

## China – water supply and demand

By Sally Garrington

### Synopsis

Over the last four decades, China has performed an economic miracle and may now be poised to be the next global superpower. However, growth of its population and manufacturing output has impinged on its environmental resources, particularly its rivers, lakes and groundwater. Its rate of water usage is not at present sustainable. This unit offers an overview of the water resources of China and the challenges it is facing in the 21st century. It investigates the huge growth in demand for water and reasons behind it, as well as the problem of untreated wastewater and the constraints of the climate. These factors have all had a role in creating the challenges of the water crisis the country now faces. There is an overview of some of the possible solutions to the uneven distribution of precipitation in the country, including the use of mega dams and the planned water transfers from the wetter south to the drier north of the country. Other, less large-scale, solutions are also discussed. The country has to determine how it can overcome serious water shortages without permanently harming its environment and the resource itself, whilst at the same time attempting to maintain its rate of development.

### Key terms

**water abstraction, South North Water Transfer Project, evapotranspiration, aquifer, water table**

### Learning objectives

This case study will help you answer questions about:

- Water as a resource – its use and abuse in both urban and rural environments
- Water as a cause of conflict, both locally and internationally
- Overuse of a natural resource, and its consequences on natural and human environments
- The impact of a declining resource on health and food supply
- How global warming can exacerbate a problem.

Exam Board	Link to specification
<b>AQA</b>	Unit 3, GEOG3 Contemporary Geographic Issues, The Human Options, Option 5: Development and Globalisation, Development issues within the world, 'Economic sustainability versus environmental sustainability', see page 12 <a href="http://filestore.aqa.org.uk/subjects/specifications/alevel/AQA-2030-W-SP-14.PDF">http://filestore.aqa.org.uk/subjects/specifications/alevel/AQA-2030-W-SP-14.PDF</a>
<b>Edexcel</b>	Unit 3, Contested Planet, Topic 2: Water conflicts, see pages 55–57; <a href="http://www.edexcel.com/migrationdocuments/GCE%20New%20GCE/UA035234_GCE_Lin_Geog_Issue_4.pdf">http://www.edexcel.com/migrationdocuments/GCE%20New%20GCE/UA035234_GCE_Lin_Geog_Issue_4.pdf</a>
<b>OCR</b>	A2 Unit F763: Global Issues, Section B: Economic Issues, Option B1: Population and Resources, see pages 38 and 39; Option B3: Development and Inequalities, see page 44 <a href="http://www.ocr.org.uk/Images/69036-specification.pdf">http://www.ocr.org.uk/Images/69036-specification.pdf</a>
<b>WJEC</b>	Unit G4, Sustainability, Theme 2, Sustainable Water Supply, see page 47 <a href="http://www.wjec.co.uk/uploads/publications/6312.pdf">http://www.wjec.co.uk/uploads/publications/6312.pdf</a>
<b>CCEA</b>	Unit A2 2: Physical Geography and Decision-Making, Section A, Physical Geography, Option A: Fluvial and Coastal Environments, 'Human demands on fluvial and coastal environments'; 'River and basin management strategies', see page 25 <a href="http://www.rewardinglearning.org.uk/qualifications/results.aspx?g=1&amp;t=1&amp;c=R&amp;s=0&amp;v=0&amp;f=0&amp;q=182&amp;d=d">http://www.rewardinglearning.org.uk/qualifications/results.aspx?g=1&amp;t=1&amp;c=R&amp;s=0&amp;v=0&amp;f=0&amp;q=182&amp;d=d</a>
<b>CIE</b>	Paper 3: Advanced Human Geography Options, Environmental management, see page 23 <a href="http://www.cie.org.uk/images/164517-2016-syllabus.pdf">http://www.cie.org.uk/images/164517-2016-syllabus.pdf</a>
<b>International Baccalaureate</b>	Geography Diploma Programme, Paper 1, Core Theme, Patterns and Change <a href="http://ibgeog2009.wikispaces.com/Resource_Consumption_Patterns">http://ibgeog2009.wikispaces.com/Resource_Consumption_Patterns</a>

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Roughly the size of Europe, China is the third largest country in the world and has the world's largest population, at 1.4 billion (2013). Two-thirds of the country, mainly in the west, consists of high plateaux and mountains where only about 6% of the population live and agriculture is limited. Eastern China has fertile plains of large rivers such as the Yellow (Huang) in the north, the Yangtze (Chang) in the centre and the Pearl (Zhu) in the south. Like most of China's rivers, they flow west to east, and it is in these eastern regions that most of China's population live. With its large and still increasing population, China has a growing demand for water to grow crops to feed its people, to enable continued industrial development and for an increasing level of domestic use. However, the country is in the throes of a water crisis which, coupled with global warming, is set to get worse. It is facing two main problems – regional water scarcity, and water pollution.

