Impacts underground

Concomitant with river flows, there are less data to show how China’s groundwater supplies have changed over recent decades. Yet groundwater is increasingly important to the economy. In the water-deficit northern China it supports substantial domestic, industrial and agricultural use, including about 50% of irrigation and as much as 70% in some areas — in part because surface sources have become scarcer while water pollution has

The ACCC project is modeling the response of groundwater to the Huanghuaihai Basin. The study area is a humid region in northern China to climate change. Natural groundwater replenishment in this region is estimated at 35-45% (Power, 2002), of which comes from rainfall. As noted above, the combination of climate change and human activities in the area has driven significant groundwater levels. For example, groundwater levels in the study area have fallen by more than 15 meters in some areas. The study area is characterized by over-extraction and pollution and is now at risk of groundwater levels being driven to zero.

Implications for adaptation planning

As China’s economy grows and demand for water increases, China will need to develop robust systems for managing water in a changing climate. However, China is not alone in experiencing these changes. Major regions in the world, including the United States, Europe, and Australia, have developed robust systems for managing water in a changing climate. However, China is not alone in experiencing these changes. Major regions in the world, including the United States, Europe, and Australia, have developed robust systems for managing water in a changing climate.

According to the ACCC project, climate change will affect water resources in a number of ways. These effects include changes in precipitation patterns, changes in streamflow, changes in evapotranspiration, and changes in groundwater levels. These changes will have significant implications for water resources management in China.

References

15. Climate change is one of a number of pressures driving agricultural intensification in China. Water, weather, climate change, urbanization, and industrialization are increasing demand and driving pressures. At the same time, climate change is making more variable and less predictable rainfall and drought conditions.

About the ACCC Project

The Adapting to Climate Change in China Project (ACCC) is an innovative policy research project, supporting China’s response to the impacts of climate change through participatory adaptation planning. ACCC provides decision-makers with the policy-relevant information they require, linking into account current and future climate change and variability. ACCC aims to improve understanding and assessment of impacts, vulnerability, and risk in the context of China’s economic development by bringing together policy and research, national and subnational planning, social and physical science for an integrated approach. This project shows the need for and lessons learnt with other developing countries in order to reduce their vulnerability to the impacts of climate change.

For more information, please visit our website at www.roadmap-collaboration.org.cn.

Key messages

1. Water supply is high water levels, with water resources rarely a concern. However, the present climate is experiencing a variety of conditions, including drought, floods, and extreme weather events. The ACCC project shows how the climate modeling may be used to improve water resources management in China.
2. ACCC project shows how climate change may influence water resources management in China. This may lead to a new way of understanding climate change and its impacts on water resources and management, connecting other non-climatic forces such as urbanization with better management of existing storage, and more nuanced policies of water conservation and sustainability.

Figure 8. Changes in rainfall (mm) from 1981-1990 to 2020-2030, northern and southern China and during flood season (right), based on PMOD data. Northern Asia, Asia and Australia show process interaction, high and low pressure systems intensification, variability. Lower pressure increases is caused by southward migration processes. Source: Wang, et al. (2012).
Climate change in China adds pressure on water resources already under stress, making the water sector a top priority in China’s national adaptation programme.

Declining water resources in China: is climate change a cause?

Across China as a whole, water resources have shrunk since the 1960s though some regions have actually led a rise or become water-rich today [Source: 2.1]. The world bank estimates the overall water scarcity and pollution at around 23.7% of GDP [6.1].

Agriculture remains China’s biggest water user, accounting for roughly 60% of total usage, mainly in the north [2.1]. This share is climbing daily as water conservation policies generate more crop yield and releases water for other uses [2.1]. The ACCC project is using climate models, water consumption abstraction and hydrological models to simulate these changes [6.1].

It is challenging to understand how much of the decline in water supply is due to rising demand and pollution, and how much is due to climate change. The ACCC project is using climate models, water consumption abstraction and hydrological models to simulate these changes [6.1].

Climate change impacts have been widely discussed since the 1960s [2.1], but the debate has been muted by the scientific community [2.1]. China’s climate experts have warned since 1994 (3.2), the world bank notes, with regret, the “hardest hit” counties. The Yangtze river basin, one of China’s most water stressed, human societies are the major causes of decline [3.2].

Changes recorded at Daxiong in the lower Yellow river show a marked change in the period 1908-2010 [2.2]. Flows have actually declined in the upper basin, due in part to less precipitation. In the middle and lower reaches, however, increased pricing and household subsidies have increased water use. A similar pattern is found in the Pearl River lower-estuaries [2.2].

Under all emissions scenarios, annual runoff in the grain-rich Yellow river basin is expected to decline 2-6%.

Particularly important for agriculture are changes during June-September, the flooding and growing season. Trends for the period are similar to those more pronounced in China, drought affecting areas such as the Yellow River basin [3.2].
Declining water resources in China: is climate change a cause?

