

59 Dams: China's climate change challenges

China is building 59 dams to create new meltwater storage reservoirs - because climate change is beginning to cause permanent shrinkage of glaciers that feed its major rivers. New plans focus mainly on the western Xinjiang region, but water shortages could soon threaten the rest of the country – as well as India and other neighbours – due to melting of Tibet's Himalayan ice sheet. Climate change experts fear that as many as 1.7 billion people worldwide could be affected by water shortages in 2100 if nothing is done to slow the current global rate of greenhouse gas (GHG) emissions. China recently became the world's number one GHG polluter (per country) – so what is its response to the climate change challenges that lie ahead?

Why do China's megacities rely on meltwater?

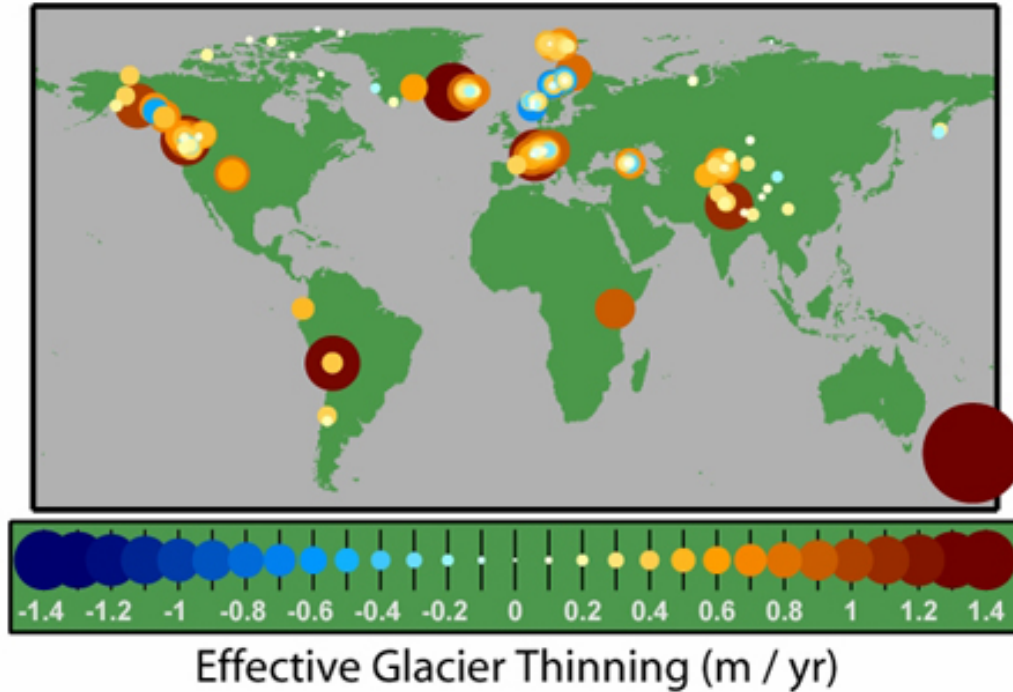
Major rivers in China, India and Vietnam are fed by seasonal melting of mountain glaciers. Every summer, icy water pours off the Himalayas and the Tian mountains. Flows from these massive hydrological stores feed into the Yangtze, the Hwang (Yellow) and other major rivers. As long as new snow falls onto glaciers each winter, cities in Asia are guaranteed a sustainable water supply. However, a warmer climate could lead to permanent shrinking and the eventual disappearance of mountain glaciers. Hundreds of millions of people would experience severely reduced water supplies.

China is home to 1.2 billion people, many of whom have recently moved to urban areas. By 2025, there will be 221 Chinese cities with populations in excess of one million, 8 of which will be **megacities** – settlements with over 10 million residents. But the sustainability of these growing settlements is threatened by a new lack of **water security** for the southeast Asian region as a whole. Many major rivers are fed by seasonal meltwater run-off from major glaciers in the region, notably the Himalayan Plateau.

