第18届世界水资源大会

水与万物：人与自然和谐共生

Tackling challenges in water resource in a changing climate (SS-2-2)

Service function of Asia Water Towers

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XVIII
World Water Congress
International Water Resources Association(IWRA)
Beijing, China | September 11-15, 2023

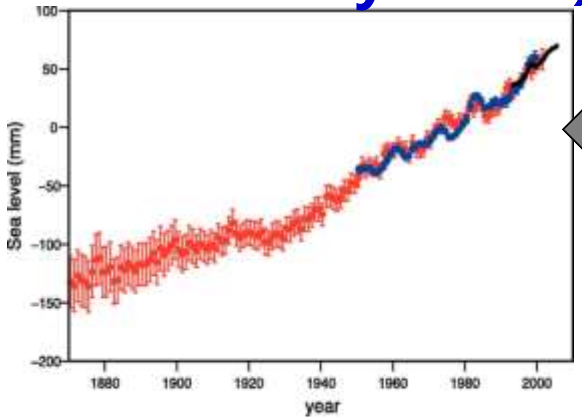
2023-09-11 北京

Outline

1. Asia Water Tower
2. Tipping point by 1.1°C warming level？
3. Operational route for a resilient socio-economy

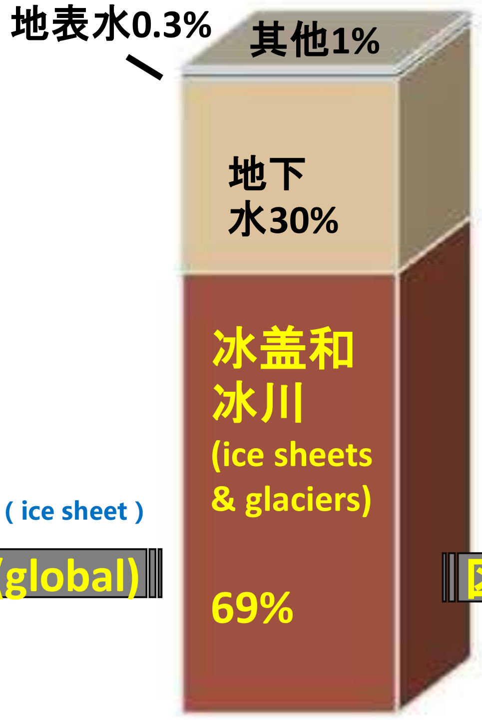
Importance of solid fresh water

驱动大洋环流
(Ocean conveyor belt)



海平面效应
(SLR)

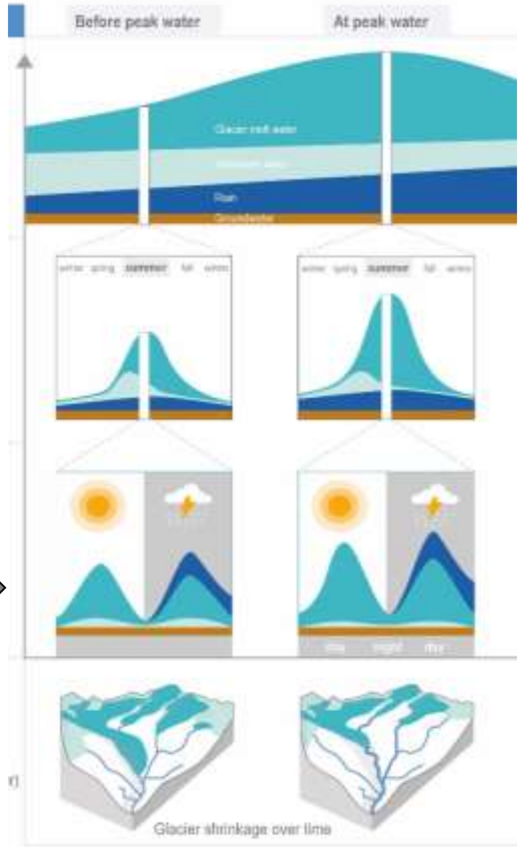
冰盖 (ice sheet)
全球(global)



全球淡水
(USGS)

冰川 (glaciers)
区域(regional)

融水拐点(tipping point)
(IPCC SROCC,2019)