## Climate

Although southern China has a humid subtropical climate with ample rain, the north of China (which contains two deserts, the Gobi and the Taklimakan) is increasingly arid and suffers from water shortages (Figure 1). In southern China the land heats up and draws in moist air from over the South China Sea. On meeting the mountains and cooler air masses, rain falls as part of the summer monsoon. Further north and west, there is less rain, and in some years the monsoon rains fall just on the southern half of China and fail to reach as far as the Yellow River. In these years there can be severe floods in the south and

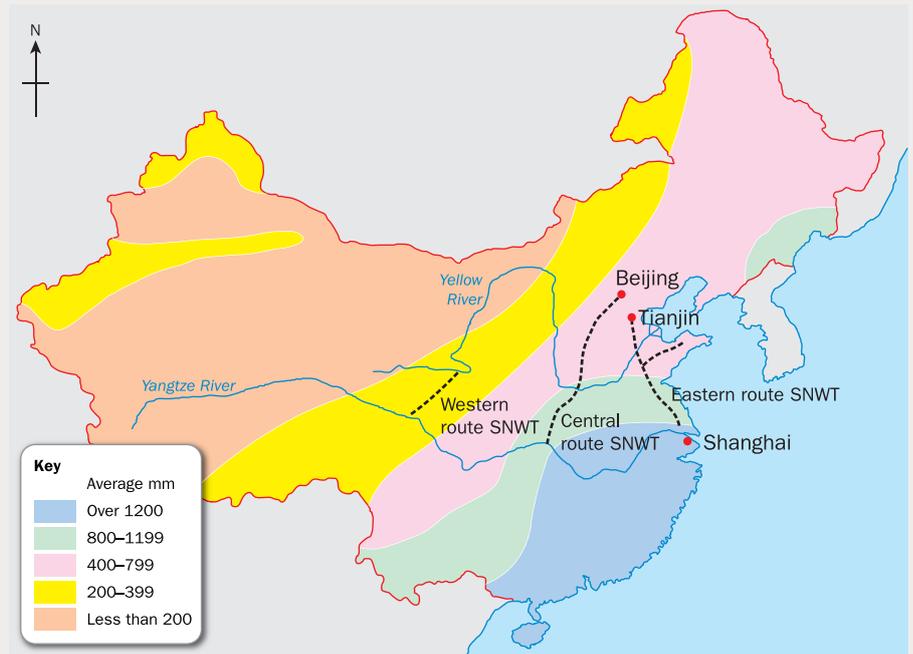


Figure 1 China – annual precipitation

droughts in the north (although in extreme years the south can also experience drought).

Overall, China experiences low rainfall. It has 20% of the world's population but only 7% of its freshwater, and as can be seen in Figure 1, it is unevenly distributed:

- South of Yangtze River there is 37% of the land mass and 81% of China's freshwater.
- North of the river, there is 63% of the land mass but only 19% of the country's freshwater.

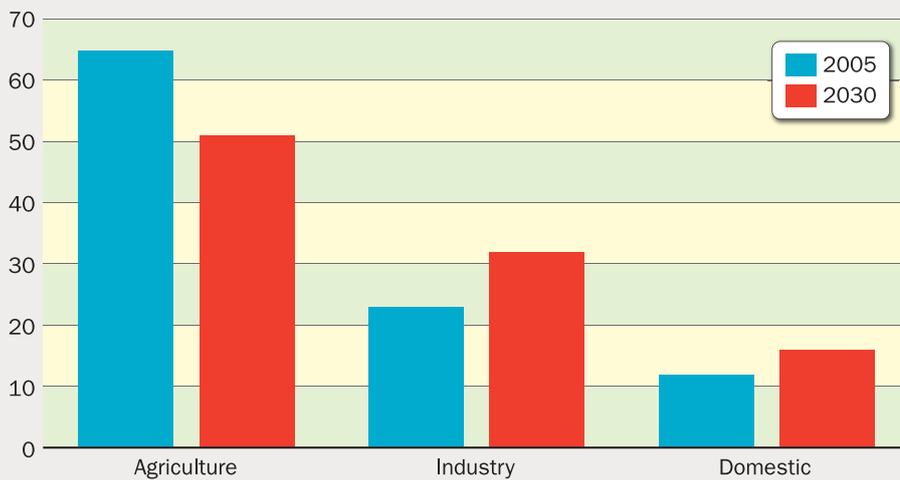
Global warming is thought to be exacerbating this difference in water resources, with more and longer droughts in the north. The north traditionally has been the 'bread basket' of China and grows large volumes of wheat – now under threat from the increasingly frequent droughts.

