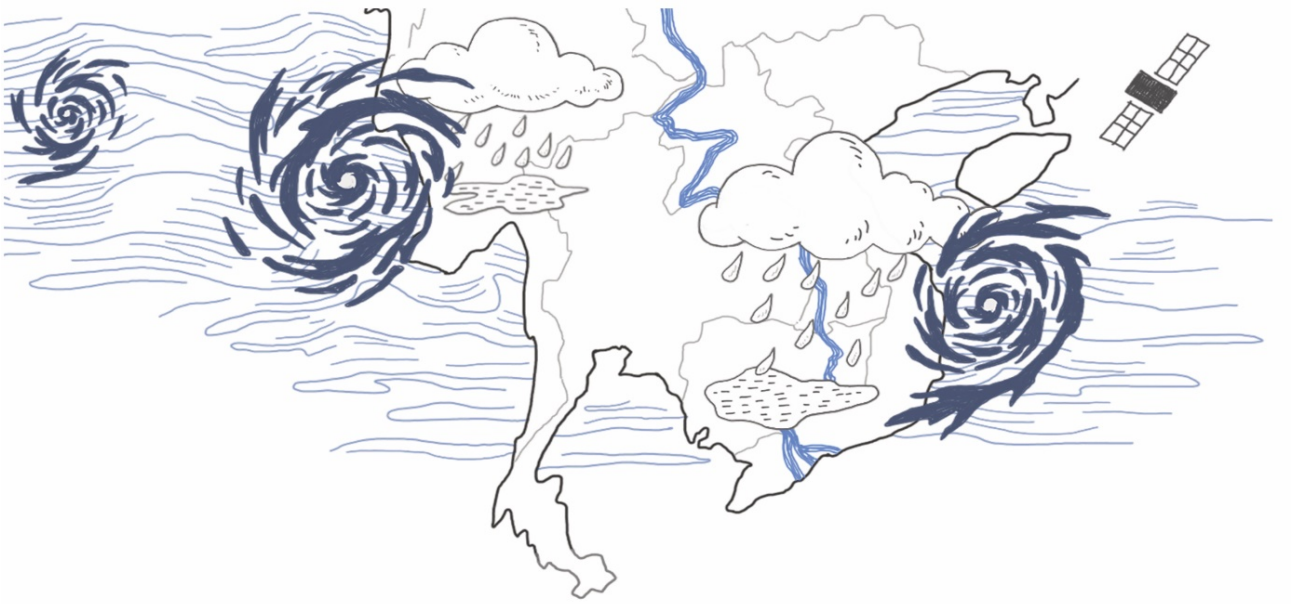
CDRI
Cambodia Development Resource Institute

# NEWS

## Aifang Chen, a core member of the project, has successfully defended her PhD thesis

12 June 2020, Aifang Chen has successfully defended her PhD thesis “Tropical cyclones associated high impact of extreme wind, heavy rainfall, and floods in the Mekong River Basin”. Aifang will start his next chapter in Beijing Normal University. Congratulations, Aifang!

Aifang Chen is a core member of the project, while one of her supervisors was the PI of the project, Prof. Deliang Chen. Her research topic is also very close to the project research framework.



Tropical cyclones are one of the most devastating natural hazards. Mekong River Basin has often been hit by tropical cyclones and suffered damages and losses. Located in the Southeast Asia, the Mekong River is the world’s 10th longest river, with 70 million inhabitants living in the basin. However, to what extent tropical cyclones impact on the Mekong River Basin? And how tropical cyclones will change in the future? A new dissertation from Aifang Chen strives to answer these questions.

# NEWS

As a consequence of global warming, tropical cyclones are predicted to occur with higher intensity. The intensity of tropical cyclones is a pivotal factor, because the intense tropical cyclones claimed for the majority of damages and losses. Advanced understanding of tropical cyclones and their impacts on society will provide insights useful for the estimation of tropical cyclone impacts in the future.

**How do tropical cyclones impact the Mekong River Basin?**

The findings show that tropical cyclones are crucial to extreme precipitation which often lead to floods. In the lower basin's riparian countries, about 24.6% of the floods are caused by tropical cyclones in 1985 – 2018. Moreover, tropical cyclone induced floods have resulted in relatively higher impacts on human mortality and displacement rates than the average of all the occurred floods.

"Flood protection measures like dikes and levees are important to prevent against floods. Countries, such as Myanmar and Cambodia, suffered more from floods, partly because of their low flood protections."


# NEWS

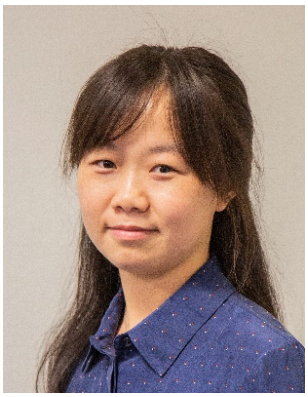
**How will the future tropical cyclone change in a warmer future?**

Collaborate with scientists from the United States, Aifang employed a downscaling technique with a specialized, coupled ocean/atmospheric model to estimate the future tropical cyclone activity. Results show that the future TC intensity is projected to increase in the Mekong River Basin, which is more prominent in areas closer to the coast.

“This will raise the future tropical cyclone related risk not only on the local, but also on the region and beyond, as the increasing tropical cyclone intensity may disrupt the local rice production, which is crucial to the global food market.”

Overall, findings from this thesis show that tropical cyclones have high impacts on society by causing heavy rainfall and floods; and the projected future rising TC intensity raises an alarm for the urgency of taking measures to mitigate potential impact of tropical cyclones on society.

