Climate Wake-Up Call: Glacier Melt and Adaptation in Western China

This briefing is part of the ongoing "China Glacier and Climate Change Impact Project," a cooperation between Greenpeace East Asia, the Institute of Geological and Natural Disaster Prevention at Gansu Academy of Sciences, and Chinese Academy of Sciences Northwest Institute of Eco-Environment and Resources Researcher Shen Yongping. Report available here (in Chinese).

1. Glaciers in China supply water to an estimated 1.8 billion people, and they're melting, fast.

Almost one-fifth of glacier area in China is already gone.[1] These glaciers are the source of many of Asia's largest rivers, which flow as far as Afghanistan, Vietnam and southern India. They comprise more than half of "Asia's Water Tower," the largest concentration of fresh water outside the polar regions[2].

High Mountain Asia is one of the most climate-sensitive regions in the world. **In some parts of western China, annual average temperatures have increased by 3 degrees C or more since the early 1950s**. In August, Greenpeace East Asia documented a glacial lake outburst at a location where average annual temperatures had reached 3 to 3.5 degrees C above than their 1951 level.[3]

Due to rising temperatures, more than 82% of glaciers in China have retreated since the 1950s.[4] Between 1960 and 2006, **the volume of glacier meltwater in China's cryosphere increased by more than half,** impacting agriculture and causing flooding and the formation of dangerous glacial lakes.[5]

Unless drastic action is taken to slow rising temperatures, roughly two-thirds of glaciers in High Mountain Asia are projected to be gone by the end of the century. ***Two thirds can be saved if the global temperature increase is capped at 1.5 degrees.[6]***

2. The rate of glacier melt has accelerated.

In summer 2018, the *"China Glacier and Climate Change Impact Project"* analyzed rates of glacier melt at key sites across western China using Sentinel 2 and Landsat 8 satellite imagery.

Tianshan No. 1 glacier, Xinjiang

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[1] Liu SY., Yao XJ., Guo WQ et al, 2015, The contemporary glaciers in China based on the Second Chinese Glacier Inventory, ACTA GEOGRAOHICA SINCA, 70(1): 3-16

[2] Yao T, Thompson L, Yang W, et al. Different glacier status with atmospheric circulations in Tibetan Plateau and surroundings[J]. Nature Climate Change, 2012, (2): 663-7.

[3] http://www.greenpeace.org/eastasia/press/releases/climate-energy/2018/Glacial-lake-in-western-China-bursts-annual-average-temperatures-in-area-up-2-to-3-C-since-1961/

[4] Liu SY., Ding YJ., Li J., 2006, Glaciers in response to recent climate warming in western China, QUATERNARY SCIENCES, 26(5): 762-771

[5] Ding, YJ., et al., 2017, Cold region hydrology introductory [M], Beijing: Science Press, 2017.7. p124

[6] Kraaijenbrink, P. D. A., Bierkens, M. F. P., Lutz, A. F., & Immerzeel, W. W. (2017). Impact of a global temperature rise of 1.5 degrees Celsius on Asia's glaciers. Nature, 549, 257

Tianshan No. 1 (also known as Urumqi No. 1) is the largest glacier that feeds into the Urumqi river in Xinjiang province. It's located at the headwaters of the river, just 120 kilometers from Urumqi city and was the site of China's first glacier monitoring station, set up in 1959.

Greenpeace analysis of satellite imagery shows that the annual rate of glacier retreat at Tianshan No. 1 has doubled, from 5000 m^2 from 1962-1986 to 10,600 m^2 from 1986-2018. Between 1964 and 2018, the total area decreased by 22.2%, or 430,000 m^2. Due to rising temperatures, the glacier split into two sections in 1993. By 2011, all of Tianshan No. 1 was in a state of net mass loss.

Laohugou Glacier No. 12, Gansu

Laohugou Glacier No. 12 is the largest glacier in the Qilian Mountains, in Gansu. Water from Laohugu and other glaciers in the Qilian mountains irrigates the Hexi Corridor, and was fundamental to the development of oasis cities along the Northern Silk Road[7].

As of 1959, Laohugou Glacier No. 2 measured 10.1 kilometers long, with an area of 21.9 square kilometers[8]. Analysis of Sentinel 2 satellite imagery shows that by 2018, the area of Laohugou No. 12 has been reduced to 20.2 square kilometers, a decrease of 7.8%.

Between 1959 and 1976 rate of retreat was 5.56 m/year. For the period 2006-2018, the rate of retreat more than doubled to reach 13.1 m/year.

Halong Glacier, Animaqing (Amne Machin), Qinghai

Animaqing, in Qinghai, is a holy mountain in Tibetan Buddhism. It's located within Sanjianyuan nature reserve, at the headwaters of the Yellow River.

Halong glacier has become 1200 meters shorter in just 30 years, from 1987 to 2017. Between 1987 to 2006, the glacier retreated 32,000 m^2 per year, and between 2006-2017, the rate of retreat nearly doubled, to 72,000 m^2 per year. In 2017 the total area was 19.73 k^2.

3. Glacier melt is a threat to water security

As glaciers retreat, the volume of meltwater increases until "peak water" is reached, and then decreases dramatically. Between 1960 and 2006, glacial meltwater runoff in western China increased by 53.5%.[9] A recent study estimates that Tianshan No. 1 will reach peak water in 2030[10].