年代际尺度

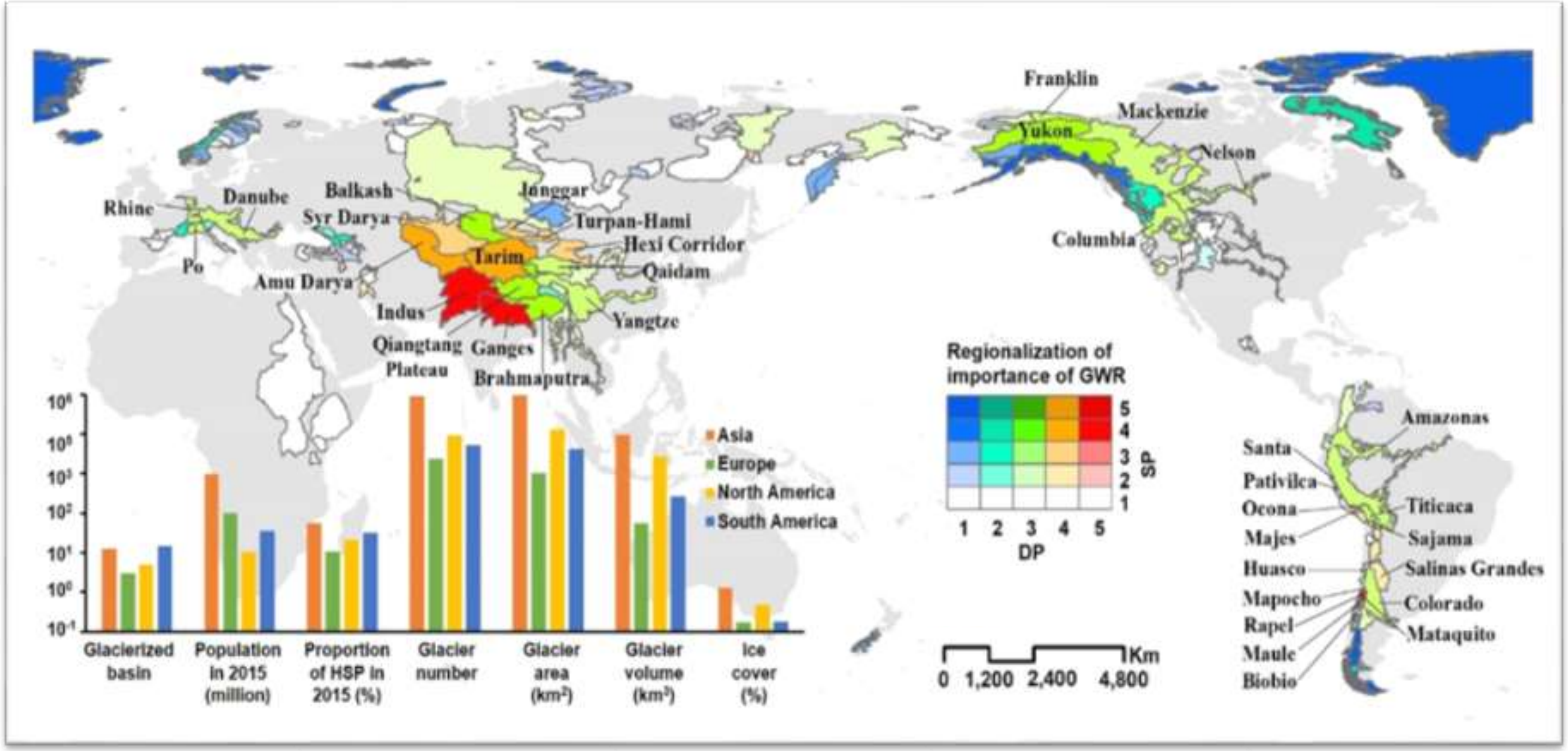
年际尺度

日尺度

水文水资源效应
(fresh water)

地球“水塔”
(global water towers）

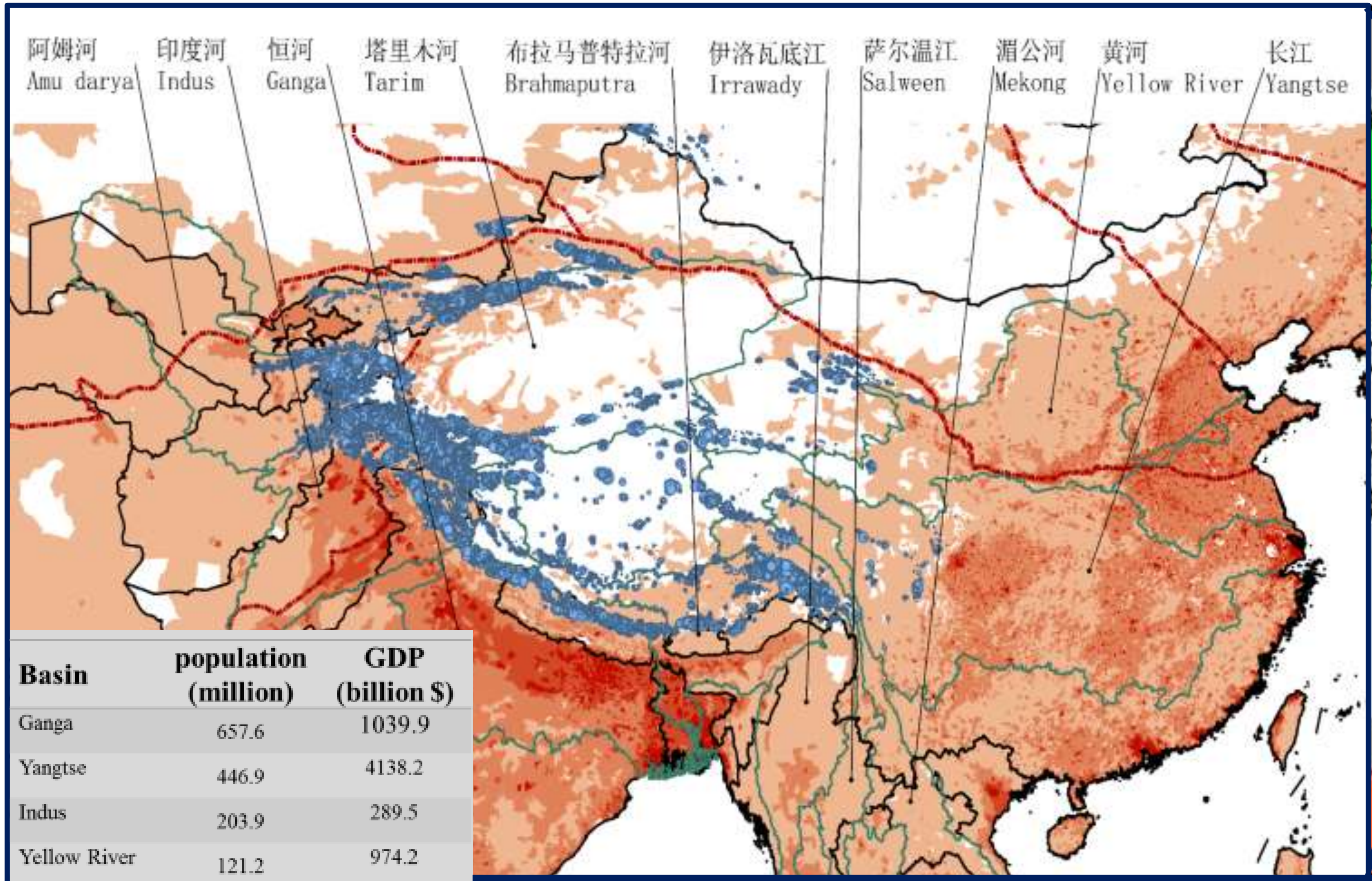
高大山脉由于其在维持下游环境和人类用水需求方面发挥的独特蓄水和供水作用，而被称之为自然界的天然“水塔”