Every summer, ice melts and feeds Asia's largest rivers. Fresh snowfall each winter replenishes the glaciers, meaning that over time the meltwater cycle is **sustainable**. However, climate change threatens to permanently reduce the size of glacial ice stores in the region. Although this will increase meltwater in the *short-term*, in the *long-term* it could lead to dangerous water shortages; because there will be very little ice left to melt!

A report in *The Guardian* newspaper (02 March 2009) states that the 3,800-metre Urumqi No1 glacier has lost more than 20% of its volume since 1962, according to the Cold and Arid Regions Environmental and Engineering Research Institute in Lanzhou. In total, about 80% of glaciers in the Tian range (a long spur of the Himalayas in western China) have declined in size (though increased precipitation has also led a small number to expand).

Mountain Glacier Changes Since 1970



Credit: World Resources Institute 2007 Earthtrends: Environmental Information

Chinese scientists have also calculated that glaciers on the Tibetan plateau have lost 989 million cubic metres of ice since the 1960s and will now continue to melt at a “worrying speed”. To put this in perspective, *The Guardian* explains that the Tibetan ice field has shrunk by 196 square kilometres - equivalent to one quarter the area of New York city (*The Guardian*, 02 March 2009).

The 59 dam solution

Details have now emerged of an **adaptation plan** that starts to address this new water security threat. A 10-year engineering project has commenced which aims to catch and store glacier run-off from the Tian range that might otherwise be lost to evaporation in the desert.

In the first phase of the project, 29 reservoirs will be built to intercept and store up to 21.8 billion cubic metres of meltwater from disappearing glaciers in the Tian, Kunlun and Altai mountains. Policymakers in Xinjiang will set aside 600 million Yuan (about £60m) over the next three years to pay for the works. Ultimately they hope to build 59 dams.

GCSE homework

- (a) Using an atlas, name FIVE large cities in China that are sited next to major rivers. (5)
- (b) Explain why it is necessary to build new dams along China's rivers to help protect future water supplies. (5)

India is also concerned

Predictions of dramatically decreased flows in the Indus basin over the next 100 years are alarming Indian scientists and policy-makers. A new Indian study titled "Mountains of Concrete: Dam Building in the Himalayas" reports that reduced snowfall will impact adversely on water supplies all the way downstream India's major rivers Indus and Ganges.

Indian scientists, like their neighbours in China, have recorded accelerated melting of glaciers and depletion of the massive water store of the region. In addition to long-term concerns with water supplies, they also fear that new hydrological hazards are being created by the outbursting of increased volumes of water from meltwater lakes hemmed in by glacial deposits or ridges of high land.

The report also suggests that new dam building in the Himalayas – although needed - will:

- transform the landscape, ecology and economy of the region
- submerge lands, homes, fields and forests on a large scale, displacing hundreds of thousands of people
- severely disrupt the downstream flows of major rivers, impacting on agriculture, fisheries and threatening livelihoods of entire populations
- lead to massive influxes of migrant construction workers, with implications for the culture and identity of local people
- bring dangerous risks to region that is seismically active

Source: *Hindu Times* 14 January 2009

How does glacial system theory help explain China's water problem?

Geographers build models that explain how glaciers work as complex systems. The body of glacial ice is a store that can change in size over time in response to inputs of snow and outputs of meltwater. When climate warms, outputs increase for a brief time as the ice store starts to melt. But once a large amount of the ice has melted away, further meltwater outputs must become much lower. All of this results in irregular water supplies that create major challenges for people that rely on meltwater supplies.

While climate remains stable, glaciers historically exist in a state of **dynamic equilibrium**. Falls of snow settle and form new ice in highland regions, providing an input to the glacial system called **accumulation**. Output flows of meltwater and evaporation are known as **ablation**. The net balance between accumulation

and ablation measure over a year is called the **annual budget**.

