

# Challenges in water security and sustainability: water culture and adaptation

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Regional Steering Committee for Asia and Pacific of UNESCO-IHP

National Key Laboratory of Water Disaster Prevention

# Contents

**1**

**Background**

**2**

**China's water culture**

**3**

**IHP-IX strategic plan**

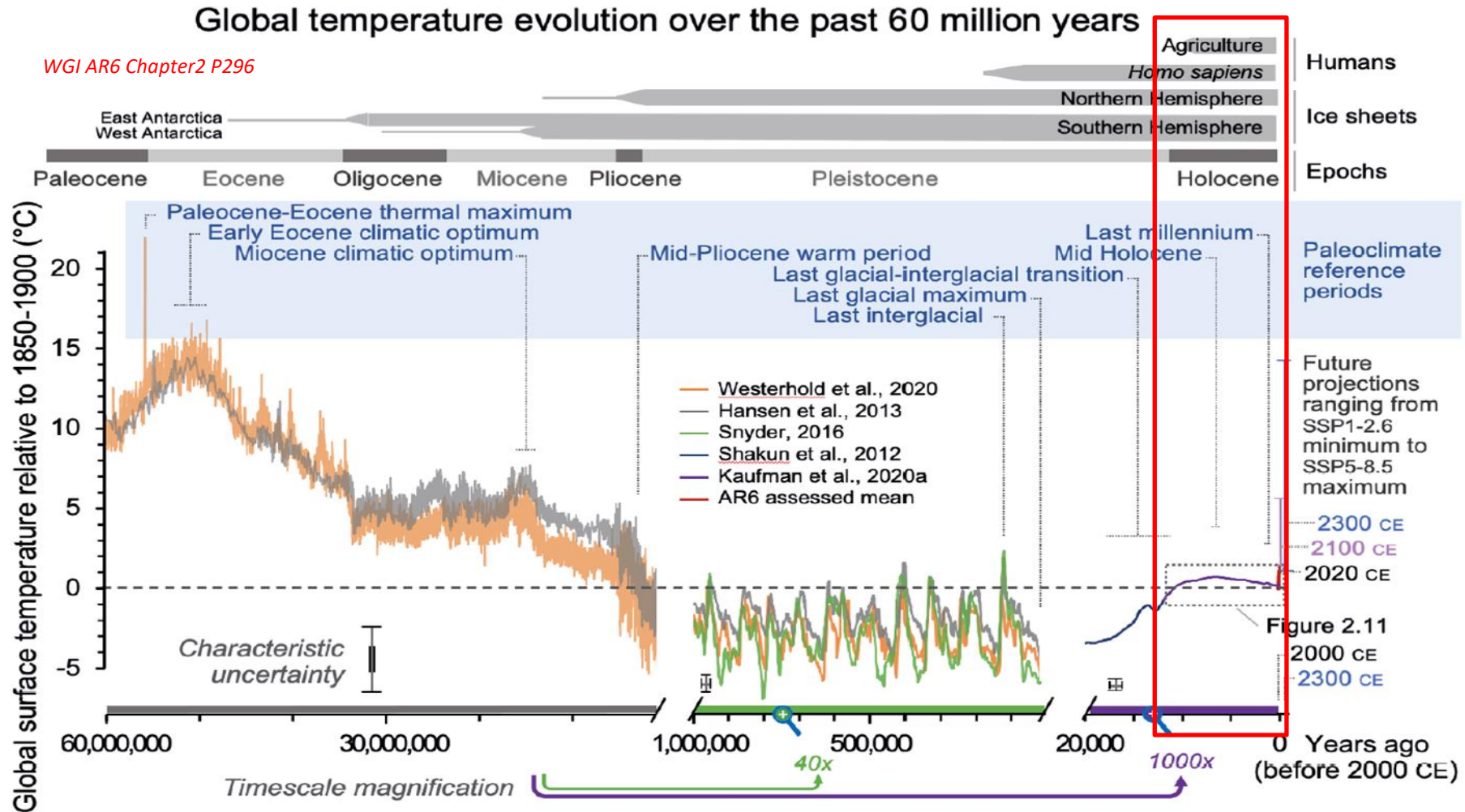
**4**

**Advances to SDGs**

**5**

**Summary**

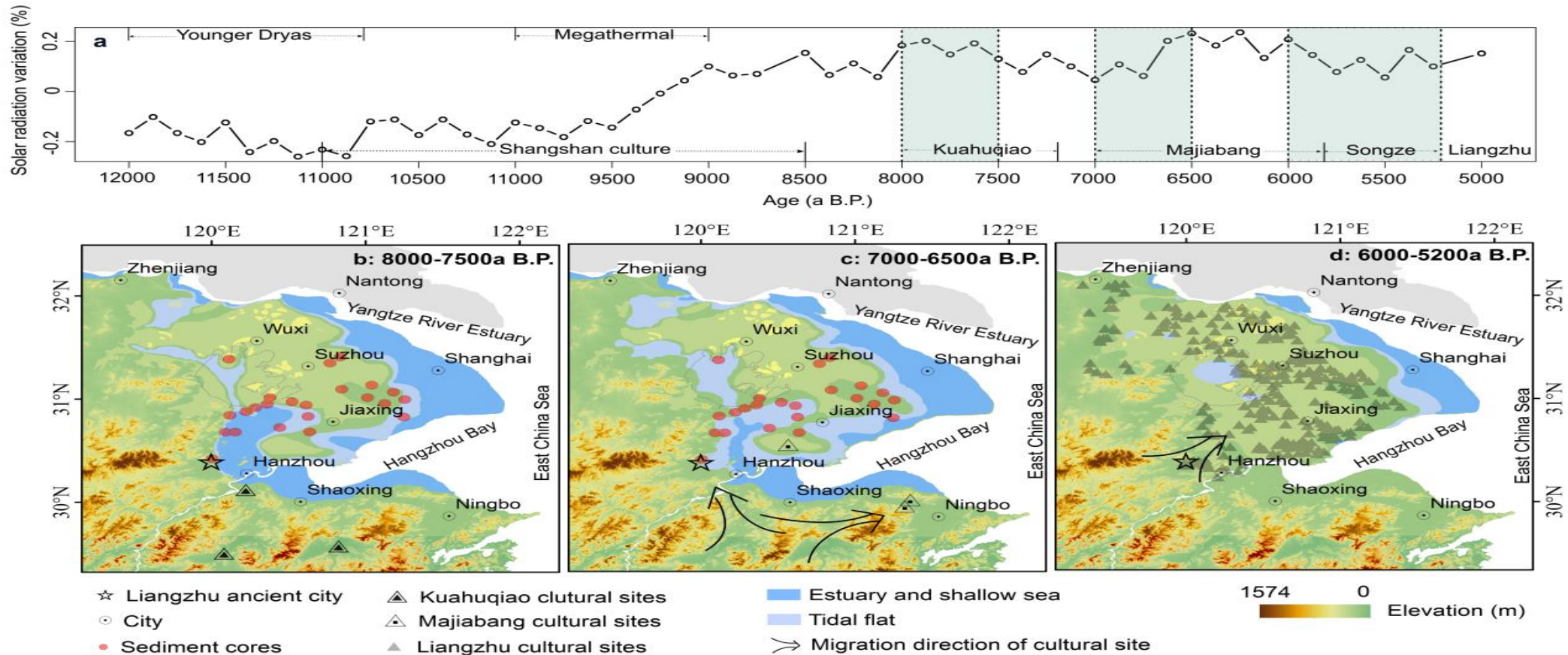
# Background



Since 10,000 BC, there has been a warm period in the temperature, which began to breed human civilization

# Background

- ❑ Solar radiation showed periodic oscillation between 8.5 kyr and 5.0 kyr, and the sea level is basically stable
- ❑ Promoting the development of Kuahuqiao, Majiabang, Songze, and Liangzhu cultures during middle Holocene





# Background

Since ancient times, the development of water conservancy projects has been an effective way to deal with water issues