**Link to thesis:** http://hdl.handle.net/2077/64068

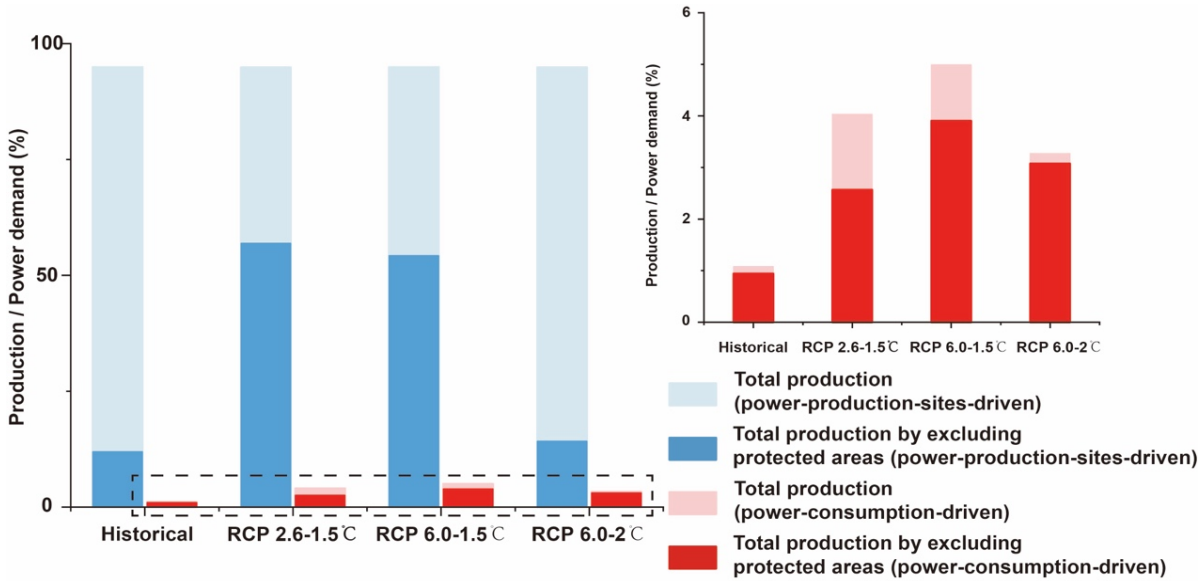


**Contacts:**
Aifang Chen, doctoral student at the Department of Earth Science
Phone number: +86-152-1010-6691
Email: aifang.chen@gu.se, aifchen@126.com

# RESEARCH

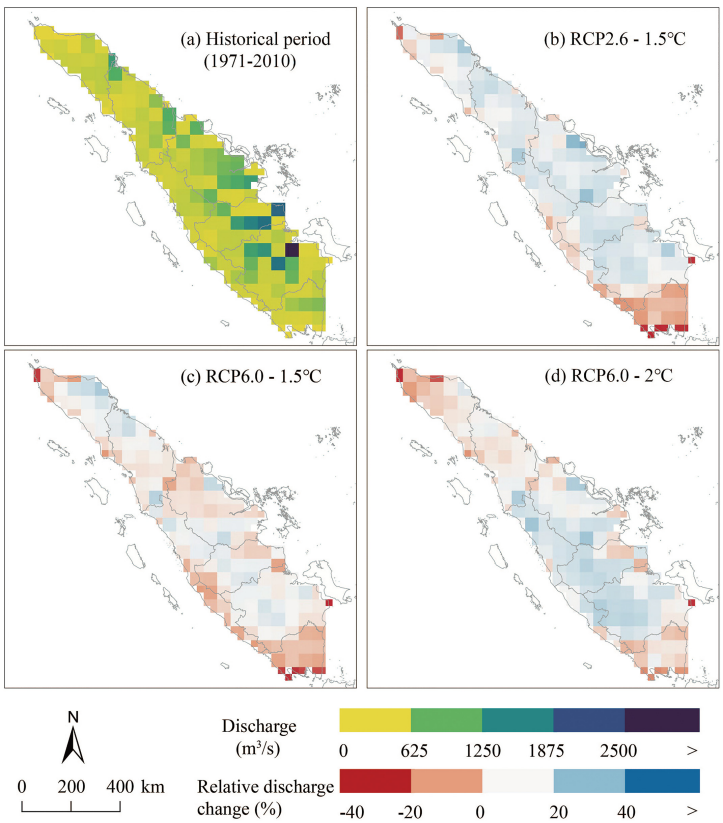
## Hydropower production benefits more from 1.5°C than 2°C climate scenario

A manuscript prepared by Prof. Junguo Liu's group entitled "Hydropower production benefits more from 1.5°C than 2°C climate scenario" was recently accepted by *Water Resources Research*, a top journal in the field of water resources. The study was led by Prof. Junguo Liu's group and cooperated with International Institute for Applied Systems Analysis (IIASA). It used a coupled hydrological and techno-economic model framework to assess hydropower production under global warming levels of 1.5°C and 2°C, while also considered gross hydropower potential, power consumption and economic factors. The results show that both global warming levels will have a positive impact on the hydropower production of a tropical island (Sumatra) relative to the historical period, however, the ratio of hydropower production versus power demand provided by 1.5°C of global warming is greater than that provided by 2°C of global warming under RCP6.0.




Generation of potential hydropower plants under the historical period and under the RCP2.6–1.5 °C, RCP6.0–1.5 °C, and RCP6.0–2 °C scenarios.