Across China as a whole, water resources have shrunk since the 1960s though some regions have dried out or become water-stressed (Box 2). The World Bank estimates the cost of water scarcity and pollution at around 3.7% of GDP (2007). Agriculture remains China’s biggest water user, accounting for roughly 60% of withdrawal, mainly in the north. This share has been declining as water conservation policies generate more gross crop yield and release water for background urban and industrial uses. As a combined demand has fallen, so has the production of wastewater and pollution, making clean water even scarcer.

It is challenging to understand how much of the decline in water supply is due to rising demand and pollution, and how much to climate factors. The ACCO project is using climate models, water consumption analysis and high-resolution hydrological models to explore these two drivers. China’s climate-related water variables since 1995 (1.2°C) has warmed, raised the southeast coast. Country-wide precipitation over the same period has not changed significantly, but there are significant differences between the northeast (decreasing), the southwest (increasing) and the northwest (staying the same) precipitation. The Yellow river basin in north China, with less rainfall and higher temperatures, river flows have fallen sharply over the last 40 years, particularly in the lower reaches of the basin (Figure 3). This reflects both climate changes and human activity, but increased withdrawals of water for irrigation, industry and domestic use are dominance (4.3 km³), the Yangtze basin in the southwest, one of China’s most water-stressed, human activities are also the major causes of decreasing flows. China’s water use has been growing since 1995 (1.2°C) has warmed, raised the southeast coast. Country-wide precipitation over the same period has not changed significantly, but there are significant differences between the northeast (decreasing), the southwest (increasing) and the northwest (staying the same) eastern and north of the Yangtze-Kang river basin. Flows recorded at Datong in the lower Yellow River river flows have dropped (the period 1960–2009). Flows have actually increased in the upper basin, due to less rainfall in the middle and lower basins, thereby increased water demand and exacerbated drought conditions. Weather fronts contribute to high (40–50%) declining in the Yangtze and Yellow river basins. Declining flows in the Yangtze and Yellow river basins are mostly due to human consumption, whereas climate change is already a major factor affecting the Yangtze and Pearl rivers.

Climate change in China adds pressure on water resources already under stress, making the water sector a top priority in China’s national adaptation program.

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Declining water resources in China: is climate change a cause? Across China as a whole, water resources have shrunk since the 1940s though some regions have seen less decline or even become water larger. The World Bank estimates the cost of water scarcity and pollution at around 2.5% of GDP (2005). Agriculture remains China’s biggest water user, accounting for roughly 60% of withdraws, mainly in the north. This share is steady declining as water conservation policies generate more crop productivity and releases water for non-agricultural use. Urbanization and industrialization accelerate as another demand stress, so does the production of wastewater and pollution, making clear water even scarcer.

It is challenging to understand how much of the decline in water supply is due to rising demand and pollution, and how much to climate change. The ACCC project is using climate records, water consumption alarams and hydrological models to separate these factors.

China’s climate data have waxed and waned since 1990 (2°C), the northeast has waxed, the southwest has waned. Country-wide precipitation over the same period has not changed significantly, but there are significant differences between the northeast (decreasing), the northwest (increasing) and the southwest (increasing).

In the Yellow River basin in north China, with less rainfall and higher temperatures, river flows have fallen sharply over the last 40 years, particularly in the lower reaches of the basin (Figure 3). This reflects both climate change and human activity, but increased withdrawals of water for irrigation, industry and domestic use are dominant. The large-scale seawater intrusion on China’s most water-stressed, human societies are the major causes of decline.

Flows recorded at Dongying in the lower Yellow River shows a marked decline in the period 1960 – 2010 (Figure 2). Figures have actually declined in the upper basin, due in part to less precipitation. In the middle and lower basin, however, increased irrigation and flood control measures have lowered river flows. A similar pattern is found in the Pearl River further south.

Declining flows in the Yellow and Helle River basins are mostly due to human consumption, whereas climate change is a major factor affecting the Yangtze and Pearl rivers. Under all emissions scenarios, annual runoff in the grain-rich Yellow River basin is expected to decline 2-6%. Particularly important for agriculture are changes during June-September, the flooding and growing season. Trends for the period are also shown in a more pronounced pattern for June. Differences in the Yangtze River, where rainfall affects mainly the rainy season.
Impacts underground

Compared with their riverbanks, there are less data to show how China’s groundwater supplies have changed over recent decades. Yet groundwater is increasingly important to the economy. In the water-deficit northern-southern China it supports substantial domestic, industrial and agricultural uses, including about 50% of irrigation and as much as 75% in some areas. In part because published sources have become scarcer water quality is getting worse.

But over-exploitation and pollution are now exerting high levels. On the North China Plain in the northeast, for example, groundwater levels in the shallow aquifers have fallen by more than 15m over the past 40 years, an even greater decline in urban areas (Figure 4). The value of arable land production throughout China that could not be far from unsustainable groundwater use has been released at an annual rate of about 12% million cubic meters. Many remaining groundwater sources are becoming depleted, and in a worst-case scenario, some 11% of urban areas will face ‘water quality, with a worsening trend.