~3000 BC

Liangzhu Dams



486 BC

Beijing-Hangzhou Grand Canal



256 BC

The Dujiangyan irrigation system



Three Gorges Dam

South-to-North Water Diversion Project

~3700 BC

Hemudu Well



~ 2000 BC

DaYu Changing blocking into dredging



214 BC

Ling Canal

recent period

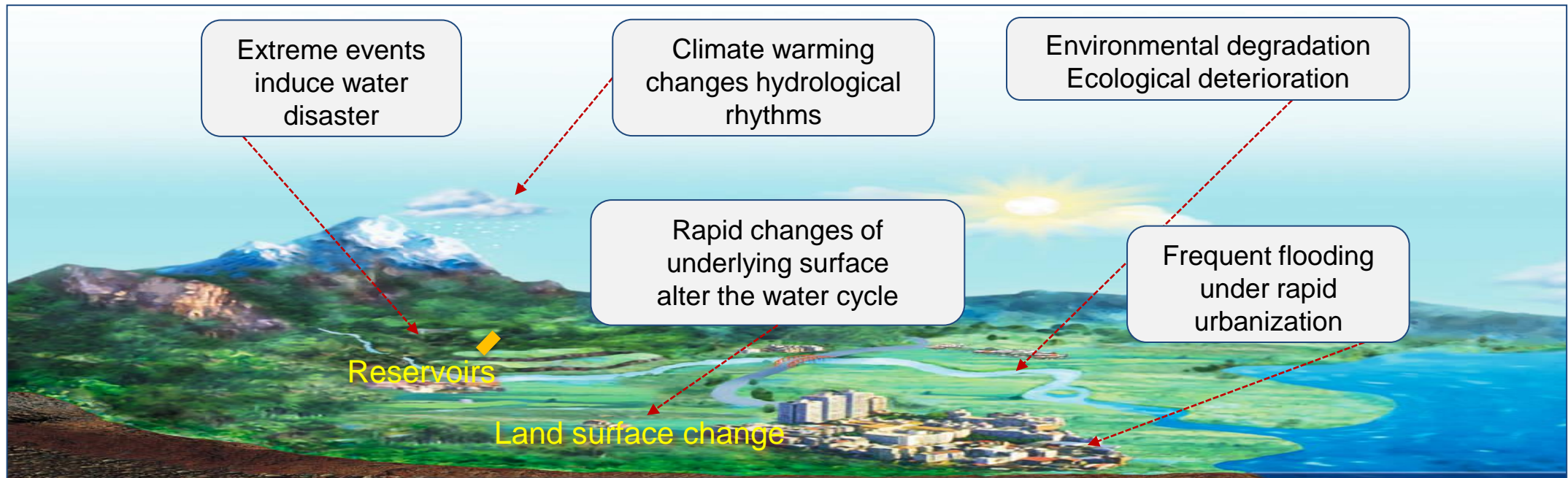
Pumping Well



Mechanization & Automation

# Background

In recent years, extreme events have become more frequent, and the water sustainable development is facing new challenges



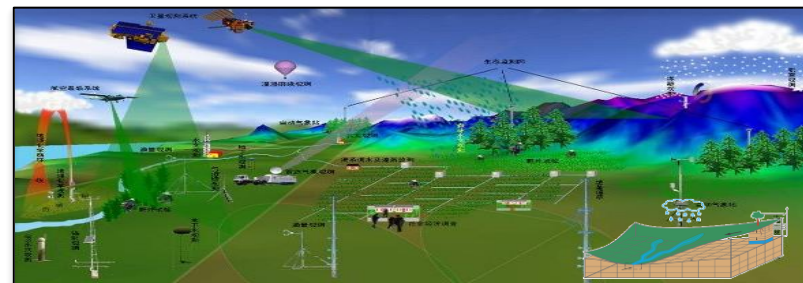
**nature** International weekly journal of science

The impacts of climate change on water resources and agriculture in China

Shilong Piao<sup>1</sup>, Philippe Ciais<sup>2</sup>, Yao Huang<sup>3</sup>, Zehao Shen<sup>4</sup>, Shushi Peng<sup>5</sup>, Junsheng Li<sup>6</sup>, Liping Zhou<sup>1</sup>, Hongyan Liu<sup>7</sup>, Yuecun Ma<sup>8</sup>, Yihui Deng<sup>9</sup>, Pierre Friedlingstein<sup>10</sup>, Chunshen Liu<sup>11</sup>, Kun Tan<sup>12</sup>, Yongqiang Yu<sup>13</sup>, Tianyi Zhang<sup>14</sup> & Jingyun Fang<sup>15</sup>

China is the world's most populous country and a major emitter of greenhouse gases. Consequently, much research has...

**Climate change affects the water cycle threatens water security**



**Science**

Global Water Resources: Vulnerability from Climate Change and Population Growth  
Charles J. Vörösmarty, et al.  
Science 289, 284 (2000); DOI: 10.1126/science.289.5477.284

**Global Water Resources: Vulnerability from Climate Change and Population Growth**  
Charles J. Vörösmarty,<sup>1,2,4,\*</sup> Pamela Green,<sup>1,2,4</sup>

The future of environmental changes have increased regional water resource vulnerability



# Background

## FLOODS

Mprongu, Zambia (May, 2021)



Dakar, Senegal (August, 2021)



Ba an, Burma (July, 2018)



Zhengzhou, China (July, 2021)



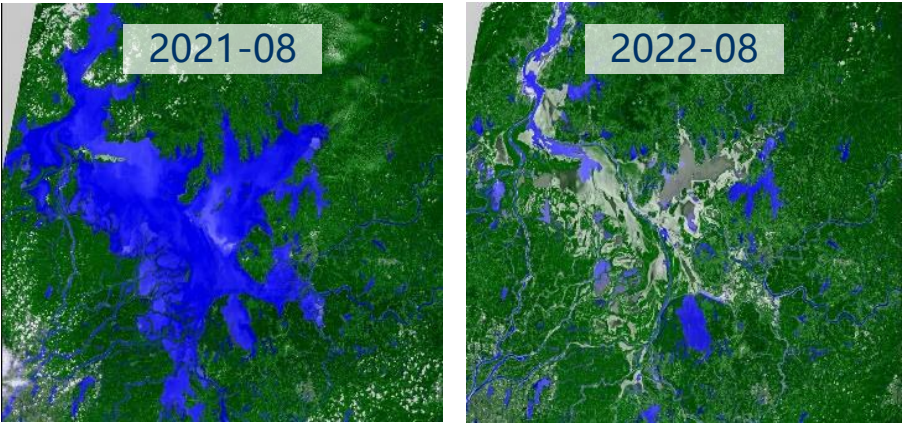


## DROUGHTS

Livingstone, Zambia (March, 2020)



Jiangxi, China (August, 2022)



Lekipia, Kenya (March, 2017)

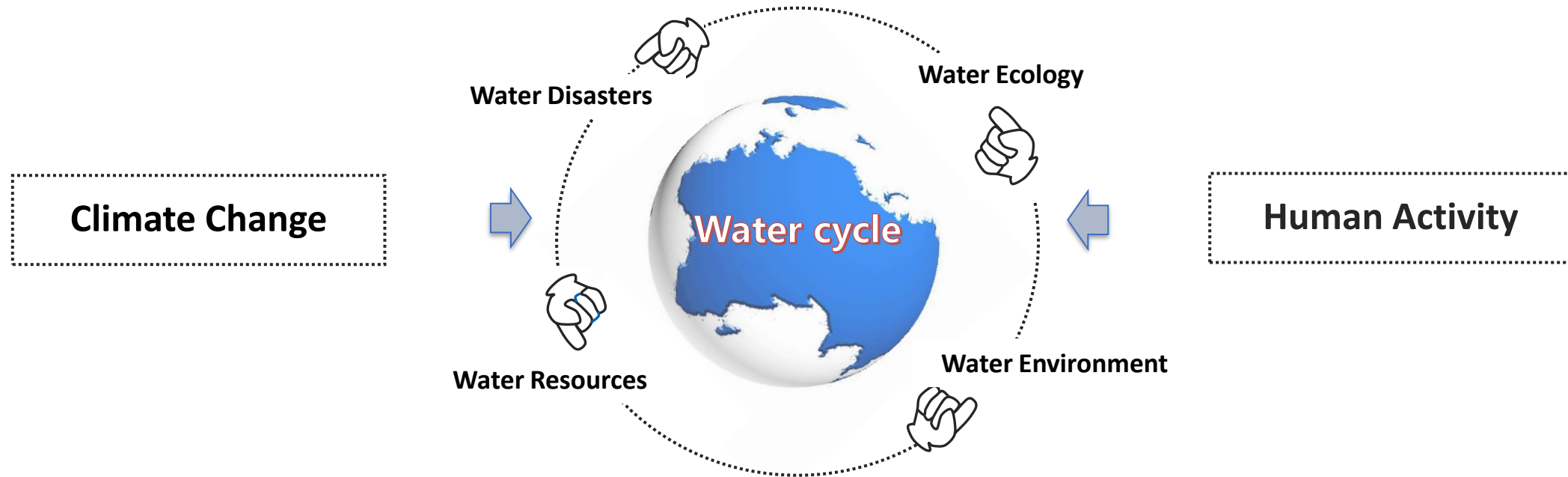


Utrecht, Netherlands (August, 2018)