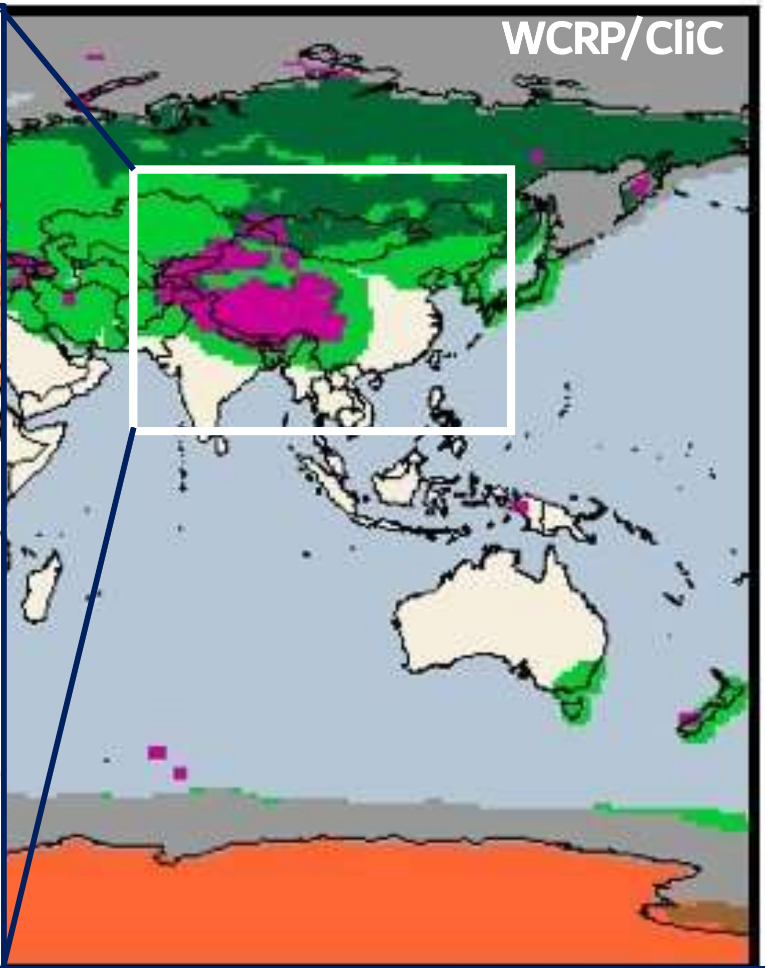
全球193个“水塔”冰川水资源重要性区划

Su, Xiao and Chen et al., 2021

Global Cryosphere by Type



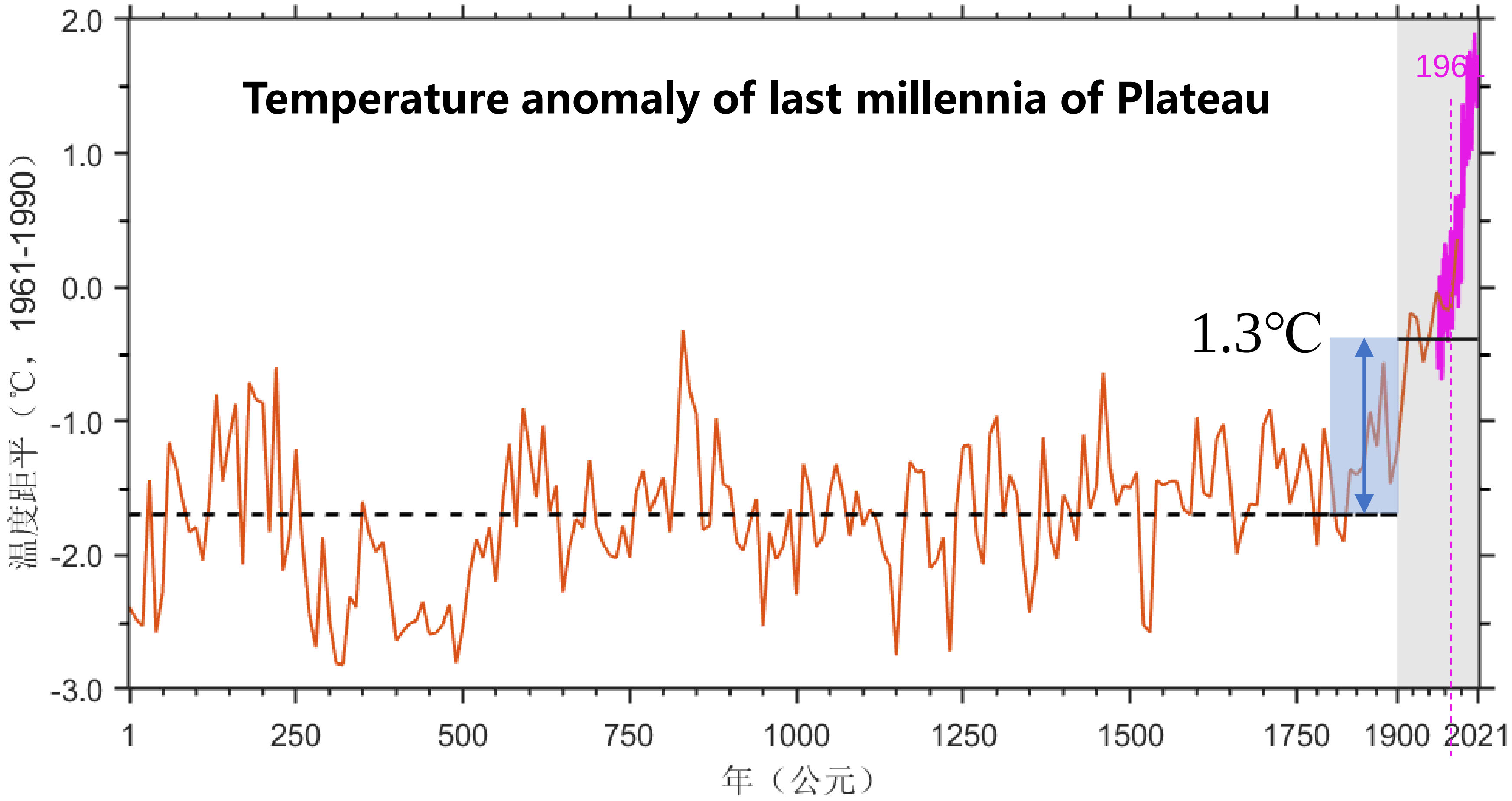
Basin	population (million)	GDP (billion $)
Ganga	657.6	1039.9
Yangtse	446.9	4138.2
Indus	203.9	289.5
Yellow River	121.2	974.2
Brahmaputra	115.0	174.2
Mekong	66.0	221.4
Irrawaddy	33.1	47.8
Amu darya	29.6	47.2
Tarim	12.4	92.4
Salween	9.1	29.3



Asia Water Tower (10 large catchments)
Influenced population: 1694.8 million; GDP: $7054.1 billion
— data by 2015