Although a glacier can experience a monthly deficit (high levels of meltwater loss) or surplus (significant new accumulation of snow), the annual budget – and thus the actual size of the ice mass - is usually relatively unchanging under stable climatic conditions. The **snout** of the glacier neither advances nor retreats, aside from minor seasonal shifts.

However, when climate warms significantly, changes can be observed that include a permanent up-valley retreat of the glacier snout (the opposite occurs when temperatures fall during a period of climatic cooling).

Climate change is predicted to bring global warming of at least 2 degrees, even if CO₂ emissions can be cut in half by 2050. Under such conditions, the major ice fields around the world would shrink, on account of the **snowline** shifting to higher altitude.

How do we know China's glaciers are retreating?

Evidence of glacial melt driven by climate change comes from two main sources:

1. **Quantitative** data has been produced by scientists since 1953. They have recorded the changing thickness and length of the Urumqi No1 Glacier (so named because it was the first icefield to be measured in China). According to the Cold and Arid Regions Environmental and Engineering Research Institute, the glacier has lost more than 20% of its volume since 1962 - as the temperature has increased by almost 1C during the same period. And the rate of shrinkage is still accelerating. For the first time last year, it was so warm in the summer that rain rather than snow fell on the glacier. A lake formed on the top of the icefield, which is retreating at the rate of nine metres a year.
2. **Qualitative** evidence comes from testimonials of locals who have witnessed the ice shrink in their locality. Ashengbieke is a tourist guide who told *The Guardian* newspaper: "While I was growing up, it used to be very cold here. It used to snow in summer, but now it rains instead." (*The Guardian*, 25 July 2008). Bahabieke, a nomad from the Kazakh ethnic group, also told the newspaper: "It has become warmer, especially these last two years."

Keywords

- **Dynamic equilibrium** means a balance between inputs and outputs of a system that is stable in the long-term but can fluctuate in the short-term.
- **Accumulation** means the addition of ice by snowfall or avalanching.
- **Ablation** is the loss of ice by melting and evaporation.
- **Annual budget** is the difference between total accumulation and total ablation for a year.
- **Snout** is the name given to the terminal (end) point of a glacier.
- **Snowline** is the altitude above which permanent snow is found.

A false sense of security

Chinese policy-makers are very concerned that increased meltwater runoff and river levels are, in the short-term, giving people a very misleading sense of security. The long-term prediction is water shortages for southeast Asia - but in the early stages of global warming, the exact opposite is observed. Thus, the problem may not be perceived to be real by people living in affected areas until it is far too late to do anything. The table “China’s vicious circle of water shortages” summarises the changes that can be expected – and the human response.

Stage	
1	Global warming is accelerating melting of China’s glaciers. This is causing them to shrink - but in a way that temporarily increases summer meltwater flows into rivers.
2	Few residents in cities that rely on this water understand the problem yet, because in recent years their summer water supplies have surged - thanks to the extra meltwater and some increased rainfall.
3	The excess supply has even been seen as a ‘bonanza’ – and is being used to water new golf courses and make artificial snow for a ski slope in the semi-desert region of Urumqi!
4	This means shortages will be even worse in the future, when the ice store has shrunk to such an extent that it no longer provides reliable supplies of meltwater runoff each summer.
5	Estimates of how long it will take Urumqi’s glacial meltwater supplies to start their decline range from 40 to 100 years.
6	To prepare for this, new dams are being built to store excess meltwater while runoff rates are still high. But no-one knows how long the new reservoir stores built up by excess meltwater will last for (some experts have called for the reservoirs to be built underground so that the water does not evaporate in the summer, when Xinjiang has the highest average temperatures in China).
7	The best hope for the region is that climate change also brings increased rainfall that can be captured and stored in the dams.

A2 homework

Explain the factors that can cause glaciers to advance or retreat. (20 mark essay)

In your answer you should:

1. Explain how glacial systems work and what is meant by the mass balance or glacial budget
2. Describe the seasonal changes that cause short-term advance and retreat
3. Describe and explain how long-term changes – either natural climate change at the end of the last ice age, or human-induced climate change today – can lead to major ice retreats and even the disappearance of glaciers altogether
4. Evaluate the relative importance of short-term and long-term factors for glaciers today

What are China's adaptation or mitigation strategies for climate change?