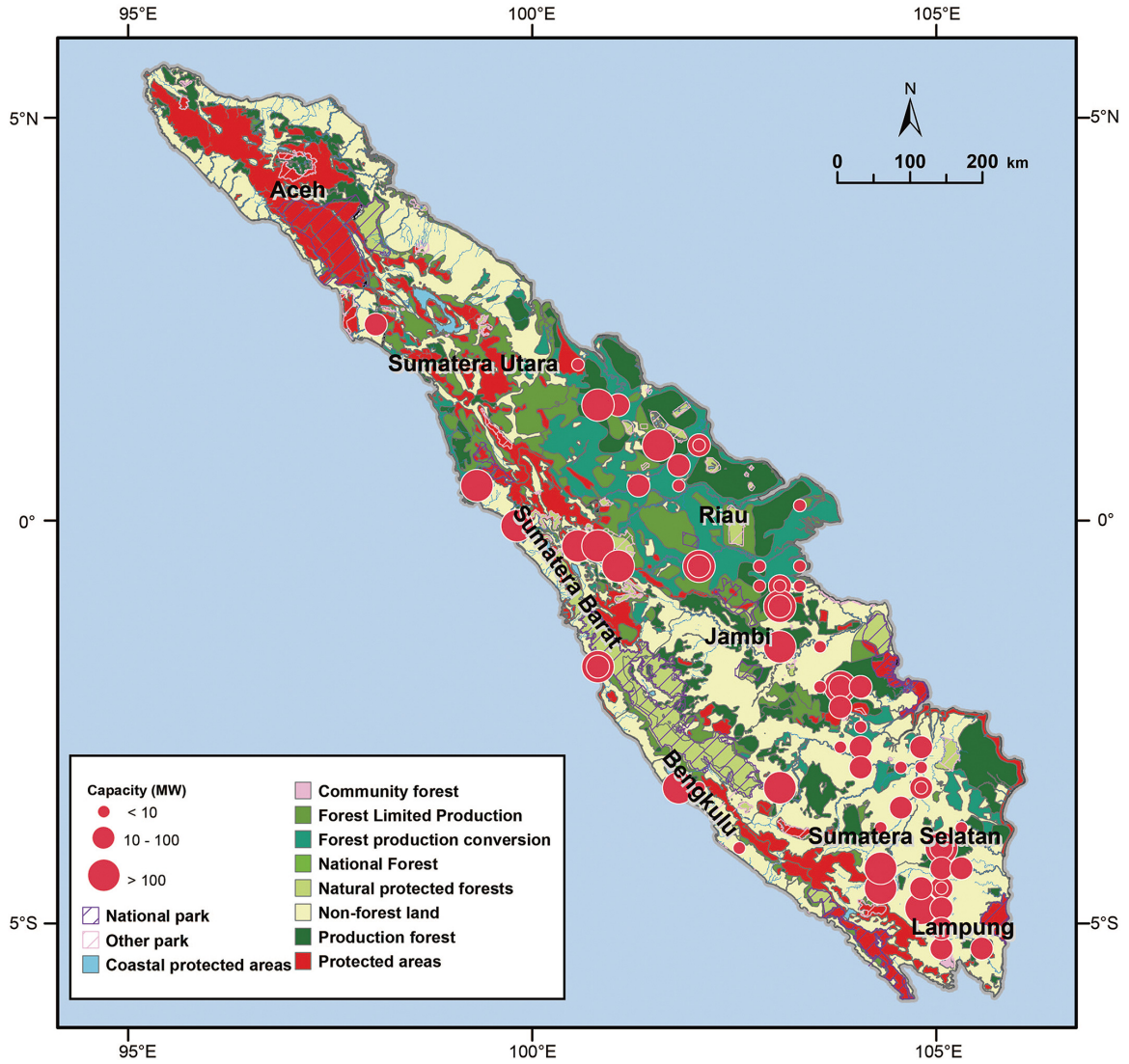
In addition, the reduction in $CO_2$ emissions under global warming of 1.5°C is greater than that under global warming of 2°C, which reveals that global warming decreases the benefits necessary to relieve global warming levels. Hydropower plays an important role as renewable and clean energy in the world's overall energy supply. Electricity generation from hydropower represented approximately 16.6% of the world's total electricity and 70% of all renewable electricity in 2015. Determining the different effects of 1.5°C and 2°C of global warming has become a hot spot in water resources research. This study investigated the influences of global warming levels of 1.5°C and 2°C on hydropower production in Sumatra, one of the Sunda Islands of western Indonesia, considering gross hydropower potential, power consumption and economic factors.




Daily mean discharge ($m^3/s$) simulated by PCR-GLOBWB for the historical period (1971–2010), and the differences in the daily mean discharge between the historical period and the 1.5 and 2 °C scenarios.

# RESEARCH

The study modeled and visualized optimal locations of hydropower plants and discussed hydropower production based on select hydropower plants and the reduction in carbon emission by using hydropower instead of fossil fuels. This study could significantly contribute to establishing a basis for decision making on energy security under 1.5°C and 2°C global warming scenarios.



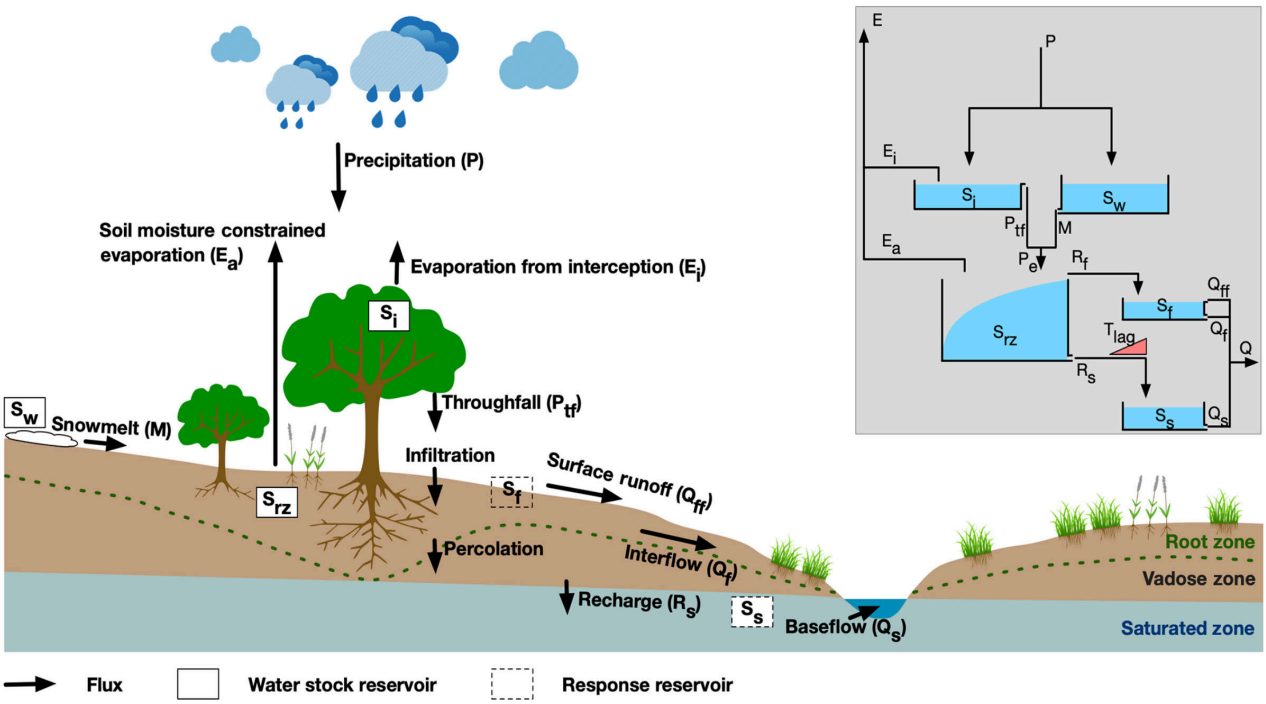

Optimal sites for hydropower plants excluding protected areas

The paper is available at the website of *Water Resources Research* https://agupubs.onlinelibrary.wiley.com/doi/abs/10.1029/2019WR025519?af=R