# Background

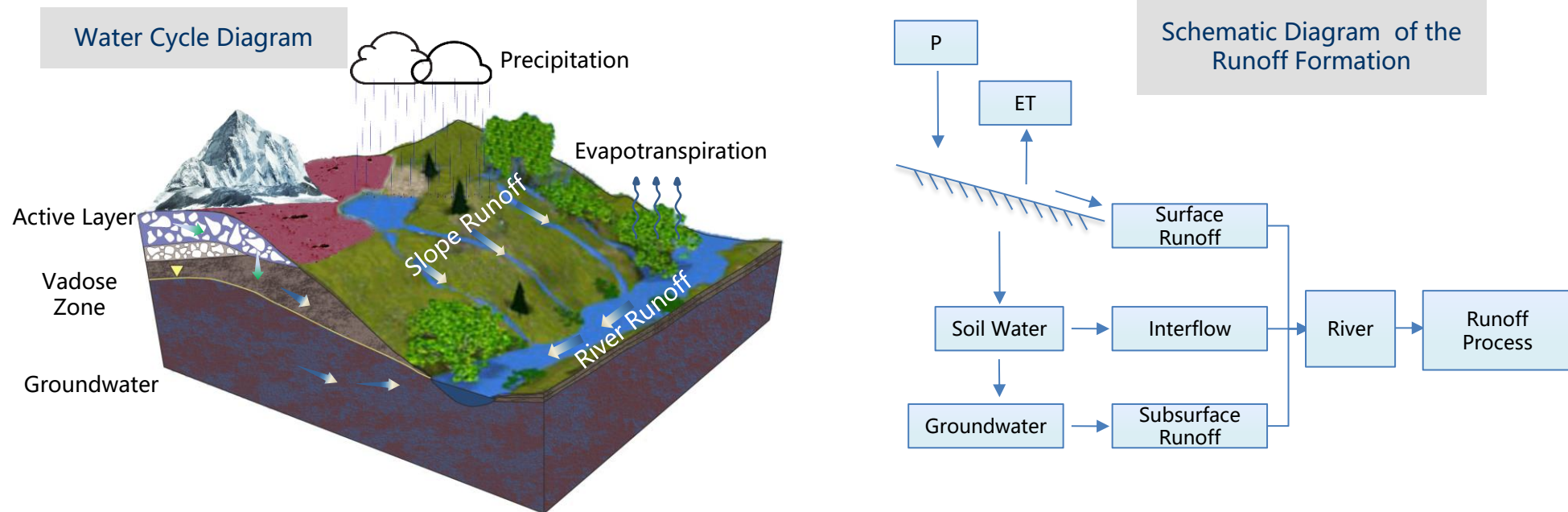


- ❑ In general, climate change intensified the spatiotemporal variation of hydrological processes. Intensive human activities altered the natural hydrological rhythm
- ❑ Flood, drought, water resources, water environment and other issues are prominent



# Background

It is urgent to pay more attentions to the water security and sustainability, and to develop solutions of water problems in a changing environment

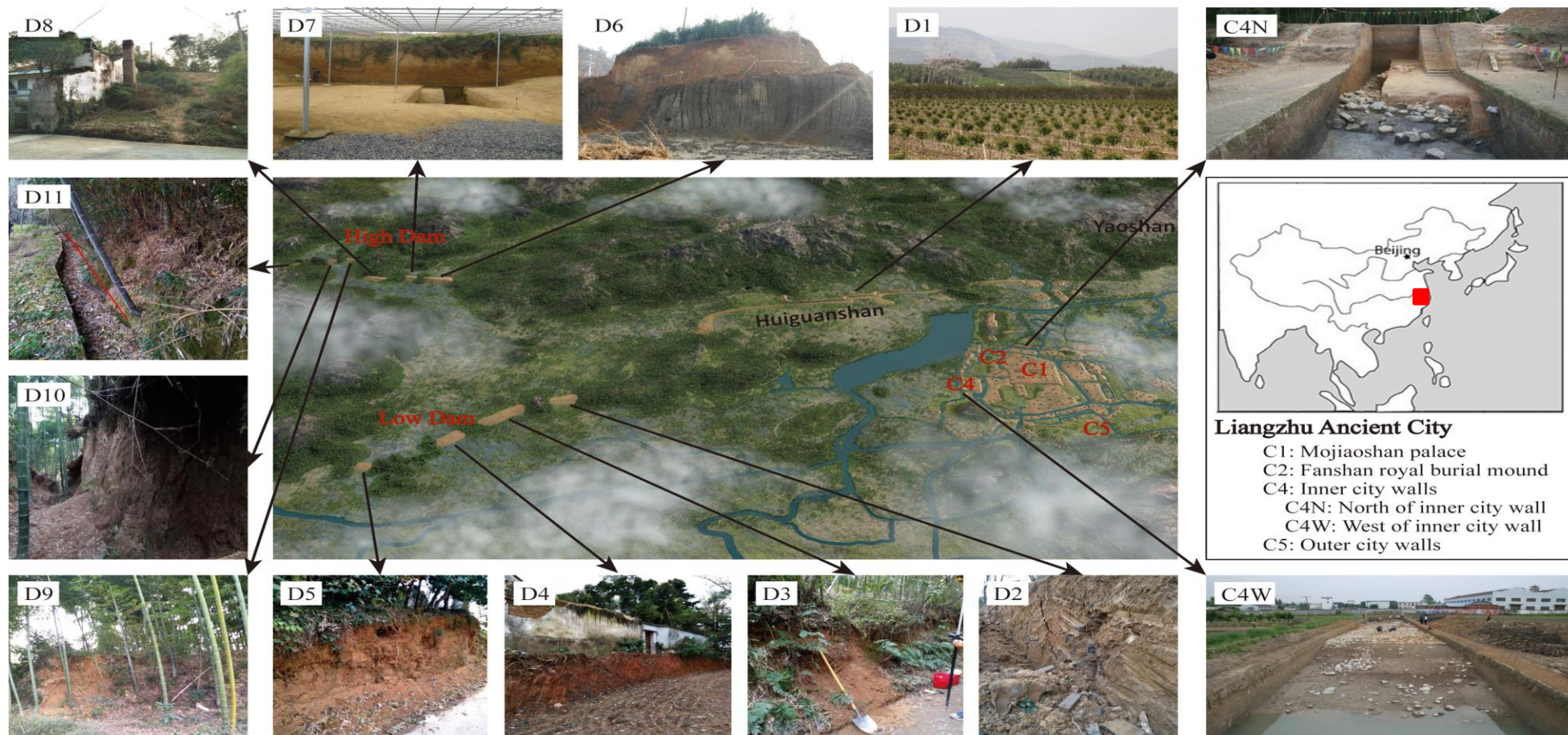


Watershed hydrologic processes: rainfall, runoff, soil water flow, baseflow, streamflow



# China's water culture -- Liangzhu culture

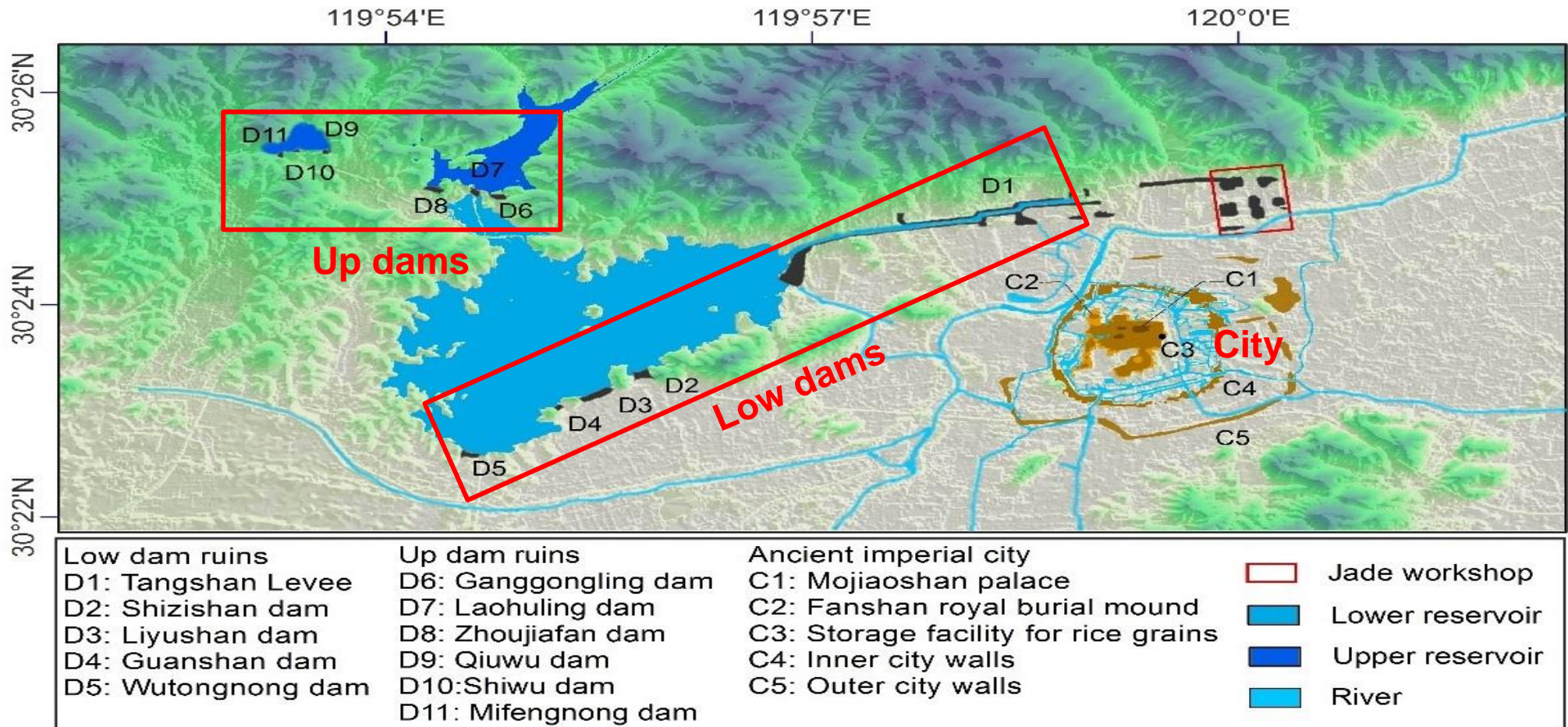
- ❑ The recently excavated Liangzhu hydraulic system has pushed back the date of formalized water engineering in China to ~ 5,100 years ago
- ❑ Dramatic increase in the number of Liangzhu ruins reflects rapid population growth