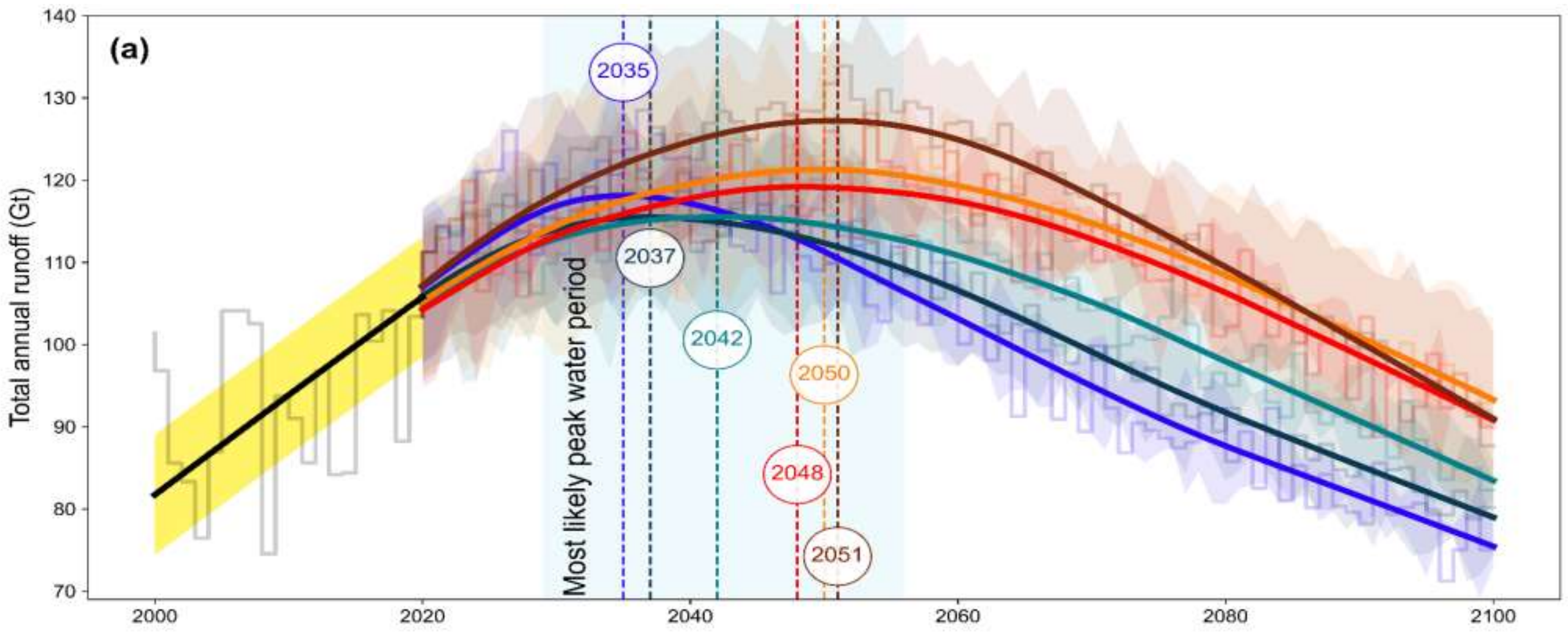
温度变化

1961年以来的增暖速度在过去2千多年前所未有



（根据Yao et al., 2019 更新）

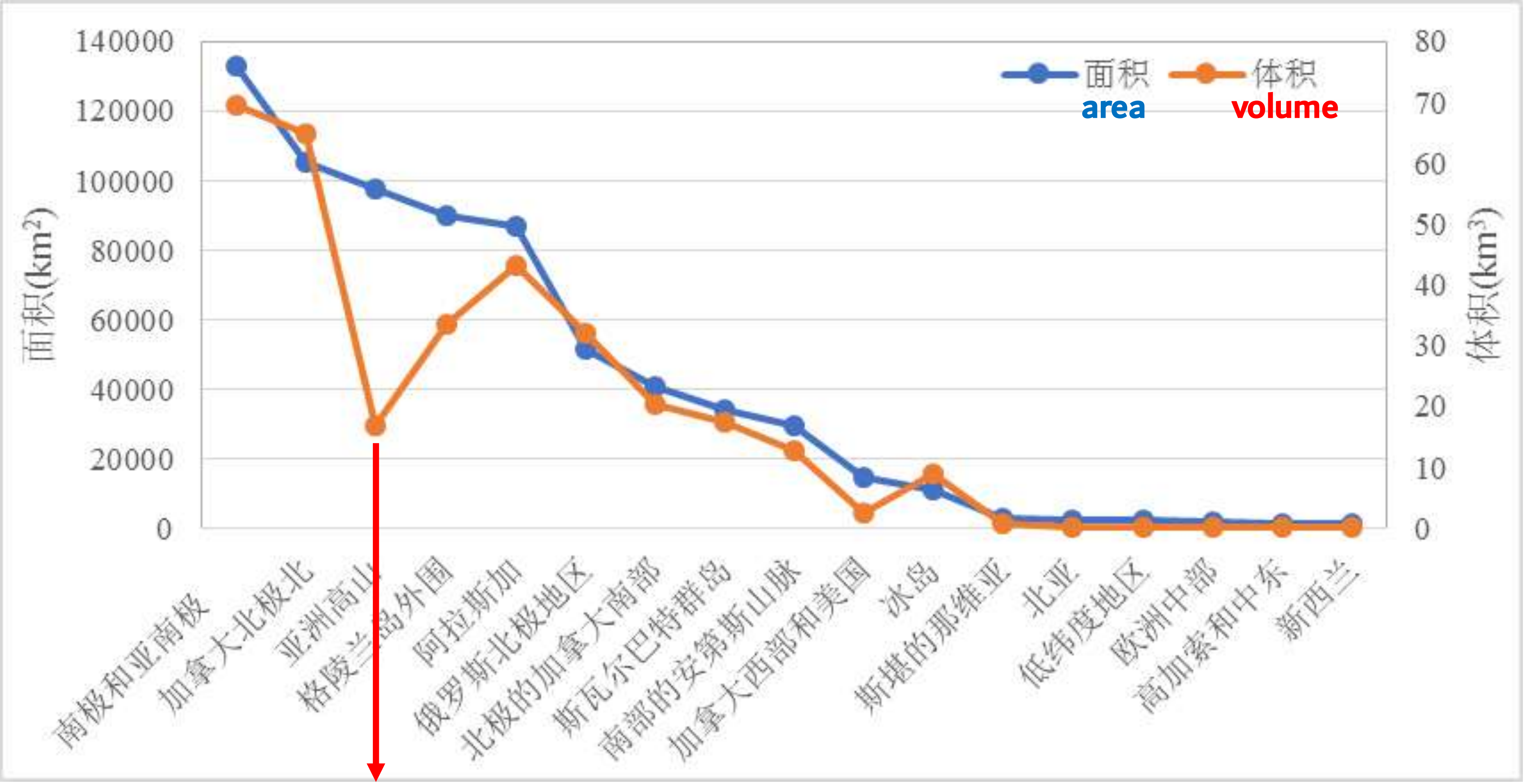
Projected peak-water over HMA drainage basins in the 21st Century



Glacier total runoff change under different climate scenarios; *(Zhao, Zhang*, Xiao* et al., 2023)*