# RESEARCH

## Development of a large scale distributed hydrological model WAYS (Water And ecosYstem Simulator)

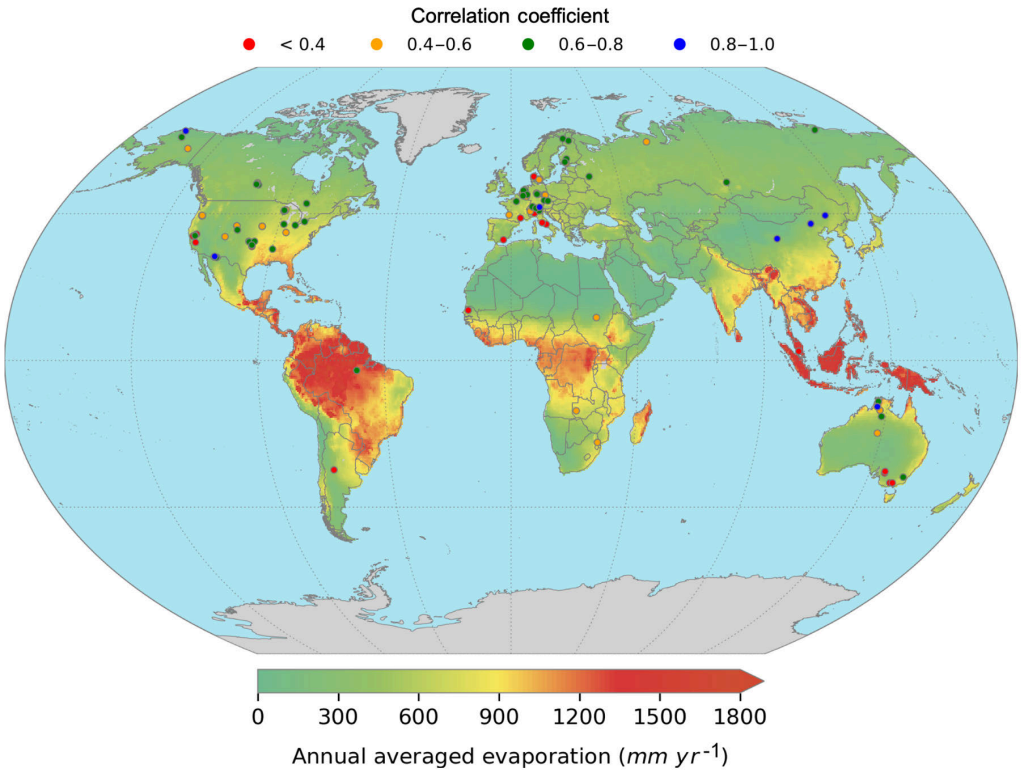
Hydrological models (HMs) are important tools for water cycle simulation and water resources assessment, which is also necessary for our project regarding the water related analysis in the Great Rivers Region (GRR) in southeast-south Asia. State-of-the-art HMs usually assuming the unsaturated soil layer or root zone layer are homogeneous with a certain depth, e.g. 100 cm. However, the plant rooting system varies spatially and the root depth can reach a depth of more than 30m. The relatively simple model structure for soil hydrology in current existing hydrological models could influence the hydrological cycles thus bring uncertainties to consequent impact studies.




Model structure of WAYS

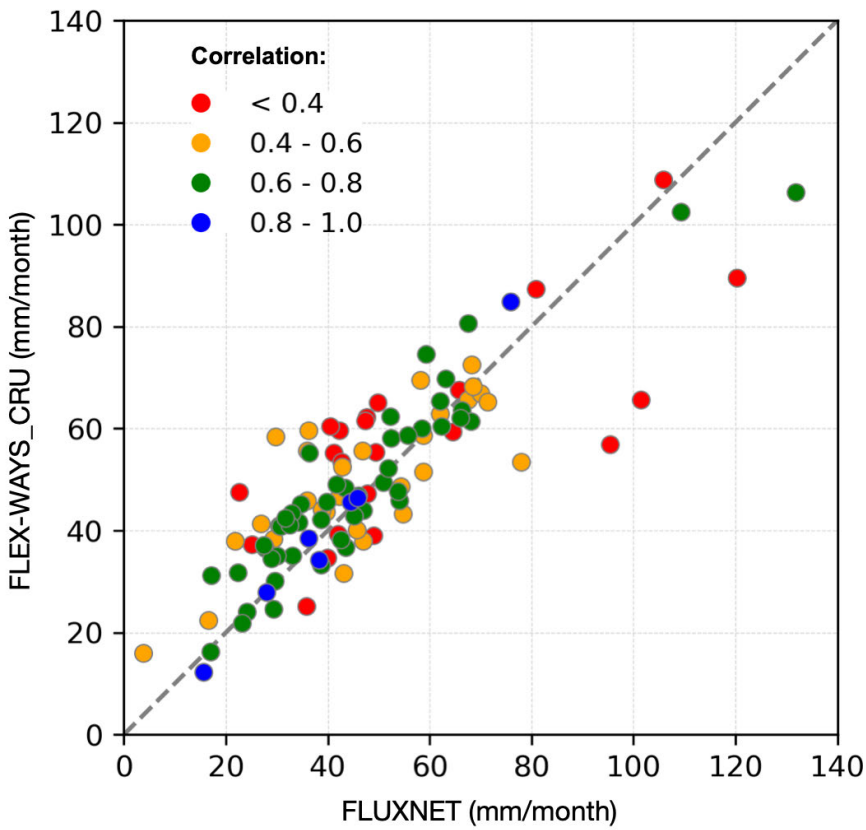
# RESEARCH

Under this background, the research team at SUSTech developed a novel distributed hydrological model, named WAYS (Water And ecosYstem Simulator), with Python 3.6 program language. Apart from the existing hydrological models, the WAYS model integrates a sophisticated soil hydrology structure into the model, which applies the root zone storage capacity to represent complex impacts of spatial heterogeneous plant rooting system on hydrological cycle. The water stored in the root zone controls the partitioning of the precipitation into evaporation, infiltration, and runoff in the model. The precise simulation of variables in the root zone by considering its spatial heterogeneity could benefit the simulation of other elements in the model, thus advancing the model simulation toward an advanced philosophy, i.e., obtaining the right answers for the right reasons rather than simply obtaining the right answers.




Averaged monthly evaporation of the WAYS simulation (WAYS_CRU) against the FLUXNET data

Moreover, the newly developed global hydrological model WAYS also improves the integrality of soil water simulation in hydrological models, as it is able to simulate the water stored in the entire root zone. This added-value feature could benefit many applications related to the root zone processes. For instance, the correct representation of root zone water storage (RZWS) could help researchers in the investigation of land–vegetation–climate–water integration, where RZWS plays a key role. The capability of RZWS simulation could also benefit the field of agriculture, as RZWS represents the plant-available water, which is closely linked to the crop yields.