# China's water culture -- Liangzhu culture

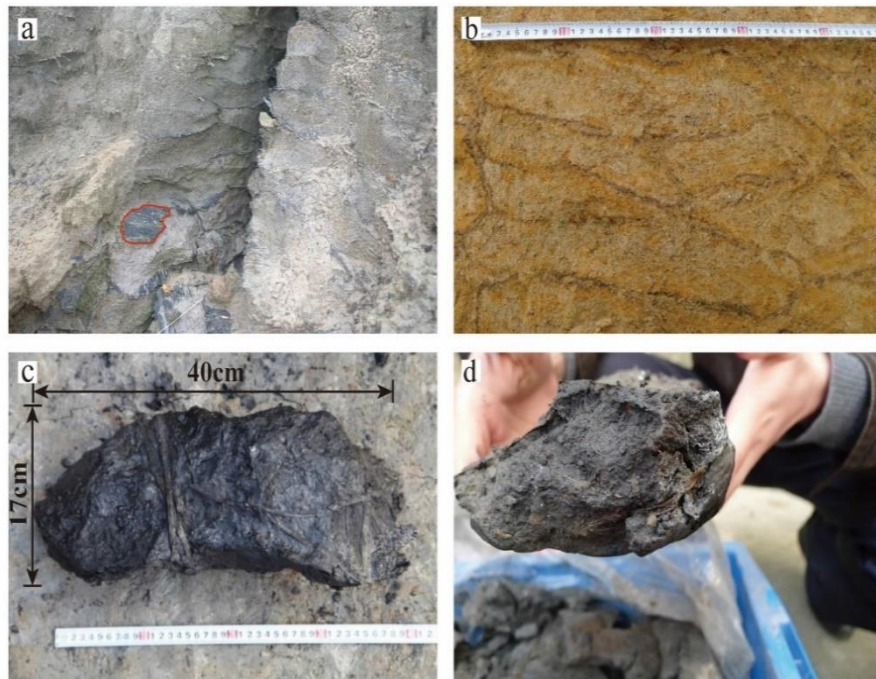
- ❑ Liangzhu water conservancy system: up and low dams
- ❑ Water conservancy functions: flood protection, store water, transport, irrigation, river flow control inside and outside the city





# China's water culture -- Liangzhu culture

- ❑ A large number of discoveries about straw-wrapped mud in Liangzhu ancient city have been found
- ❑ The development of Liangzhu was apparently driven by the improved rice cultivation. As a result, progress in rice farming in Liangzhu also boosted the ability of Liangzhu people to build this system



Straw-wrapped mud  
on the dam body

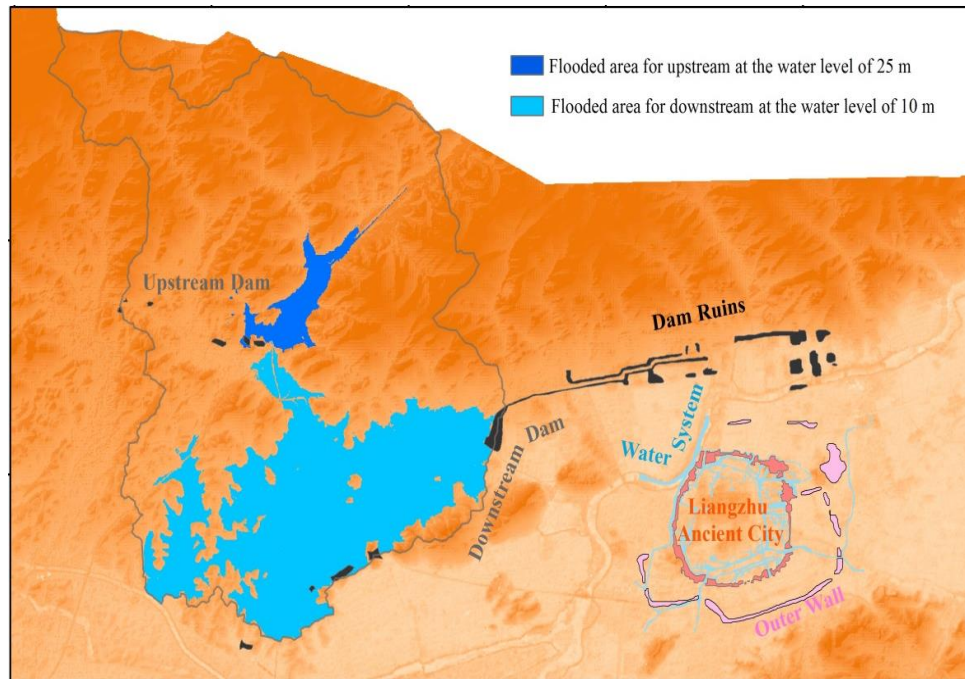


Remains of rice paddies and dividing ridges at  
the Maoshan site



# China's water culture -- Liangzhu culture

- ❑ The impressive extent and structure of Liangzhu water management system and city reveals the wisdom of the ancients in 5000 years ago
- ❑ The ultimate decline and abandonment of the Liangzhu city illustrated a profound lesson to the global urgency of developing sustainable water systems that can survive through changing climate and increasing population



Flooded area map for each reservoir at the highest water level



Stone plows, farming tools, inscribed deity image, and jade



# China's water culture -- Ancient Water Management

- Reduce inflow and broaden outflow
- Irrigate with the flood

- Divide and rule
- Desilting and overflow

节源开流，分而治之，借洪灌溉，飞砂溢流

- Composed of fish mouth diversion embankment, Feisha weir spillway, and treasure bottle mouth inlet
- Making full use of the local geographical conditions to divert water without dams
- Self-flow irrigation, water diversion, flooding, sand drainage and flow control

Dujiangyan (都江堰, 276 to 251 B.C.)



- Composed of the water moldboard, Big Tianping, Little Tianping, South Canal and North Canal
- The channel is characterized by shallow, narrow, curved and sharp
- Flow from the lower elevation (Xiang River) into the higher elevation (Li River)

Ling Canal (灵渠, 214 B.C.)



# China's water culture -- Modern Water Management

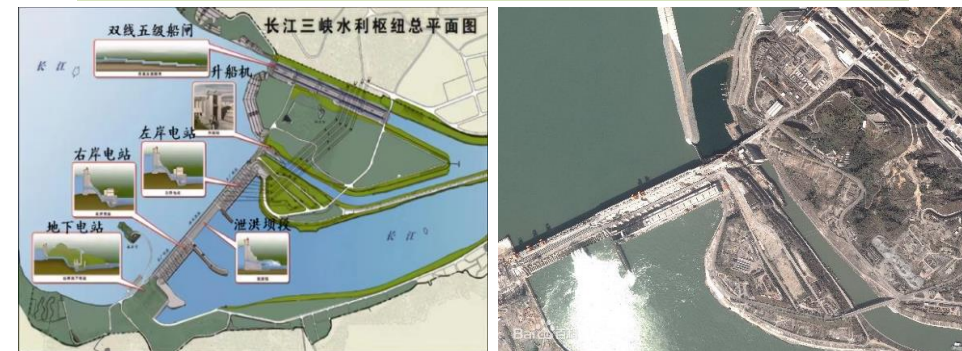
- **Water Saving Priority**
- **Systematic governance**

- **Spacial Balance**
- **Two-way efforts (Government and Market)**

节水优先，空间均衡，系统治理，两手发力

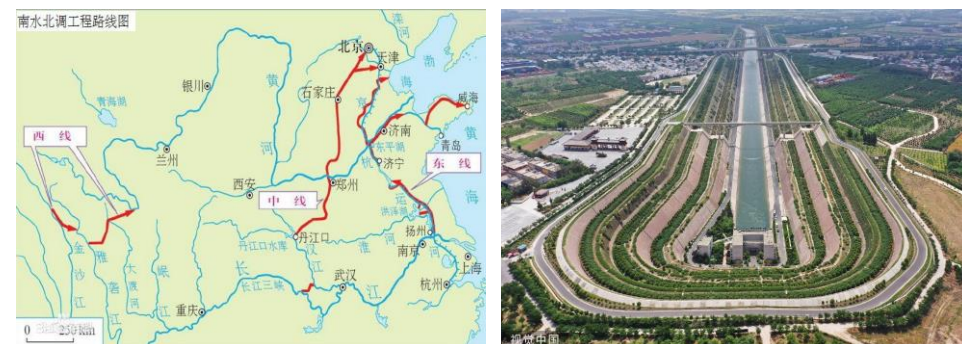
- Composed of dam, hydropower plant and navigable buildings
- Address the threat of severe flooding
- An important part of China's energy planning and power industry production
- The link of Yangtze River shipping
- Improve future ecological environment