The ACCC project is modelling the response of groundwater to the Huanghua-Ili (Hari) plain in northeastern China to climate change. Natural groundwater replenishment in this region is estimated at 34% of the flow, 75% of which comes from rainfall. As noted above, however, the combination of climate change and human activity may be quite different from what groundwater use has been at an annual rate of about 30% million cubic meters. Many remaining groundwater sources are becoming depleted, and in a worst-case scenario, some 11% of urban areas will face ‘water quality, with a worsening trend.

Climate change amplifies existing patterns of shortage and excess. These pressures and uncertainties may require a new strategy of demand management, especially for non-irrigated sources such as urban water use, with a new strategy of demand management, especially for non-irrigated sources such as urban water use, and improved policies to mitigate emissions, and new emphasis on water conservation and recycling.

References

14. Climate change is one of a number of pressures on water resources in China. As China’s growing economy and population for water resources, China will need to develop novel systems for water resources management to ensure water availability in a more sustainable and cost-effective manner. At the same time, climate change is having more severe and abrupt effects on water sources. This may require a new look at demand management, consisting of non-traditional sources such as urban water use with better management of existing storage, and new emphasis on water conservation and recycling.

About the ACCC Project

The Adapting to Climate Change in China Project (ACCC) is an innovative policy research project, supported by China’s response to the impacts of climate change and water-related basin-based adaptation planning. ACCC provides decision-makers with the policy-related information they require, linking to other accounts and future climate change and variability. ACCC aims to improve understanding and awareness of impacts, vulnerability and risk in key sectors in China, to bring together policy and research, and national and sub-national planning, social and physical science for an integrated research. This project shows the links between the project and lessons learned with other developing countries in order to reduce the vulnerability to the impacts of climate change.

For more information, please visit our website at www.adaptingchina.org.cn.

Key messages

- Although climate models agreements will continue, rapid population growth is not expected. However, the projected population growth will be slow, particularly in northern and eastern regions, where urbanization is expected to accelerate.
- Water security will be critical to China’s economic and social development, especially in the context of climate change. The Adaptation to Climate Change in China project focuses on how the local climate modeling and adaptation decision-making processes are being improved in different regions, including the agricultural sector.
- Climate change is one of a number of pressures on water resources in China. As China’s growing economy and population for water resources, China will need to develop novel systems for water resources management to ensure water availability in a more sustainable and cost-effective manner. At the same time, climate change is having more severe and abrupt effects on water sources. This may require a new look at demand management, consisting of non-traditional sources such as urban water use with better management of existing storage, and new emphasis on water conservation and recycling.

Figure B: Changes in rainfall (mm) from 1981-1990 to 2021-2050, southern (wd) and dry (wd) periods only, based on PR2EX model. Southern A2, A1B and B2 emission scenarios. High and low greenhouse gas emissions, respectively. Blue diamonds indicate increased growth in crops; red indicates increased yields. Source: Ming et al., 2015.
Impacts underground

With conventional water resources, there are less ways to know China’s groundwater supplies have changed over

The AOC Project is modeling the response of groundwater flows in the Huanghe River basin in northwestern China to climate change. Natural groundwater replenishment in this region is saturated at 4:1 in the summer, and 72% of which comes from rainfall. As rainfall drops, the balance between precipitation and groundwater use has shifted, with an overall decline in millimeter (mM) precipitation. Many remaining groundwater supplies are becoming depleted, and at least 70% of the area is threatened by a lack of water quality. With a warming trend, China’s future measures to adapt to the changing climate should be:

1. Understand the importance and irreversibility of impacts climate change on water resources, and incorporates the impacts of climate change into water resources assessment and planning.

2. Improve the iterative and circular utilization of water resources, advance management of water demand and build a water-saving society.

3. In the most vulnerable regions, construct new water infrastructure, adopt strict water-conservation policies and maintain the capacity of water resources.

4. Develop water availability by increasing the use of unconventional sources.

5. Develop better emergency response plans, and improve predictability and capability for emergency responses to extreme events.

6. Accelerates the development of the national water resources management and information system, provide reliable information for management and decision making.

7. Increase awareness of climate risks and ensure a new trend on water management resources.

References


12. Key messages

- Although climate models agree warming will continue, rainfall projections are less certain. However, the phenomenon of wet to dry conditions is predicted, increasing water security in some northern regions and decreasing in others.

- As China’s economic growth and population for water resources, China will need to develop complex systems for water management in all seasonal and weather conditions, particularly in the water-scarce north. This may require a new kind of adaptation, managing scarce resources to non-traditional sources such as urban waste water with better management of existing storage, and reduce more intensive water conservation and consumption.