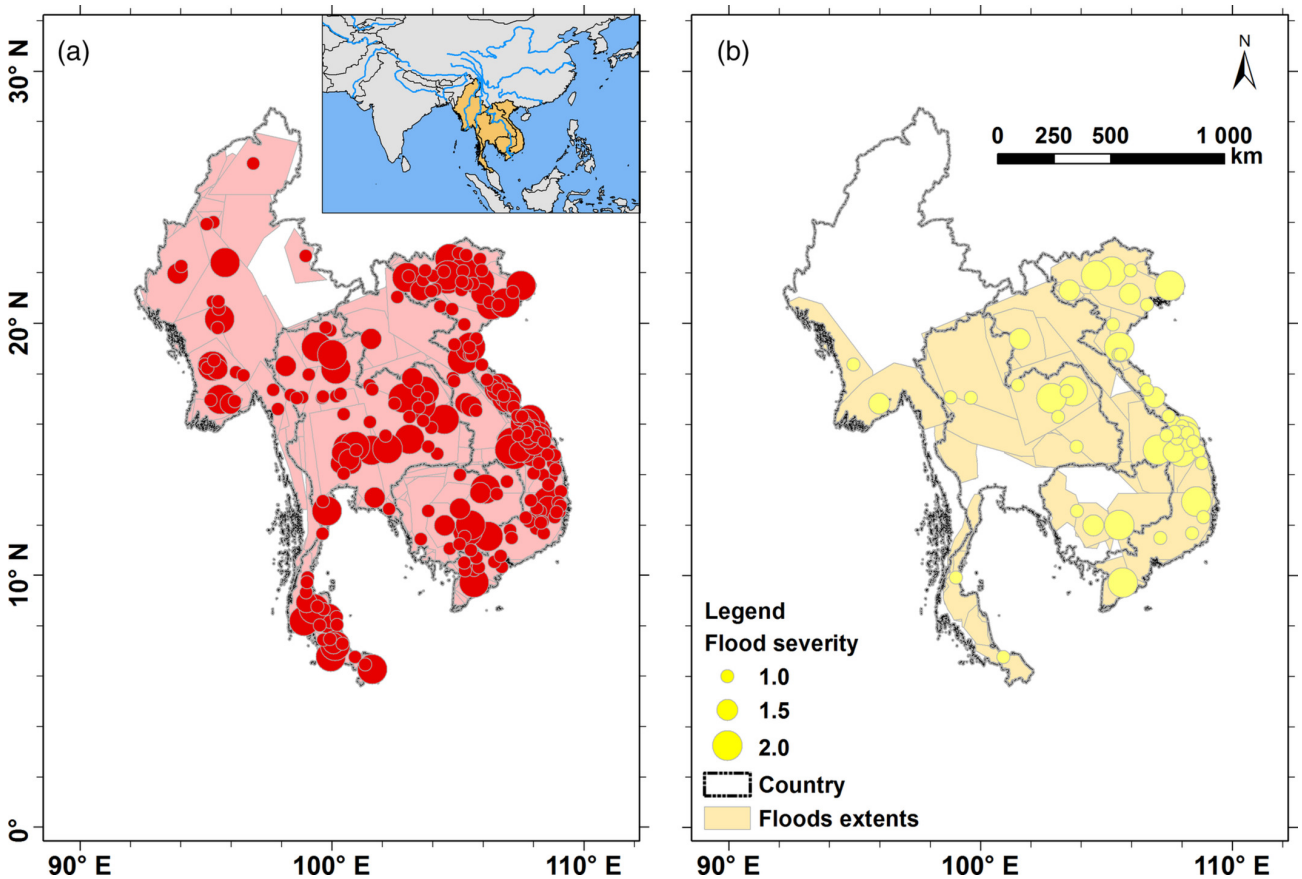

Averaged monthly evaporation of WAYS simulation (WAYS_CRU) against the FLUXNET data

The model description paper has been published on December 2019 in the journal *Geoscientific Model Development* (https://www.geosci-model-dev.net/12/5267/2019/).

# RESEARCH

## Flood impact on Mainland Southeast Asia between 1985 and 2018—The role of tropical cyclones

Floods in the Mainland Southeast Asia (MSEA) can be caused by heavy monsoon rainfall, tropical cyclones and dam breaks. A recent study conducted by the research group led by Prof. Deliang Chen reveals that tropical cyclone induced floods have higher impacts, compared with the average impact of all types of floods. Prof. Chen is one Co-PI for the project "Climate Change and Water Resources in the Great River Regions in Southeast and South Asia" under the CAS Pan-TPE programme, and the August Röhss Chair at the University of Gothenburg.

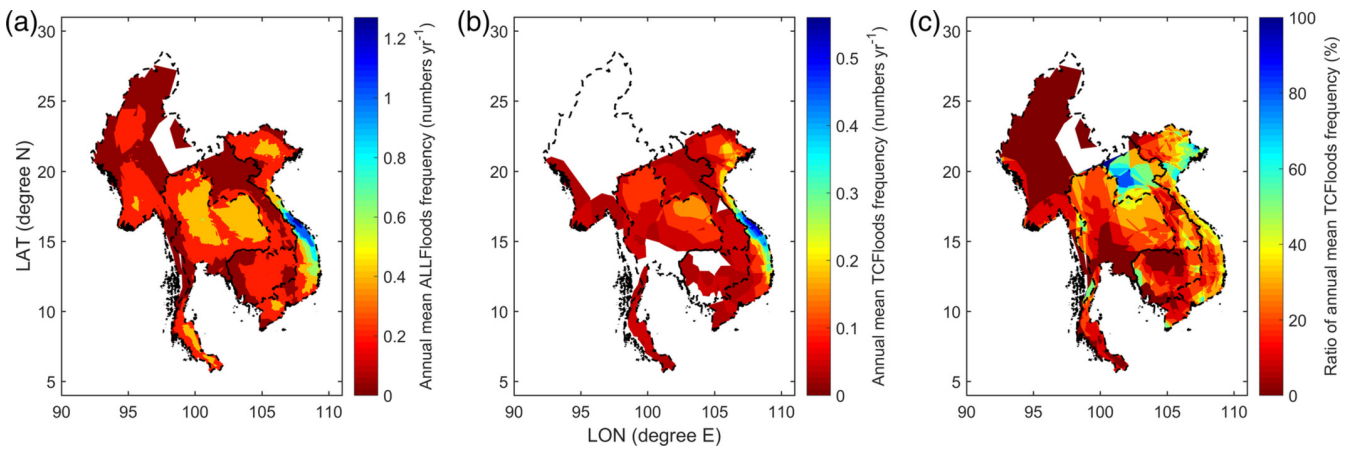



Spatial extent of floods and severity in the Mainland Southeast Asia in 1985–2018

# RESEARCH

The MSEA consists of five countries: Cambodia, Laos, Myanmar, Thailand and Vietnam, and landfalling tropical cyclones in the MSEA can induce severe flooding by the associated intense rainfall. Employing the Dartmouth Flood Observatory large flood data archive (http://floodobservatory.colorado.edu/Archives/index.html). This study estimates spatiotemporal change of occurrence and impacts of floods by all possible causes (ALLFloods) in the MSEA, and quantifies the contribution from tropical cyclone induced floods (TCFloods).