**Three Gorges Project (三峡工程, 1994-2009)**



- Divided into three lines (West Line, Central Line and East Line)
- Solving water shortage in the north
- Increase the carrying capacity of water resources and the efficiency
- Improve the environment deteriorated by water shortage

**South-North Water Transfer (南水北调, 2003-2020)**





# UN's Sustainable Development Goals

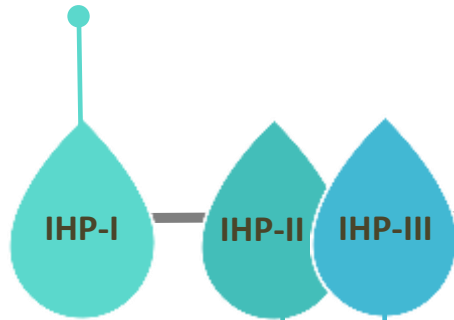
Both China's water culture and UNESCO-IHP IX emphasize the importance of sustainable water governance, to support the implementation of the **SDG6: CLEAN WATER AND SANITATION** and **SDG13: CLIMATE ACTION**

## The 17 Sustainable Development Goals (SDGs)



**holistic and integrated**

**IHP's First Phase (1975-1980):** maintained the research orientation of IHD



**IHP's Second Phase (1981-1983) and Third Phase (1984-1989):** planned under the theme "Hydrology and the Scientific Bases for Rational Water Resources Management" to include practical aspects of hydrology and water resources

**IHP's Fourth Phase (1990-1995):** "Hydrology and Water Resources Sustainable Development in a Changing Environment"

**IHP's Fifth Phase (1996-2001):** "Hydrology and Water Resources Development in a Vulnerable Environment"

**IHP's Sixth Phase (2002-2007):** "Water Interactions: Systems at Risk and Social Challenges". This phase represented a turning point for IHP. Its focus shifted from studying the occurrence and distribution of water in the environment towards societal aspects of water resources, highlighting the need for better assessment and management, in particular at transboundary level

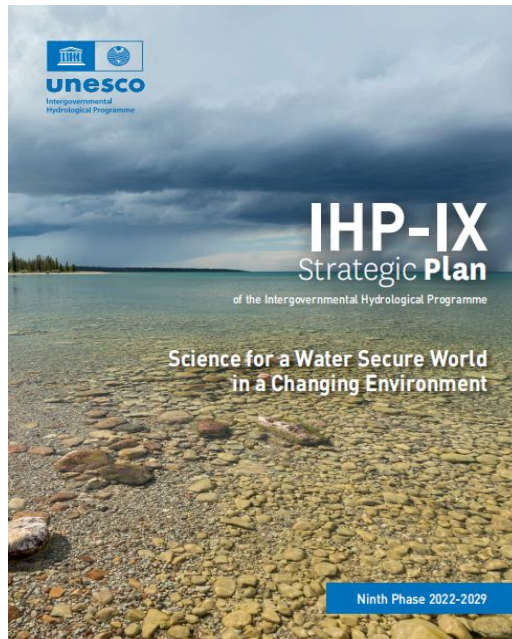
**IHP's Seventh Phase (2008-2013):** "Water Dependencies: Systems under Stress and Societal Responses"

**IHP's Eighth Phase (2014-2021):** "Water Security: Responses to Local, Regional and Global Challenges"

**IHP's Ninth Phase (2022-2029)**



- ❑ IHP-IX “Science for a Water Secure World in a Changing Environment”, identifies key water priority areas to support Members States to achieve the 2030 Agenda and the Sustainable Development Goals (SDGs), especially **water related SDGs**
- ❑ There is a need to promote **sustainable water governance** as a long-term activity through sound data, capacitated human resources, and increased partnerships



## Five priority areas:

1. Scientific research and innovation
2. **Water Education** in the Fourth Industrial Revolution including Sustainability
3. Bridging the **data-knowledge gap**
4. Integrated **water resources management** under conditions of global change
5. **Water Governance** based on science for mitigation, **adaptation and resilience**

**34** expected outputs

**165** Key activities (draft implementation Plan)

## Water Governance as a FOUNDATION

As the only Intergovernmental Programme of the UN system devoted to water research, water resources management, education and capacity building, IHP is governed by:



### The IHP Intergovernmental Council

As per its [Statutes](#) and [Rules of Procedure](#), the IHP Intergovernmental Council is composed of **36 UNESCO Member States** elected for four years by the General Conference of UNESCO at its ordinary sessions. Each of UNESCO's six electoral regions (North America and Western Europe; Eastern Europe; Latin America and the Caribbean; Asia and the Pacific; Africa, and Arab States) elects Member States for membership in the Council to ensure **equitable geographical distribution and appropriate rotation**. The Council ensures **planning, definition of priorities, and supervision of the execution of IHP**.

### The IHP Bureau

It is composed of **six members** elected by the Council for two years **representing the six electoral regions of UNESCO**. The IHP Bureau fixes the dates of the Council sessions, prepares them, supervises the implementation of its resolutions, and reports to the Council.





## Water Education needs to be improved at ALL LEVELS



Water education must go beyond the teaching of hydrological sciences, and be both **multidisciplinary and interdisciplinary**



Need to advance scientific knowledge through the **training of scientists** as well as increasing knowledge on water issues through courses aimed at **water professionals and decision makers**



Essential to reach out to **media professionals** so that they can communicate water issues accurately and effectively. Need to include **community education strategies** to promote communitywide water conservation, and skills in local co-management of water. Efforts will be made to make water a significant component of the K-12 curriculum

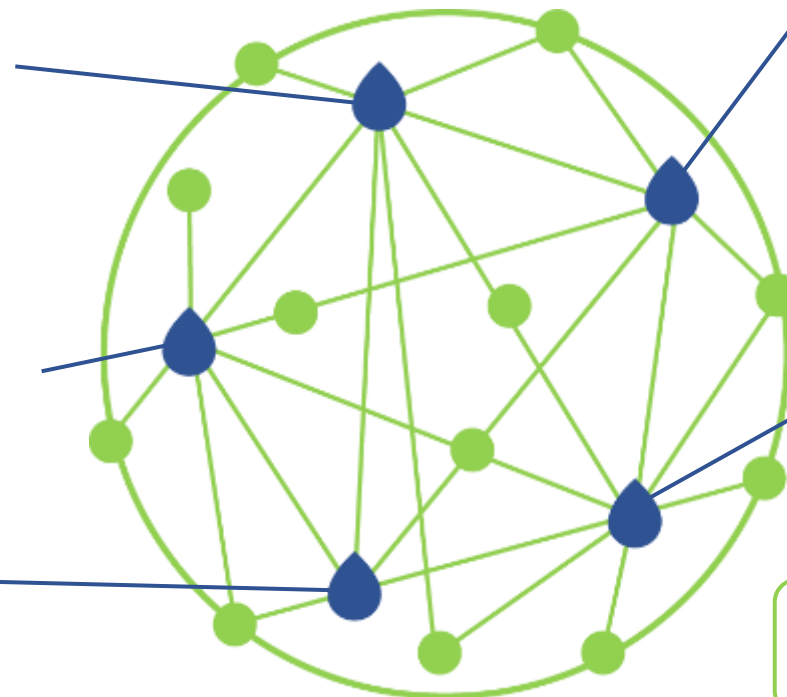
## Water Information Communication Technologies (ICTs): Driving a NEW ERA of Water Resources Management

Since the inception of IHD, UNESCO has been developing a network of networks, often called the UNESCO Water Family, composed of different kinds of water institutions that have been joining forces with UNESCO in order to support the implementation of its water programmes and the Organization's strategic goals. The UNESCO Water Family operates globally as a network which includes:

**UNESCO staff** located at the Paris headquarters of the IHP Secretariat and the Regional Hydrologists located in the UNESCO field offices

**IHP National Committees** representing the Programme in **169** Member States

**35 water-related Category 2 Centres** under the auspices of UNESCO



**The World Water Assessment Programme (WWAP)**, with its secretariat hosted and led by UNESCO in Italy and which produces the periodic World Water Development Report (WWDR)