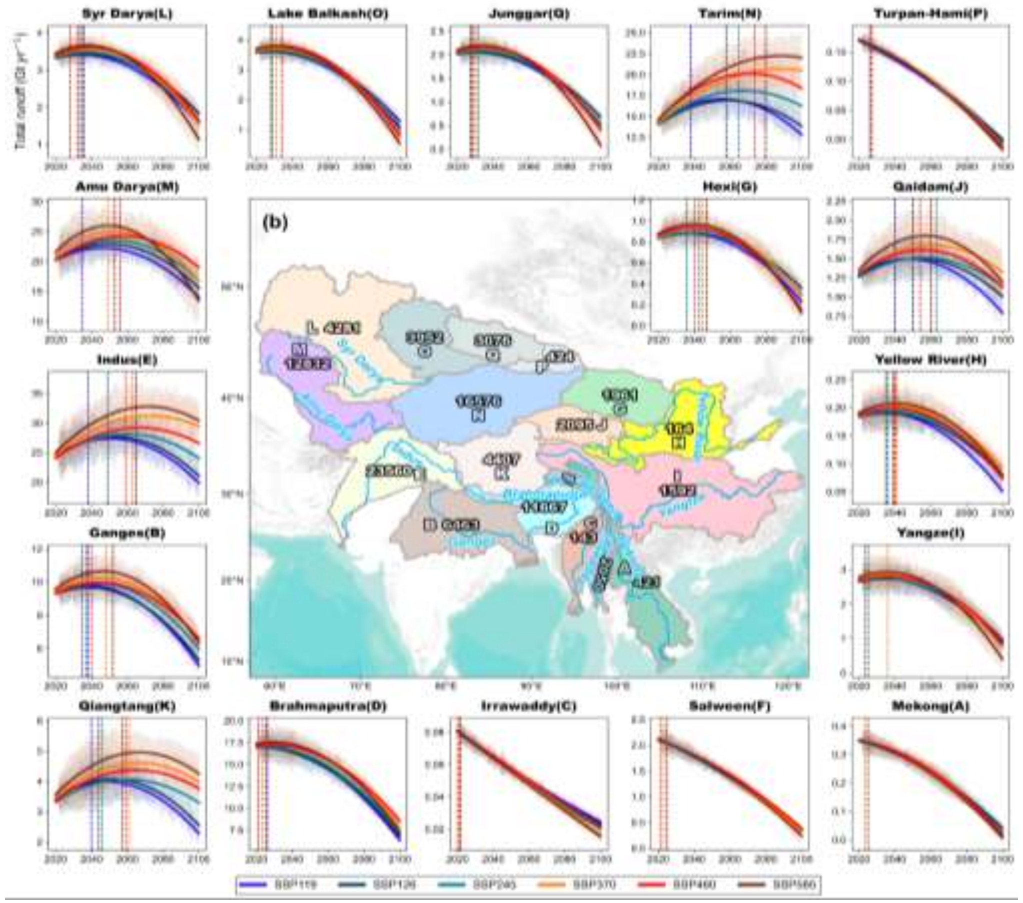
- Glacier evolution model integrated the ice flow dynamics is employed to project the peak water of glacier runoff in major drainage basins. Most drainage basins (14/17, SSP245) will reach peak water before 2050s.

Distribution of total glacier area and volume over the major high mountain and polar regions



星罗棋布，但冰量小
(High Mountain Asia: big number but small size)

Projected peak-water over HMA



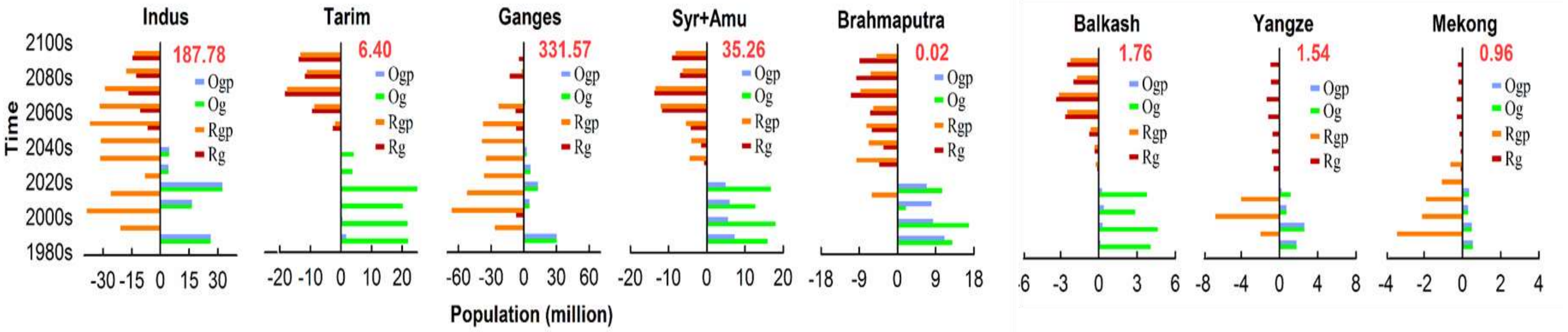
Glacier runoff change in major drainage basins over HMA

	SSP119	SSP126	SSP245	SSP370	SSP460	SSP585
Yellow River(H)	2036	2035	2036	2041	2040	2039
Yangtze(I)	2025	2025	2023	2036	2025	2025
Turpan-Hami(P)	2027	2026	2027	2027	2026	2027
Tarim(N)	2038	2058	2065	2080	2074	2080
Syr Darya(L)	2035	2033	2036	2032	2028	2036
Salween(F)	2025	2023	2023	2023	2021	2025
Qiangtang(K)	2040	2044	2046	2061	2059	2057
Qaidam(J)	2040	2050	2063	2060	2054	2060
Mekong(A)	2025	2025	2023	2023	2025	2025
Lake Balkhash(O)	2029	2029	2028	2031	2034	2029
Junggar(Q)	2027	2027	2032	2031	2028	2029
Irrawaddy(C)	2022	2022	2022	2020	2021	2022
Indus(E)	2038	2049	2063	2063	2059	2065
Hexi(G)	2036	2043	2036	2045	2040	2047
Ganges(B)	2038	2035	2037	2048	2040	2052
Brahmaputra(D)	2026	2025	2023	2023	2021	2025
Amu Darya(M)	2035	2049	2049	2049	2056	2053

The Peak water for glacier runoff in major drainage basins under different climate scenarios

- Glacier evolution model integrated the ice flow dynamics is employed to project the peak water of glacier runoff in 11 major drainage basins.
- The most drainage basins (14/17, SSP245) will reach peak water before 2050s.