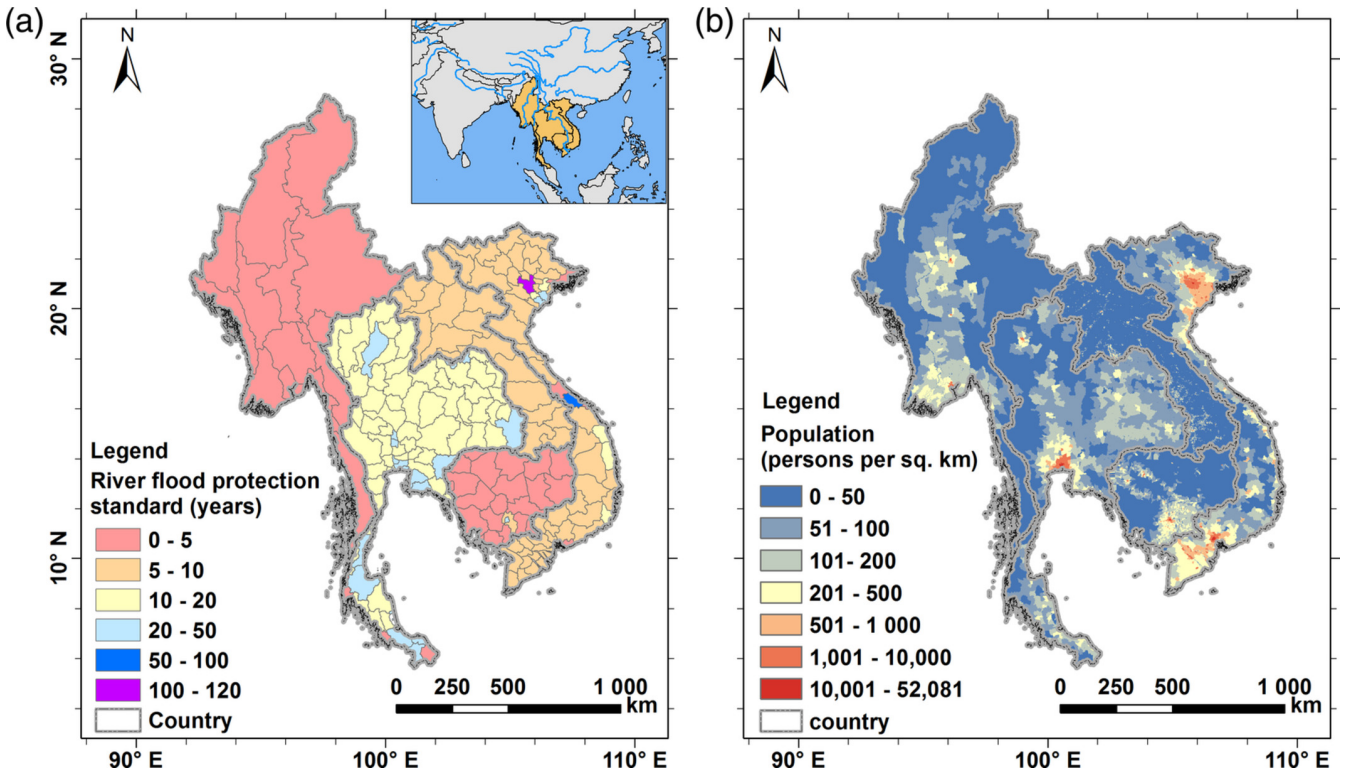
Overall, ALLFloods have increased significantly during 1985 – 2018, while no significant change is found for TCFloods. However, ALLFloods' (TCFloods') impacts on human mortality have generally decreased significantly during 1985 – 2018 (1988 – 2018), although high-impact floods did occasionally occur. About 24.6% of all floods are caused by tropical cyclones; and TCFloods have higher impacts on human mortality and displacement rate than the average of ALLFloods.




Spatial pattern of annual mean flood frequency in the Mainland Southeast Asia for 1985–2018

# RESEARCH

Flood protection standards vary in the MSEA, which has implications for flood-induced mortalities. Higher flood impacts are found in Myanmar, which is at least partly caused by its relatively low flood protection standards. As previous studies from the research group projected rising future intensity of tropical cyclones influencing this area (Chen et al. 2020 Science Bulletin), results of this study point to increased flood risks associated with tropical cyclone in the MSEA. The article was featured by PreventionWeb, the global knowledge sharing platform on disaster risk reduction, managed by the UN Office for Disaster Risk Reduction (UNDRR).




Spatial pattern of flood protection standards and population count in the Mainland Southeast Asia.

The results were published in the Journal of Flood Risk Management. Full article link: https://doi.org/10.1111/jfr3.12598