After a slower start than some countries, China is increasingly embracing a range of climate change adaptation and mitigation strategies. Along with India, China was not asked to be a signatory to the Kyoto Agreement in 1997. Both of these large emerging economies were not initially expected to place environmental concerns ahead of meeting their own economic development goals. However, so serious have the predictions and early signs of global warming become, that China is now seizing the initiative in moving forwards its own new adaptation and mitigation measures.

According to the *Financial Times* (15 September 2008): "The good news is that Beijing has started to articulate a clear strategy for addressing the issue... The main plank of China's climate change plan is a tough set of goals for energy efficiency. Between 2006 and 2010 the government aims to cut energy wastage by 20 per cent. The results for 2006 were well below target, but for 2007 the government got close to the level it needs to meet the five-year target. The government has also set an ambitious goal for using renewable energy, hoping that by 2020 about 20 per cent of electricity needs will be met by wind, solar and hydropower."

Keywords

- **Adaptation** means dealing with the consequences of climate change, for instance by strengthening flood defences.
- **Mitigation** means slowing global warming by tackling the underlying problem of the build-up of greenhouse gases, for instance by switching to renewable energy sources.
- **Eco-city** is a planned settlement with a much lower ecological footprint than conventional towns and cities, usually thanks to energy-efficient architecture and renewable energy supplies.
- **Ecological footprint** is a measurement of the total area of land needed to provide an individual or society with the energy, food and resources they consume and the waste they produce.

Adaptation measures

The new dam building programme that we studied is an example of an adaptation measure. This is a response to water shortages that does not seek to tackle the underlying problem of global warming but instead looks to minimise impacts on people's lives – by managing the loss of ice in a way that maximises water stores. However, this adaptation measure is, by its nature, only a short-term solution. If China's glaciers shrink significantly in size, then there will one day be very little meltwater left to fill the reservoirs unless rainfall increases greatly.

Mitigation measures

Attempts at climate change mitigation involve tackling the problem at its source - in this case, trying to reduce GHG emissions and prevent a significant and dangerous rise in world temperatures. Two notable Chinese strategies have recently been reported:

- *China's wind turbines* China's industrial miracle has been enormously over-dependent on coal, to the extent that one new coal-burning power station was, until recently, being built every few days. This kind of future is unsustainable – not just due to the impact burning fossil fuels has on the atmosphere but also for reasons of energy security: it is in China's long term interests to input greater use of renewables into its energy equation. The *Financial Times* (17 April 2009) reports that China is now the world's fourth-largest wind turbine market. It doubled its capacity in 2008, a rate of growth three times higher than the rest of the world. Much of the build-up is taking place on the grasslands of Inner Mongolia.
- *China's Ecocities* Many of these ambitious projects were intended to be models of green urban design involving the construction of entire new settlements that aimed to have minimal ecological footprints. Unfortunately in recent years many plans have been scrapped or projects abandoned. One project in particular, Dongtan, was set to be a 8,400 hectare city close to Shanghai that aimed to have a greatly reduced ecological footprint compared to a conventional city. Renewable energy, reliable public transport and high levels of water efficiency would give Dongtan's 50 000 residents an ecological footprint of just 2.6 global hectares per person (the figure is 5.5 for a conventional city footprint). The plan has been dropped though, mainly due to corruption of the political figures who championed the scheme. Environmentalists have also recently spoken out about the negative impacts Dongtan would have had on local wetlands. Whilst the design and purpose of these cities aimed to mitigate the negative effects rapid urbanisation brings, problems arose with the planning and design being undertaken by international firms, with little or no, local consultation. For green living to succeed it not only has to limit carbon emissions but actually be liveable — and adapted to local circumstances. [Read more](#)