**44 UNESCO Water Chairs and UNITWIN networks**

Together, they represent over **1500** water experts worldwide



# Understanding of hydrological processes with HMS and field observations

## Hydrological modeling:

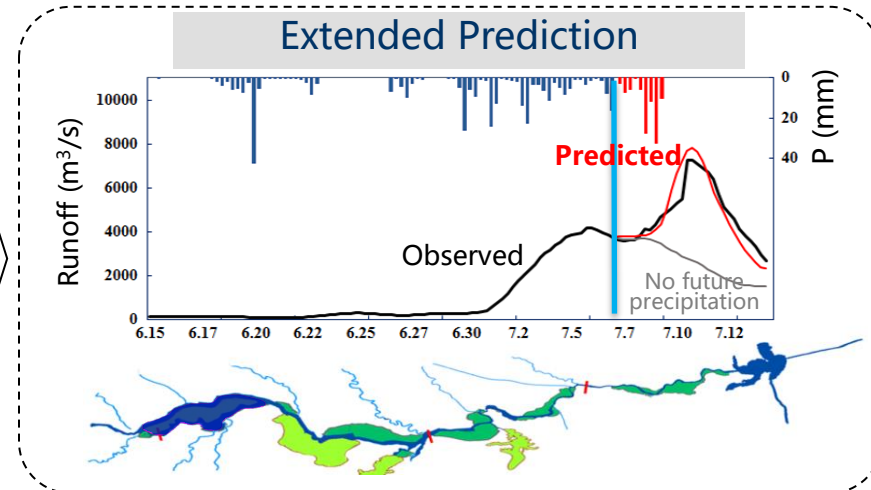
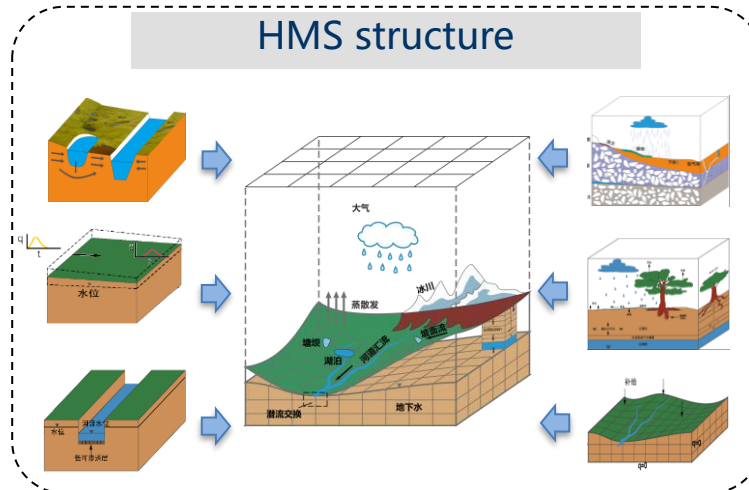
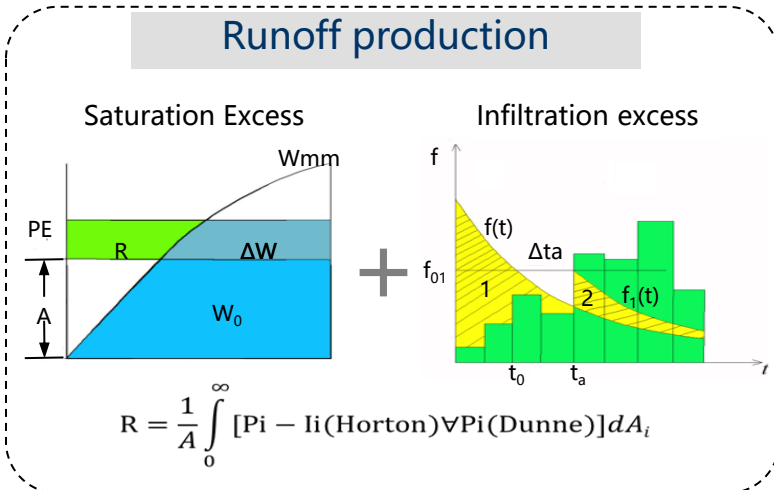
- *Hydrologic Model System (HMS), HydroGeoSphere (HGS) - Canada, .....*
- Reducing uncertainty, advancing parameterization, improving accuracy

## Two-way coupling between WRF and HMS:

- Extended prediction and early flood warning
- Applied for flood forecasting in large river basins, reducing damages and saving life

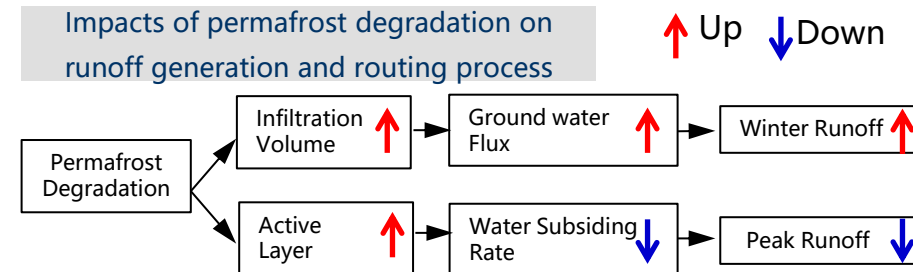
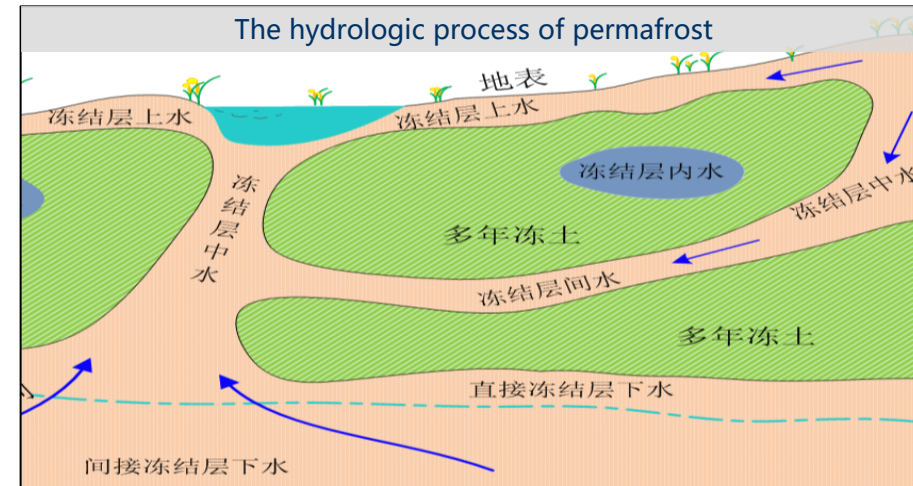
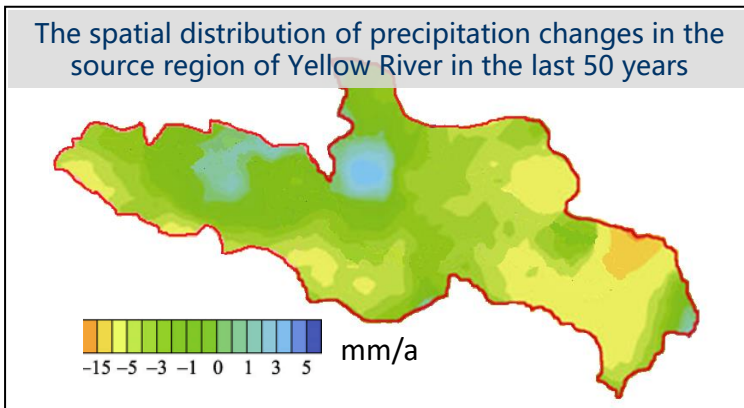
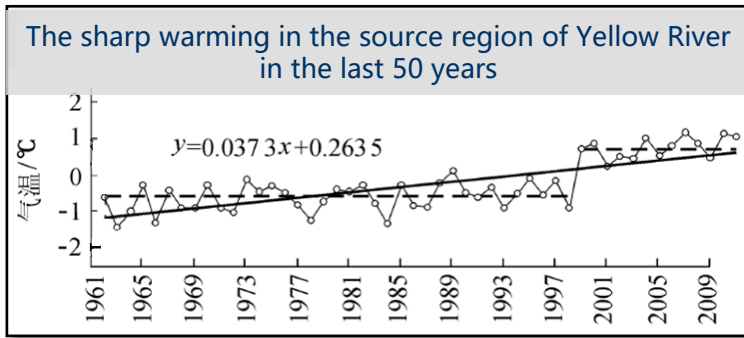


JoH, 1999, 2006; WRR, 2014, 2021, 2022 .....



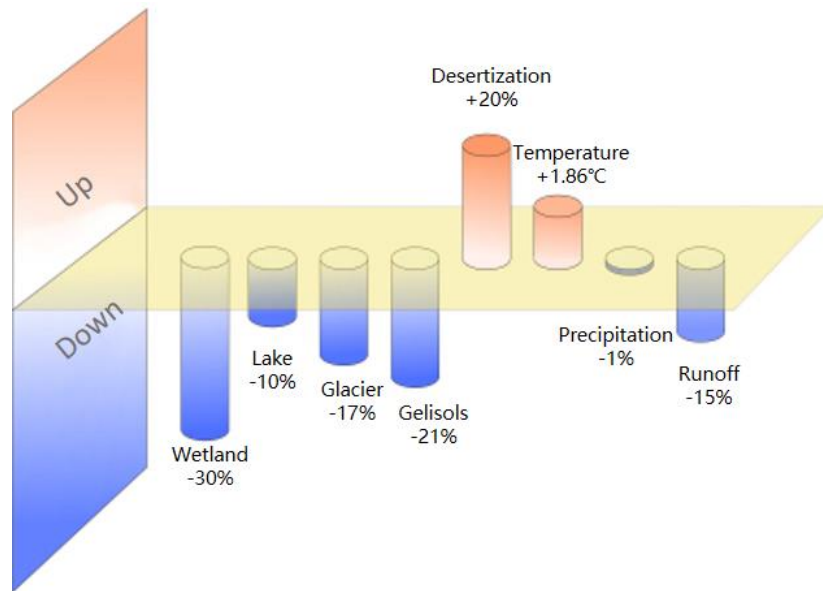
# Climate change leads to the variation of hydrological processes

The climate warming and serious permafrost degradation greatly intensify the heat exchange among the soil, water and ice. And the multi-source runoff generation in the alpine cold region requires further research.