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[7] Sun MP, Liu SY., Yao XJ., et al, 2015, Glacier changes in the Qilian Mountains in the past half century: Based on the revised First and Second Chinese Glacier Inventory[J]. ACTA GEOGRAPHICA SINICA, 70(9): 1402-14.

[8] Wang ZT., 1981, The 1st Chinese Glacier Inventory I: Qilian Mountains [M]. Lanzhou: Lanzhou Insititute of Glaciology and Cryopedology, Chinese Academy of Sciences pp:1-249

[9] Ding, YJ., et al., 2017, Cold region hydrology introductory [M], Beijing: Science Press, 2017.7. p124

[10] Li ZQ et al, 2018, Mass balance and dynamic process simulation of mountain glacier, (Changes in Cryosphere and its Impacts/ Editor: Ding YJ & Xiao CD) Beijing: Science Press 2018.9

If the global average temperature increase is capped at 2 degrees C, most glaciers in China will reach "peak water" between 2040-2070[11]. Soon after, the amount of meltwater will decrease dramatically, causing severe water shortages across the region.

In some parts of western China, seasonal water changes are already occurring as a result of rapid glacier melt. The Aksu River Basin in Xinjiang is reliant on water from the Kumarak and Tailan rivers, and glacial runoff accounts for 52.4% and 69.7% of water in these rivers, respectively[12].

Although the basin is typically very arid, an increase in runoff due to glacier melt enabled rapid development in the area since the 1980s. Vegetation coverage in the Aksu River Basin expanded from 10976.13km^2 to 13065.00km^2, an increase of 19.03% over just 18 years.[13]

However, glacier melt has caused flooding in the spring and contributed to water shortages in summer, affecting crops. In 2016, total annual water use in the Aksu River Basin reached 10.848 billion m3, exceeding water resources by 72.9%[14].

4. Increased Disaster Risk

Accelerated glacier melt causes changes in water availability and an increased risk of glacier-related disasters. In alpine regions, higher temperatures lead to snow and ice melt earlier in the season. This can cause flooding in springtime and lead to water shortages when irrigation is needed in summer.

Over the past four months, two severe glacier disasters have occured in western China.

On August 10 of this year, a natural barrier holding back a glacial lake in Xinjiang collapsed, releasing 35 million m^3 of floodwater into the Yarkant River Basin and leading to the evacuation of nearby residents. Average annual temperatures in high mountain areas of the Yarkant River Basin, where the glacier outburst occurred, have increased by 3 to 3.5 °C since 1961. At 19:00 on August 10, the Kyrgyzstan Kuluk Banner Station in Kashgar recorded a flow rate of 1,570 m3 per second and a super-alert flow of 370 m3 per second.[15]

On October 17, a glacier collapse released an avalanche of ice and glacial debris into the Yarlung Zangbo River, blocking the river and leading to the formation of a glacial lake[16]. The Yarlung Zangbo

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[11] Huss, M., & Hock, R. 2018. Global-scale hydrological response to future glacier mass loss. Nature Climate Change, 8(2), 135-140. doi: 10.1038/s41558-017-0049-x

[12] Wang GY., Shen YP, Su HC., et al. 2008, Runoff changes in Aksu River Basin during 1956-2006 and their impacts on water availability for Tarim River, Journal of Glaciology and Geocryolgy, 30(4): 562-568

[13] Greenpeace extracted vegetation covered region based on MODIS NDVI 2000 and 2018 summer data.

[14] Xinjiang Statistical Yearbook 2017, China Statistics Press, 2017.10 ISBN: 978503782664

[15] http://www.greenpeace.org/eastasia/press/releases/climate-energy/2018/Glacial-lake-in-western-China-bursts-annual-average-temperatures-in-area-up-2-to-3-C-since-1961/

[16] https://mp.weixin.qq.com/s?__biz=MjM5NDU2MTQ5NQ==&mid=2650429509&idx=1&sn=1ca3735180b119a50a57ce4d0346365f&chksm=be8b14fd89fc9debf2a9cc8ac5c9c1aa8c4cf33682cd1916c0ea8f684c1b3d1f24441aad638a&scene=0&subscene=91&sessionid=1542017482&ascene=7&devicetype=android-23&version=26070338&nettype=WIFI&abtest_cookie=BAABAAoACwANABQABAAjlx4AV5keAIqZHgCLmR4AAAA%3D&lang=zh_CN&pass_ticket=3blBbrEEK29pKjX6QEEojvIrlf9AKJl1KZIOifS7bD4CgCLOZI7aprbbJ0L7vji6&wx_header=1

River, known as the Bramaputra in India, is considered to be the highest plateau river in the world. At 9:00 am on August 19, the storage capacity of the barrier lake reached 550 million m3. Following the landslide, 6,600 people were evacuated along the river, and flood warnings were issued in Arunachal Pradesh and Assam in India.

5. Policy Recommendations

1. Improve long-term risk assessments and strategic adaptation planning; Build on scientific research and monitoring of glacier hazards; Establish early warning systems in locations that are at high risk of glacier flooding; Implement sustainable water management policies according to changing runoff.

2. Urgently enhance China's 2030 climate targets (nationally determined contribution), including increasing the carbon intensity reduction target and accelerating the timeline for peaking emissions.

3. Take the latest climate science, particularly the IPCC 1.5C Special Report on Global Warming of 1.5 Degrees, into consideration in planning for climate change mitigation, adaptation, and disaster relief.