(Zhao, Zhang*, Xiao* et al., 2023)

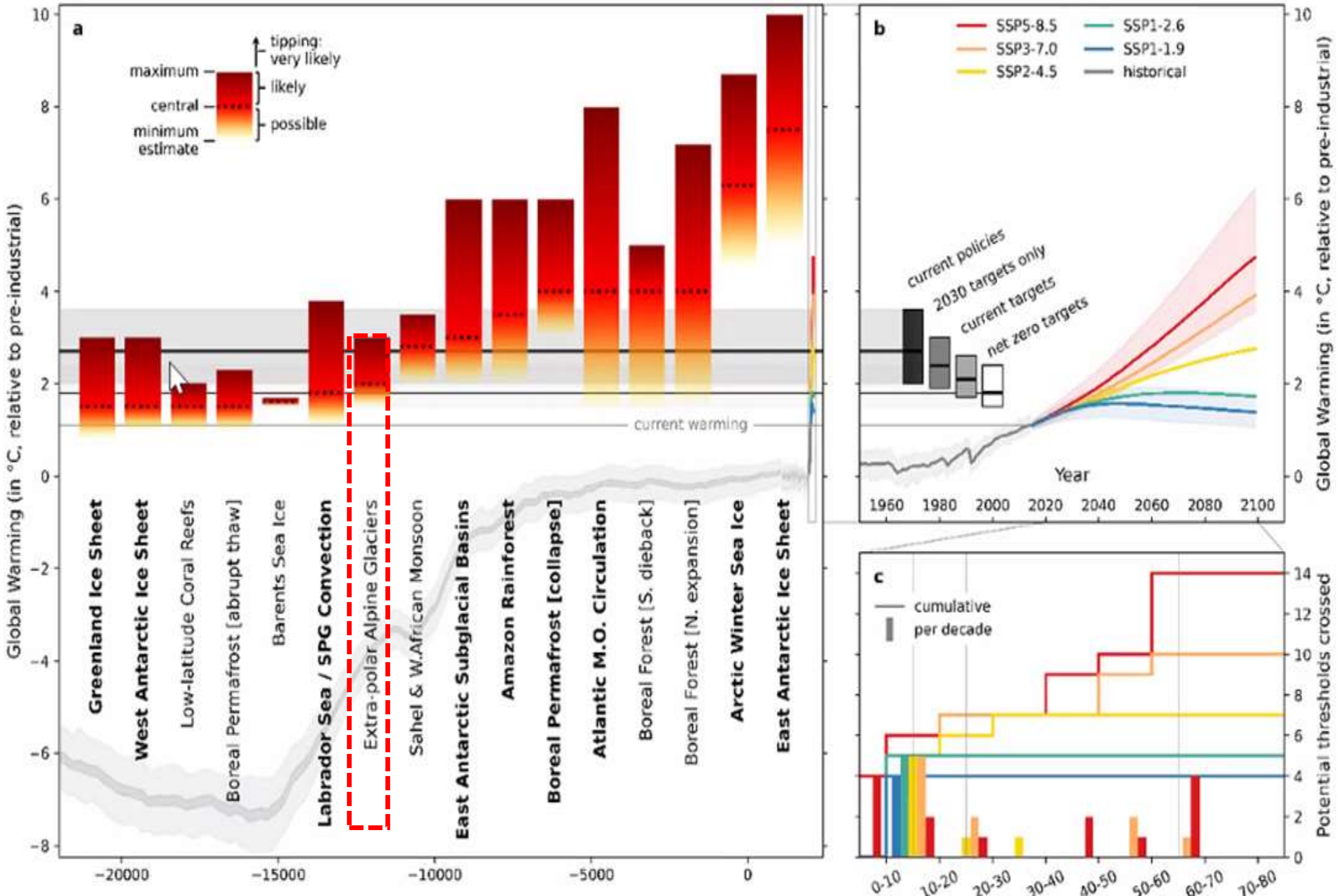


Opportunities (green bar) and risks (red bar) associated with changes in the service potential of glacial meltwater and population in the Asia's important water tower units