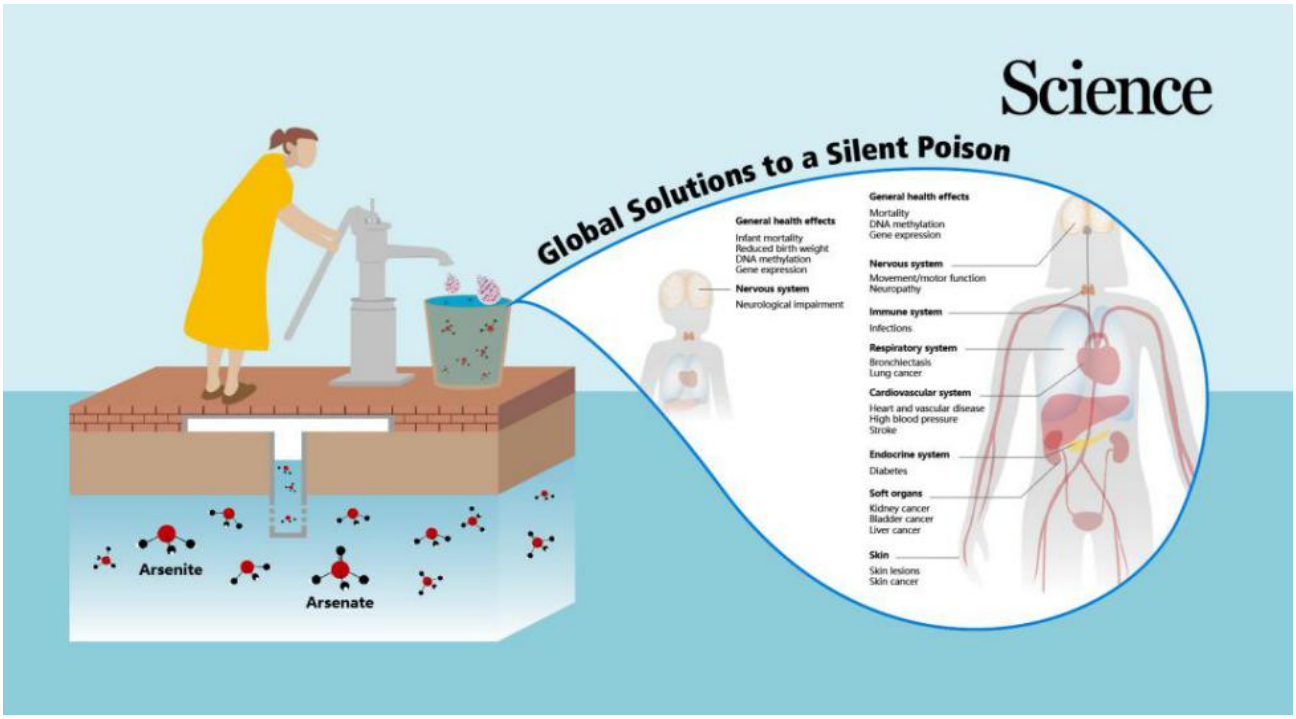
# RESEARCH

## Global Solutions to a Silent Poison

In 2010 the U.N. agreed to a resolution declaring the human right to "safe and clean drinking water and sanitation." The safety of drinking water is a vital issue for many communities around the world. Chair Professor Yan Zheng, School of Environmental Science and Engineering from Southern University of Science and Technology (SUSTech) was invited to publish a perspective article, titled "Global Solutions to a Silent Poison" in Science (IF = 37.2). Her article accompanied "Global Threat of Arsenic in Groundwater" by Joel E. Podgorski and Michael Berg of the Swiss Federal Institute of Aquatic Science and Technology

Prof. Yan Zheng is collecting domestic drinking water in Cambodia

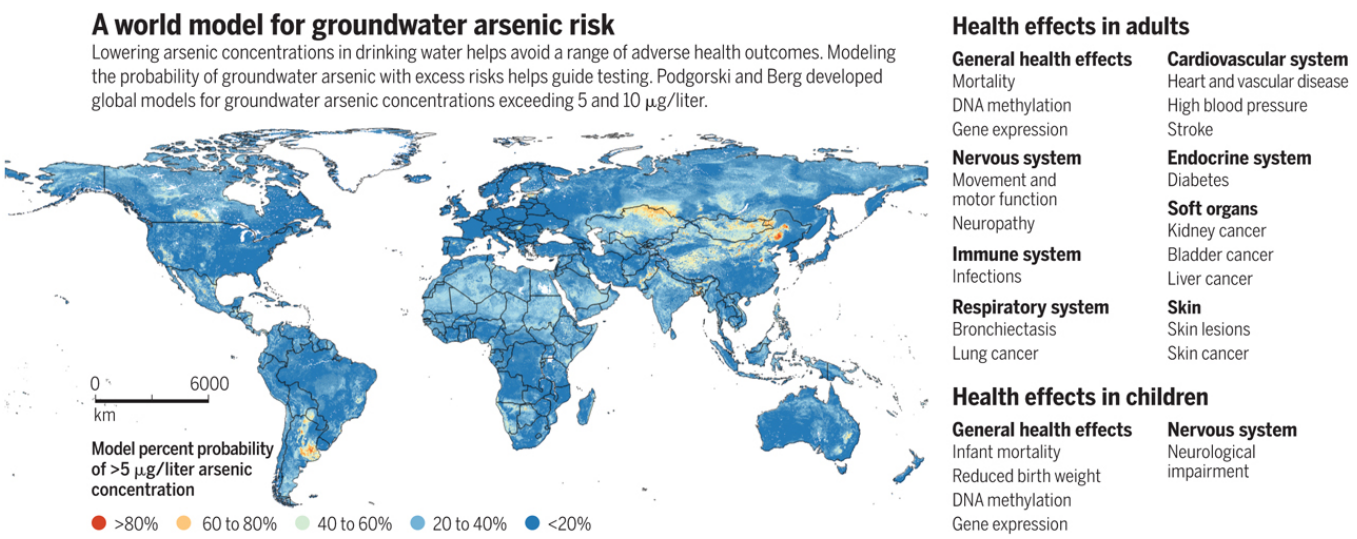
Zheng had previously covered this issue in a paper she wrote with her former student Sara V Flanagan (Columbia University) and former colleague Richard B Johnston (now with the World Health Organization). Their paper was titled "Arsenic in tube well water in Bangladesh: health and economic impacts and implications for arsenic mitigation." That paper was published in the Bulletin of the World Health Organization (IF = 6.8). In that paper, the authors found that 45 million people were drinking well water containing unsafe levels of arsenic. It was leading to 1 death in every 18 adult deaths (about 6%). Yet, incomplete data meant that global information on this problem was highly inconsistent.




The health impact of InAs exposure on adults and children

# RESEARCH

Zheng's article in *Science* also looked at the most recent WHO provisional guideline values for drinking water at ten micrograms of inorganic arsenic per liter. It is encouraging that many countries have revised their drinking water standard down from 50 micrograms per liter, with several adopting more health-protective five micrograms as their standards. However, in Bangladesh, and parts of India, and even China, the less health-protective 50 microgram standard is still permitted for dispersed rural population due to the lack of high-quality water sources.




A world model for groundwater arsenic risk

The diverse range of standards is highly concerning, given that inorganic arsenic is highly toxic. It has been listed as a class I carcinogen by the International Agency for Research on Cancer for many years. Its colorless, tasteless and odorless nature, when dissolved in water, has given it the unfortunate title of "the king of poisons" and "the poison of kings."