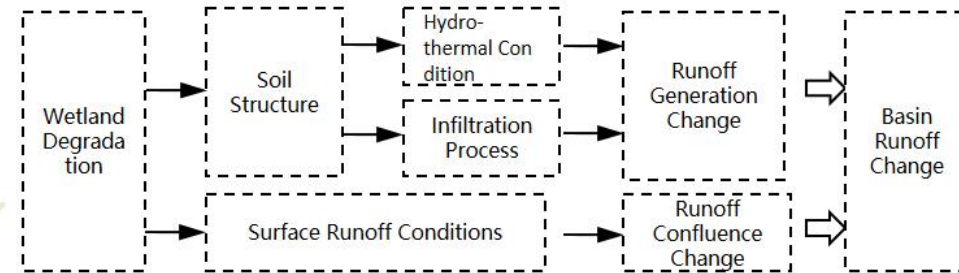


# Human activities changed patterns of natural runoff generation and routing

The vulnerable ecological environment, as well as the deep excavation and drainage of the river source region, have resulted in the severe wetland degradation, the damaged soil structure and hydraulic characteristics, the increased variety of hydrothermal conditions and infiltration processes, and the varied mode of runoff generation and routing in wetlands.



The drastic change of environmental factors in the river source region in the last 50 years

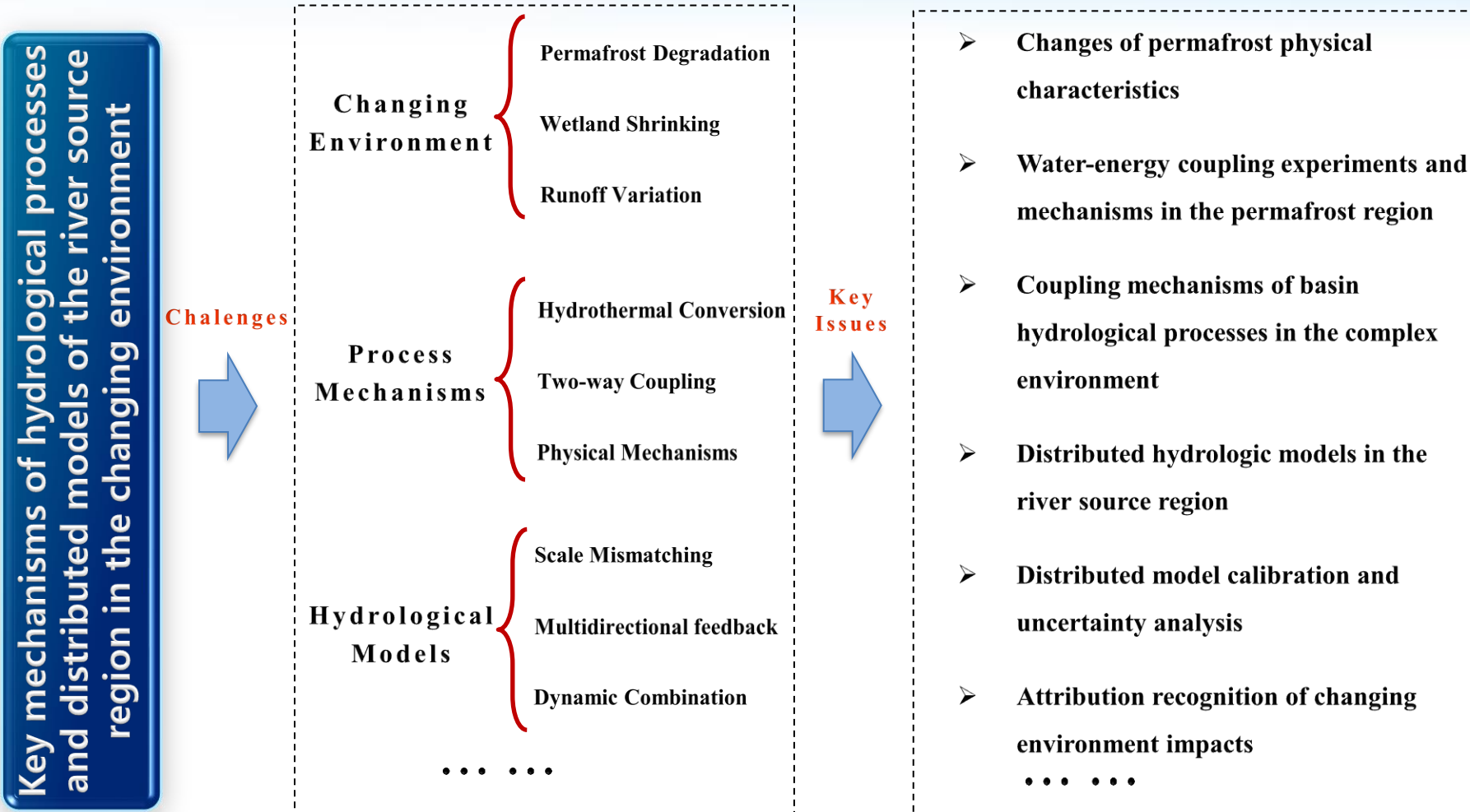


The severe degradation of wetland ecosystems in the river source region

The increasing complex evolution of hydrological processes and data scarcity in the river source region, make difficult to conduct research there.



# Key questions in the cold region hydrology



**It requires a systematic study of the above issues**

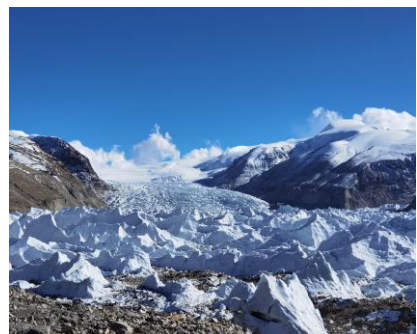
# Cold region hydrology of the Tibetan Plateau

## ❑ Six nested experimental sites constructed in headwaters of the Mekong, Yangtze rivers:

- Changdu ecological/hydrological site (3900m above sea level (a.s.l.))
- Yala Xiangbo cryosphere hydro-ecological site (4900m a.s.l.)
- Source region of Yangtze River permafrost observation site (5200m a.s.l.)
- .....

## ❑ Key scientific studies in the Tibetan Plateau:

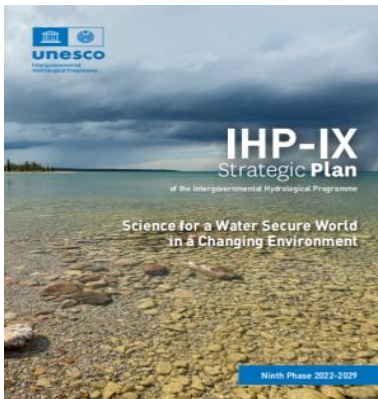
- Permafrost change and its influence on hydrological processes
- Water cycle and vegetation/evapotranspiration processes
- Surface water and groundwater interactions in the headwater
- Emissions of greenhouse gas from inland waters in the Tibetan Plateau
- .....



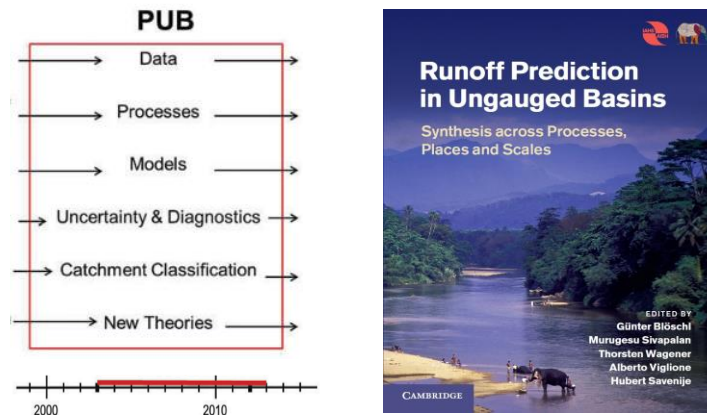
# Coordinating scientific programs

- UNESCO-IHP (International/Intergovernmental Hydrological Program) strategic plan:
  - 1975-2021, IHP's First - Eighth Phases
  - 2022-2029, Science for a water secure world in a changing environment (**IHP-IX**)
- INARCH, a cross-cut project of the GEWEX Hydroclimatology Panel
- IAHS Decades:
  - 2003-2012, Predictions in Ungauged Basins (**PUB**);
  - 2013-2022, Everything Flows: Change in hydrology and society (**Panta Rhei**)
  - 2023-2032, Hydrology Engaging Local People IN one Global world (**HELPING**)