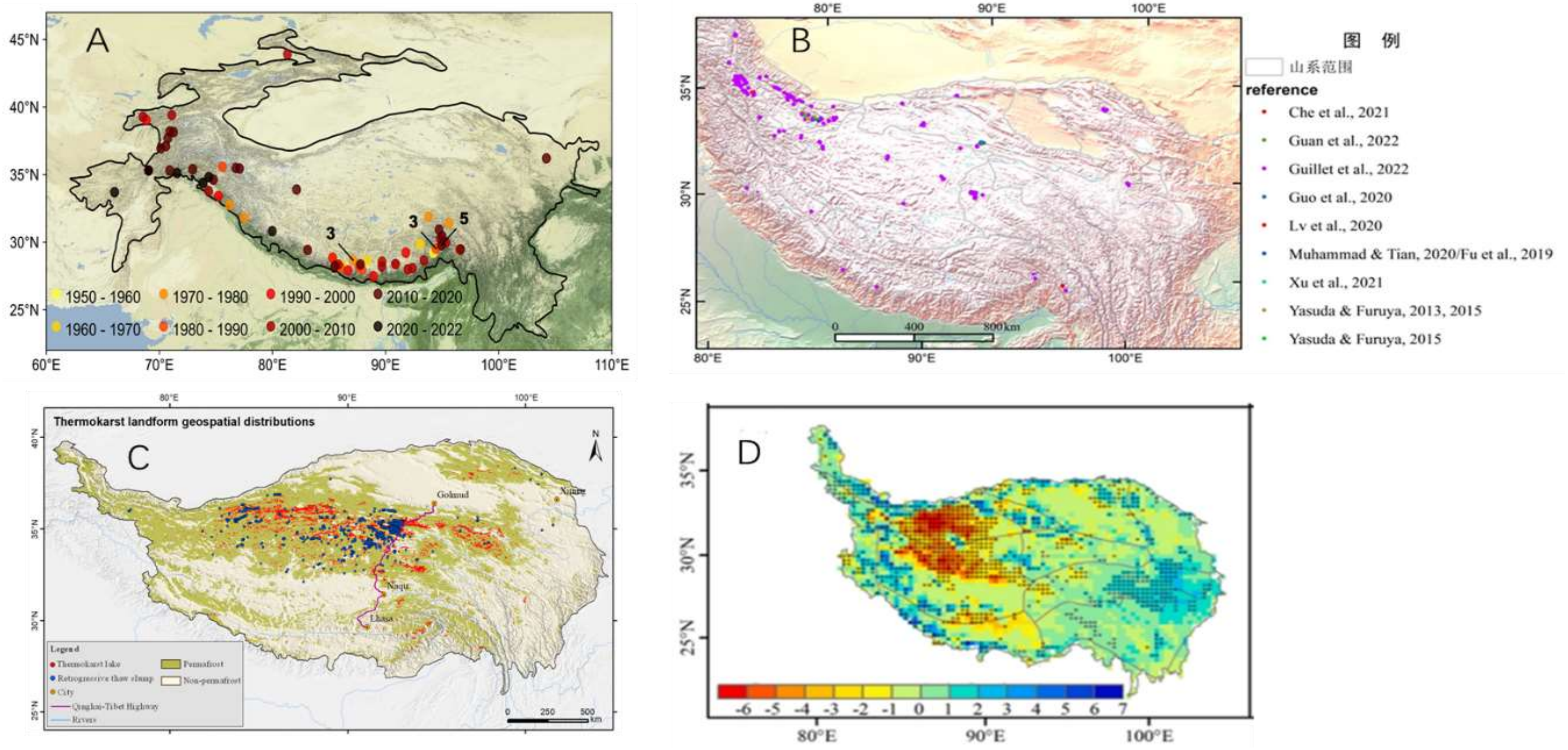
Su, Xiao and Chen et al., 2021

- Both meltwater supply and demand (population) are expected to continue to rise for a certain period, but after the "peak", they will steadily decrease.
- There is a mismatch between the peak times of meltwater and population, which further creates both opportunities and risks that vary with the basin and time.
- Both opportunities and risks are the greatest in the Indus River basin.

Updated assessment suggests >1.5°C global warming could trigger multiple climate tipping points



Mckay et al., 2022

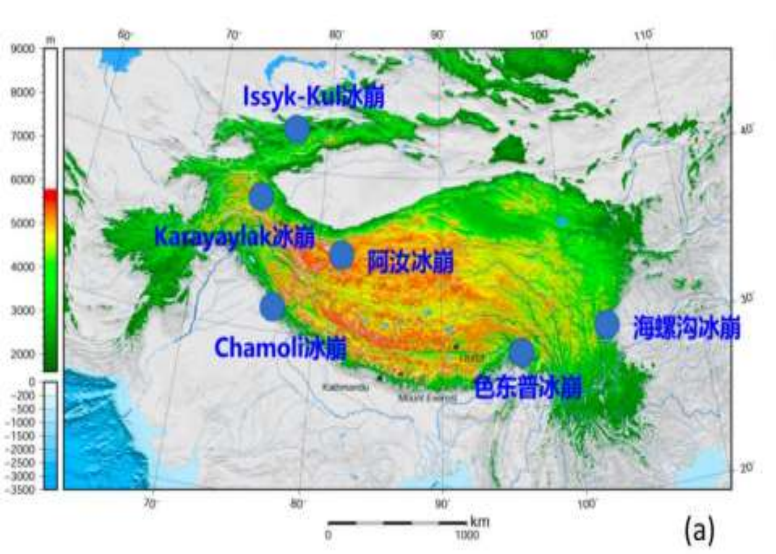


高原冰冻圈突变事件（**A,B,C）的空**间分布以及**1980—2020年高原**积雪日数变化趋势（单位：**天/年） 的空**间分布，**Ma et al., 2023）（D）（据Xiao et al., 2023）**。

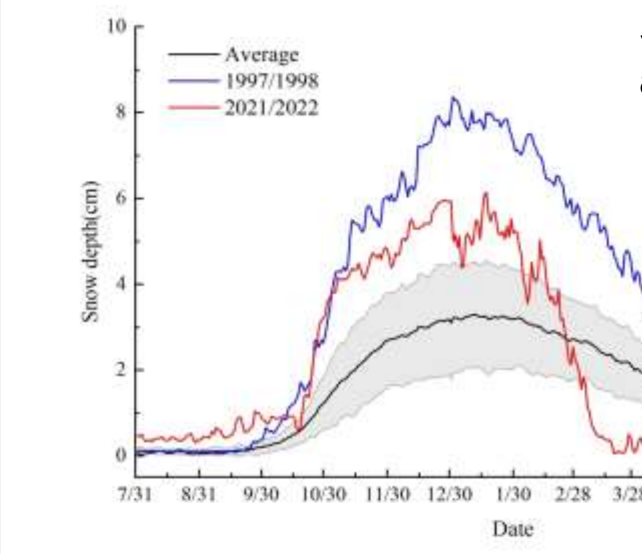
A) 冰崩事件（**以年代**为划分阶段，**数字代表同一地点**发生次数；资料来源：张议芳等，**2023**；**Acharya et al., 2023)**； **B)青藏高原**跃动冰川分布图**; C) 青藏高原**热融湖塘和热融滑塌分布图（资料来源，**Wei et al., 2021**；**Luo et al., 2022)**。

Abrupt events of cryosphere (ACEs）in Asian High Mountain region

Frequent occurrence of abrupt massive collapse of glacier mass, widespread thermal-karst of permafrost and snow cover anomaly