# RESEARCH

Long-term exposure of inorganic arsenic has been shown to affect the development of the fetus and infants, with long-lasting effects later in life. Plenty of studies have shown adverse health effects on many parts of the human body, possibly involving the epigenome as a mechanism of inorganic arsenic's toxicity.

In closing her article, Yan Zheng emphasizes the desperate need to screen for arsenic in domestic wells, particularly in predicted high-risk areas. The development of sensitive, reliable, inexpensive, and user-friendly testing methods will improve screening methodologies while identifying exposed populations. It is also cheaper to minimize the impact of arsenic through prevention, rather than treat the impact of arsenic exposure.

The results were published in the *Science*. Full article link: https://science.sciencemag.org/content/368/6493/818.full

# Publications

## Selected Publications Since September 2019

- Ying Meng, Junguo Liu, Sylvain Leduc, Sennai Mesfun, Florian Kraxner, Ganquan Mao, Wei Qi, Zifeng Wang. Hydropower Production Benefits More From 1.5 °C than 2 °C Climate Scenario. *Water Resources Research*, 2020, 56(5):e2019WR025519.
- Ganquan Mao, Junguo Liu. WAYS v1: a hydrological model for root zone water storage simulation on a global scale. *Geoscientific Model Development*, 2019, 12:5267–5289.
- Aifang Chen, Kerry A.Emanuel, Deliang Chen, Changgui Lin, Fuqing Zhang. Rising future tropical cyclone-induced extreme winds in the Mekong River Basin. *Science Bulletin*, 2020, 65(5):419-424.
- Yan Zheng. Global solutions to a silent poison. *Science*, 2020, 368 (6493):818-819.
- Zhenzhong Zeng, Alan D. Ziegler, Timothy Searchinger, Long Yang, Anping Chen, Kunlu Ju, Shilong Piao, Laurent Z. X. Li, Philippe Ciais, Deliang Chen, Junguo Liu, Cesar Azorin-Molina, Adrian Chappell, David Medvigy and Eric F. Wood， A reversal in global terrestrial stilling and its implications for wind energy production. *Nature Climate Change*, 2019, 9:979-985.

# Publications


- Qiuhong Tang, Cuo Lan, Fengge Su, Xingcai Liu, He Sun, Jin Ding, Lei Wang, Guoyong Leng, Yongqiang Zhang, Yanfang Sang, Haiyan Fang, Shifeng Zhang, Dongmei Han, Xiaomang Liu, Li He, Ximeng Xu, Yin Tang , Deliang Chen. Streamflow change on the Qinghai-Tibet Plateau and its Impacts. *China Science Bulletin*, 2019, 64:2807–2821

- Qiuhong Tang, Xingcai Liu, Yuanyuan Zhou, Jie Wang, Xiaobo Yun. Cascading Impacts of Asian Water Tower Change on Downstream Water Systems. *Bulletin of Chinese Academy of Sciences*, 2019, 11.

- Lian Feng, Yanhui Dai, Xuejiao Hou, Yang Xu, Junguo Liu, Chunmiao Zheng. Unrealistic phytoplankton bloom trends in global lakes derived from Landsat 9 measurements. *EarthArXiv*, 2020.

- Wei Qi, Junguo Liu. Studies on changes in extreme flood peaks resulting from land-use changes need to consider roughness variations. *International Association of Scientific Hydrology Bulletin*, 2019, 64(16):2015-2024.

- Junguo Liu, Dandan Zhao, Ganquan Mao, Wenhui Cui, He Chen, Hong Yang. Environmental Sustainability of Water Footprint in Mainland China, *Geography and Sustainability*, 2020, 1(1):8-17.


# Publications

- Tinghai Ou, Deliang Chen, Xingchao Chen, Changgui Lin, Kun Yang, Hui-Wen Lai, Fuqing Zhang. Simulation of summer precipitation diurnal cycles over the Tibetan Plateau at the gray-zone grid spacing for cumulus parameterization. *Climate Dynamics*, 2020, 54:3525–3539 .
- Chaoyue Li, Haiyan Fang. Variation trend and the influencing factors of runoff and sediment flux in the Mun River Basin, Thailand. *Chinese Journal of Applied Ecology*, 2020, 31(2):590-598.
- Wen Wu, Jifu Liu, Lanlan Guo, Xhifei Deng. Methodology and Assessment of Proxy-Based $V_{s30}$ Estimation in Sichuan Province, China. *International Journal of Disaster Risk Science*, 2020, 11:1-12.
- Lyubing Zhang Michela Pacifici Binbin V. Li Luke. Drought vulnerability among China's ungulates and mitigation offered by protected areas. *Conservation Science and Practice*, 2020, 2:e177.
- Mengfei Mu, Qiuhong Tang, Songjun Han, Xiaomang Liu, Huijuan Cui. Using GRanD Database and Surface Water Data to Constrain Area–Storage Curve of Reservoirs. *Water*, 2020, 12:1242.
- Chenwei Shen, Qingyun Duan, Wei Gong, Yanjun Gan, Zhenhua Di, Chen Wang, Shiguang Miao. An Objective Approach to Generating Multi-Physics Ensemble Precipitation Forecasts Based on the WRF Model. *Journal of Meteorological Research*, 2020, 34(3):1–20.

# Publications


- Xian Zhu, Zhigang Wei, Wenjie Dong, Zhenming Ji, Xiaohang Wen, Zhiyuan Zheng, Dongdong Yan, Deliang Chen. Dynamical downscaling simulation and projection for mean and extreme temperature and precipitation over central Asia. *Climate Dynamics*, 2020, 54:3279–3306.
- Yafeng Zhang, Bin He, Lanlan Guo, Daochen Liu. Differences in Response of Terrestrial Water Storage Components to Precipitation over 168 Global River Basins. *Journal of Hydrometeor*, 2019, 20(9):1981–1999.
- Kailun Gao, Anmin Duan, Deliang Chen, Guoxiong Wu. Surface energy budget diagnosis reveals possible mechanism for the different warming rate among Earth's three poles in recent decades. *Science Bulletin*, 2019, 64:1140-1143.
- Yan Wang, Kun Yang, Xu Zhou, Binbin Wang, Deliang Chen, Hui Lu, Changgui Lin, Fuqing Zhang. The Formation of a Dry-Belt in the North Side of Central Himalaya Mountains. *Geophysical Research Letters*, 2019, 46:2993-3000.


# Contact Us

## The Contact Information:


**Address:**
School of Environmental Science and Engineering, Southern University of Science and Technology, Shenzhen, P.R. China

**Phone: 0755-88018012**

**Email:** liujg@sustech.edu.cn

**Web:** http://www.lancang-mekong.net