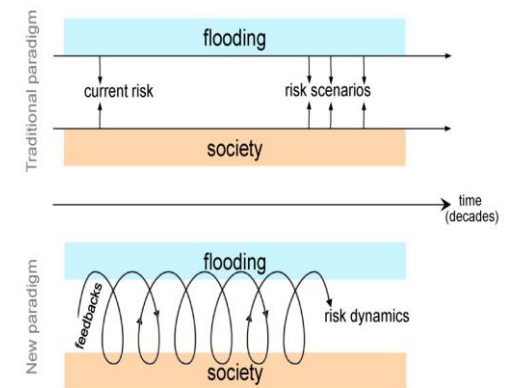
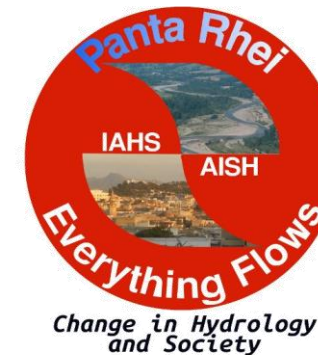
UNESCO IHP IX  
(2022-2029)



Predictions in Ungauged Basins  
(PUB) (2003-2012)



Everything Flows: Change in hydrology and society  
(Panta Rhei) (2013-2022)





# UN 2023 Water Conference

From March 22 to 24, the United Nations (UN) 2023 Water Conference was held at the UN Headquarters in New York, United States. This meeting was co-hosted by **Netherlands and Tajikistan**. Leaders, ministers, senior representatives of the UN system, and over 1200 representatives from civil society, youth, women, and the private sector participated.

The 2023 UN Water Conference is the most standardized and influential water related thematic conference at the UN level in the **past 50 years**, since the Mar del Plata Water Conference was held in 1977. It aims to address the challenges of water to public health, ecological environment, food and energy security, and economic development, raise awareness of the global water crisis, and take concerted actions to achieve the water-related goal of sustainable development.

The 2023 UN Water Conference includes the opening and closing ceremonies, six plenary meetings and **five interactive dialogues**, as well as ~200 side events and special activities.

The Water Action Agenda was also adopted at the 2023 UN Water Conference, calling on all countries, industries, and actors to work together to address global water challenges. The Water Conference has anchored the direction and clarified the path for accelerating the achievement of the water-related SDGs and global water security.


# UN 2023 Water Conference -- 200 Side events



## TAKING NEXT STEPS FOR A WATER AND CLIMATE RESILIENT WORLD THROUGH CAPACITY DEVELOPMENT OF PEOPLE AND ORGANIZATIONS



 Thursday, 23<sup>rd</sup> March 2023

 12.30 – 13.45 (EST)

 ECOSOC Chamber, UN Headquarters  
New York, USA

Pre-Register Now >>



<https://docs.google.com/forms/d/e/1FAIpQLSdvW7WaeShiwYite7E18NRxtTW5jIRDQClqZvafDIHsaa03#Q/viawfarm?vc=0&c=0&w=1&tr=0>

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UNESCO: [r\\_elfithri@unesco.org](mailto:r_elfithri@unesco.org)

# UN 2024 World Water Forum

The World Water Forum is the largest international gathering in the water sector involving various stakeholders, which has been co-hosted by the **World Water Council** and a host city. The Forum is held every three years and has been taking place since 1997. The World Water Forum is not just a conference: it includes a three-year preparation phase (preparatory phase), a one-week event (event phase), and a presentation of the results (synthesis phase) with ongoing support for collective action.

The Forum brings together participants from all levels and areas, including politics, multilateral institutions, academia, civil society and the private sector, among others. Over the years, the number of people participating in the Forum has grown from a few hundred to tens of thousands, from both the international community and host countries.

On 18th to 25th of May 2024, the heads of state, the heads of international organizations, high level government officials, experts, scholars, entrepreneurs and economists from all over the world will **share their knowledges, experiences, and practices** regarding a wide range of topics related to water.



# Looking forward

- ❑ Unwavering focus on addressing hydrological unknowns and mentoring the next generation of scientists
- ❑ Confronting global water challenges:
  - **Build** a sustainable and resilient society by expanding the scientific understanding of hydrological cycle, advancing technical capabilities, and promoting public education
  - **Provide** science-based innovative solutions for water governance
  - **Facilitate** the acceleration of progress toward UN sustainable development goals



the UNESCO Water Family in Asia & the Pacific responds to the Covid-19 pandemic

## The Answers are in the Water

Tuesday, 28 July 2020, 13.00 – 15.00 Jakarta Time (GMT+7)

**Background**

Across Asia and the Pacific, the Covid-19 pandemic has impacted individuals, communities and nations in numerous ways – many of which are only just beginning to emerge. All governments around the region face the dilemma of balancing the economic well-being of their citizens with the need to protect a safe environment. Science has a crucial role to play in delivering information that helps us understand and meet the challenge of the virus in our societies and beyond for all to recover better.

The water resources are centrally placed in this regard. Access to clean and safe water is essential for the more rapid recovery – the first task of delivery against the spread of the virus. This in turn requires that the management, distribution and monitoring of water for human use is added and improved to the best available science and technology.

Some countries in the region are tracking the presence of the Covid-19 virus, an ecosystem providing environmental conditions towards the ability to understand the presence and movement of the virus from country to country.

The UNESCO Water Family in Asia and the Pacific has the ability and technical expertise to help regional water resources and managers to establish water resilience for all.

Some of the key messages to be discussed include:

- How the UNESCO Water Family in Asia and the Pacific has the ability and technical expertise to help regional water resources and managers to establish water resilience for all.
- How the UNESCO Water Family in Asia and the Pacific has the ability and technical expertise to help regional water resources and managers to establish water resilience for all.

**List of speakers:**

1. **Prof. Zhenqin Yu** - IAGLR Chair, Chinese National Committee for Water Resources, Ministry of Water Resources, China
2. **Dr. David Al Chelton** - International Design Institute (IDI), Taiwan
3. **Dr. Toshiyuki** - Tokyo Electric Power Company (TEPCO), Canberra, Australia
4. **Prof. Ian White** - Australian National University (ANU), Canberra, Australia
5. **Dr. Barbara Jansen-Pacheco** - UNESCO Chair on Water Resilience, Universidad Carlos III de Madrid, Central University, Spain/Portugal
6. **Prof. David Harrold** - Asia Pacific Water Forum (APWF), Australia
7. **Prof. Jacques Delgado** - Asia Pacific Center for Sustainable (APCS), Australia
8. **Mrs. De Sun Park** - International Center for Water Delivery and Sustainable Use (ICWDU), Korea
9. **Prof. Yasuki Yoshikawa** - Japanese National Committee for IWRM, Japan

**Agenda:**

Time	Agenda
13:00 – 13:15	Opening Session (Moderated by Zhenqin Yu)
13:15 – 13:30	Progress and Interlink (Moderated by Toshiyuki)
13:30 – 13:45	Opening Session (Moderated by Toshiyuki)
13:45 – 14:00	Regional Perspectives (Moderated by Toshiyuki)
14:00 – 14:15	Question and Answer (Moderated by Toshiyuki)
14:15 – 14:30	Regional Perspectives (Moderated by Toshiyuki)
14:30 – 14:45	Question and Answer (Moderated by Toshiyuki)
14:45 – 15:00	Closing Session (Moderated by Toshiyuki)

File: IAHF\_2020\_3-4\_2020  
<https://doi.org/10.5194/iafhs-2020-3-2020>  
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**Preface: Hydrological processes and water security in a changing world**

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The world's freshwater environment is changing rapidly and facing unprecedented pressures. A growing global population and economic development have led to increasing demands on water resources and water management. The impact of climate change and intensive anthropogenic activities is now posing a great threat to the hydrological cycle leading to various water issues, such as floods, droughts, over-exploitation of water resources, pollution, and ecosystem degradation in many countries. On a global scale, more than two billion people are experiencing high water stress. Consequently, understanding hydrological processes in terms of local, regional and global scales is critical for addressing these water issues, including water resources planning and management for everyone on the planet.

The 10th climate FRIENDS conference was co-organized by UNESCO and Government of China from 6-9 November 2019 in Beijing, with the focus on the theme of hydrological processes and water security in a changing world, under which eight thematic topics were discussed during the conference: (1) hydrological observations under the changing environment and society; (2) river regimes and hydrological cycles under the changing environment; (3) simulation and prediction of surface water and groundwater processes under the impact of human activities; (4) urban hydrology and water resources; (5) multi-objective water resources allocation and operation; (6) integrated watershed management in a changing world; (7) water quality and sediment transport; and (8) river health and ecological health under changing environments. The conference

global level FRIENDS track moved down its strength as a global network supporting a science-based network of high-level hydrological research at the river basin level and larger scales. These activities undertaken by FRIENDS regional scientific groups of researchers, resulted in several topics related to regional hydrology and scientific publications, which is a contribution to water security within the framework of the IWRM and beyond to water-related sustainable development goals (SDGs) of the United Nations Agenda 2030 for sustainable development. Paris Agreement and Sendai Framework.

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