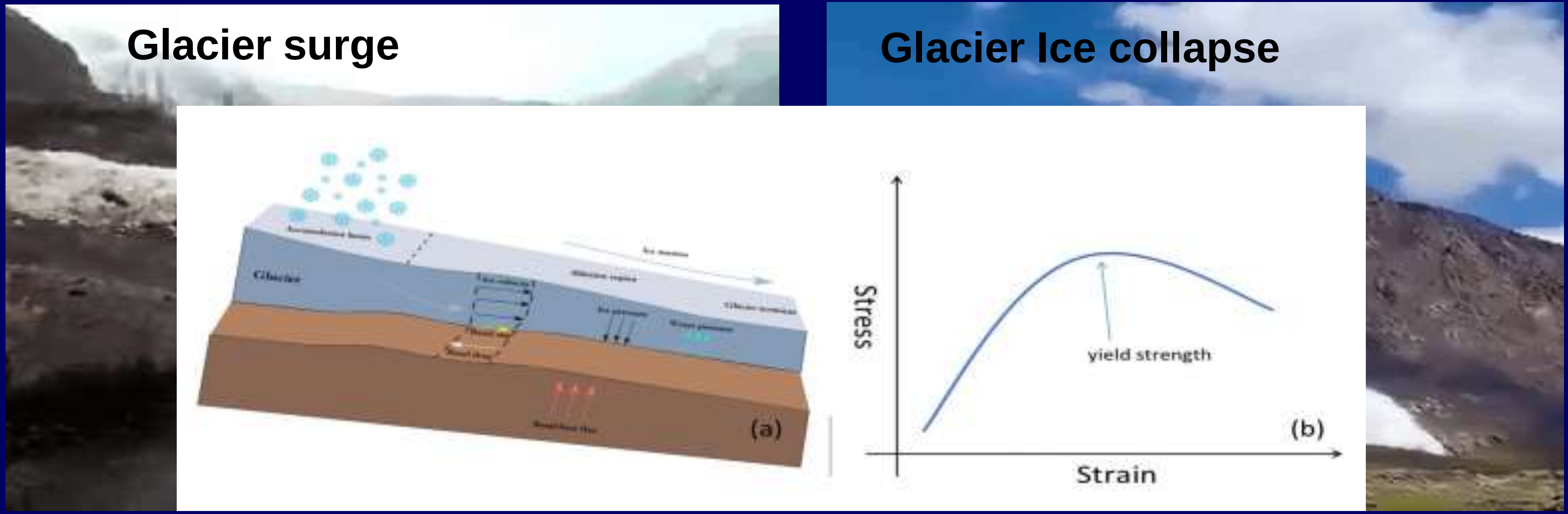


Snow-cover anomaly

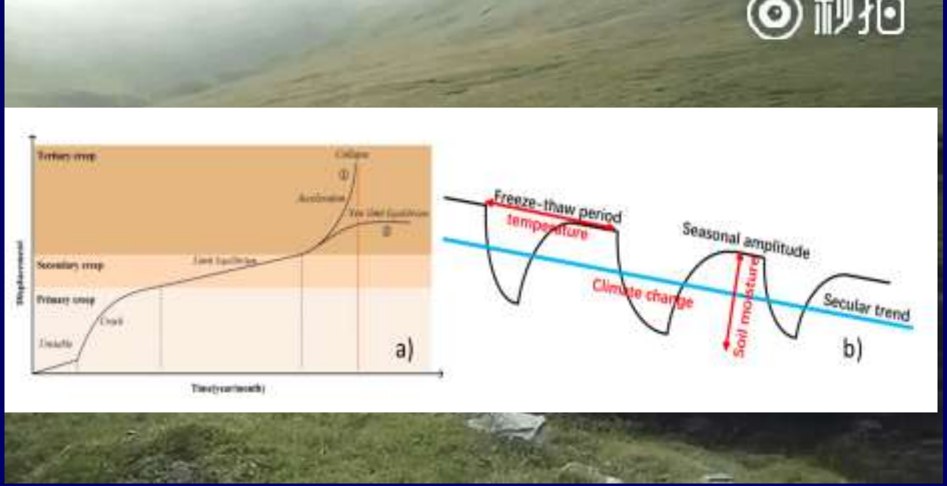


Glacier surge

Glacier Ice collapse



Permafrost thermal-karst



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Cryosphere

Oasis

Desert

Eurasian inland oasis ecosystem

冰退沙进，沙进人走

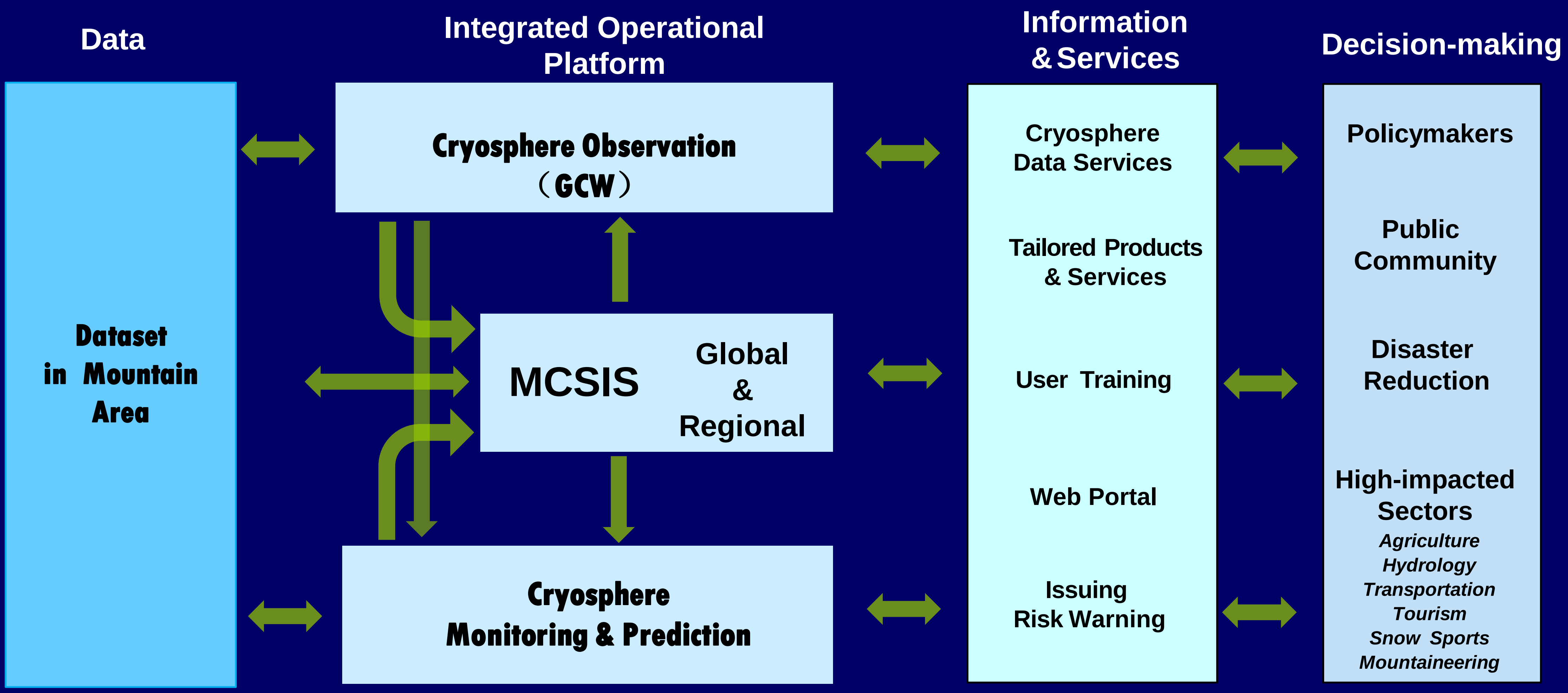
(By Dahe Qin)

- Our Safe boundaries have been defined to safeguard the ability of the Earth's biophysical systems to continue to function and provide services to all living beings on Earth. Meltwater is a fundamental wellbeing to many arid and semi-arid regions such as in northwest China. Climate warming accelerates human and nature's exposure to significant harm.

- When meltwater crossing tipping points for the region, eco-refugees and poverty is unavoidable. Actions must be taken for climate mitigation so that Intergenerational justice and intra-generational justice being achieved.

Suggestion: International Operation Framework on High Mountain Cryosphere Service

(Asia, Europe, NA, SA & Tropic)



MCSIS: *M*ountain *C*ryosphere *S*ervices *I*nformation *S*ystem

Bayi Glacier, Mt. Qilian *Courtesy: Y. Zheng*