## Water demand

As China's population has grown and standards of living have improved, demand for water has increased by over 400%. More

homes now have piped water and washing machines. China's rapid industrial development has also made huge demands on its water resources, but the largest consuming sector is still agriculture. Figure 2 shows the division between the sectors and how it will change by 2030. The lack of precipitation in the north of the country has led to groundwater stores (aquifers) being used. In fact 60% of water used by the Chinese comes from these. This is especially so in the north, whereas in the south, surface water from rivers and lakes is dominant. The over-abstraction of groundwater has meant that water tables have fallen, especially below cities. This has caused subsidence and the collapse of some buildings. In parts of Beijing, the water table has fallen by up to 300 metres.

The government is focused on development, but now realises that without a sustainable water supply there will be serious problems in the near future. At present China relies heavily on coal-fired power stations,



**Figure 2** Sector share of water resources, 2005 and 2030 (est)

with new ones being opened every month. Large amounts of water are used to process the coal. Huge amounts of pollution enter the rivers from untreated industrial wastewater from coal and other industries. The incidence of cancer has increased by 80% over the last 30 years (often clustered in certain villages), linked to contaminated drinking water.

Agriculture in the north is heavily dependent on irrigated farming (60%). With the rivers failing to provide enough, farmers drill boreholes to access the groundwater – often illegally – and add to the massive reduction of the aquifers. Figure 3 summarises some of the reasons for the increase in demand for water.

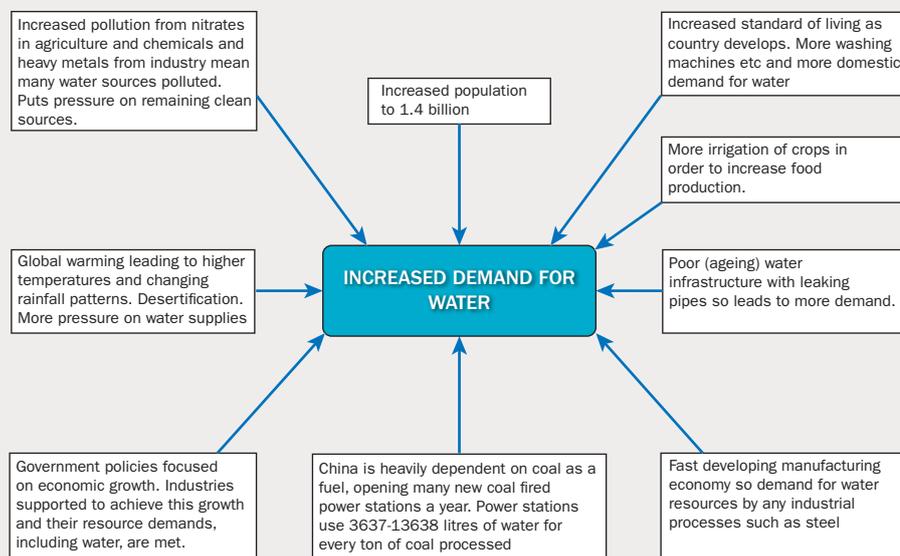
### Challenges of maintaining China's water supply

Figure 4 shows some of the problems associated with increased water demand in China. Agriculture is confronted by water shortages, and much of what is available is heavily polluted. 33% of the Yellow River's water is too polluted to use even for watering crops. Much of the irrigation carried out is inefficient, with less than 45% of the water sent down the systems actually reaching the crops. Cities have to cope with polluted drinking water plus the problems of subsidence. Rapid urbanisation without adequate sewerage systems in place has meant most wastewater going directly into the

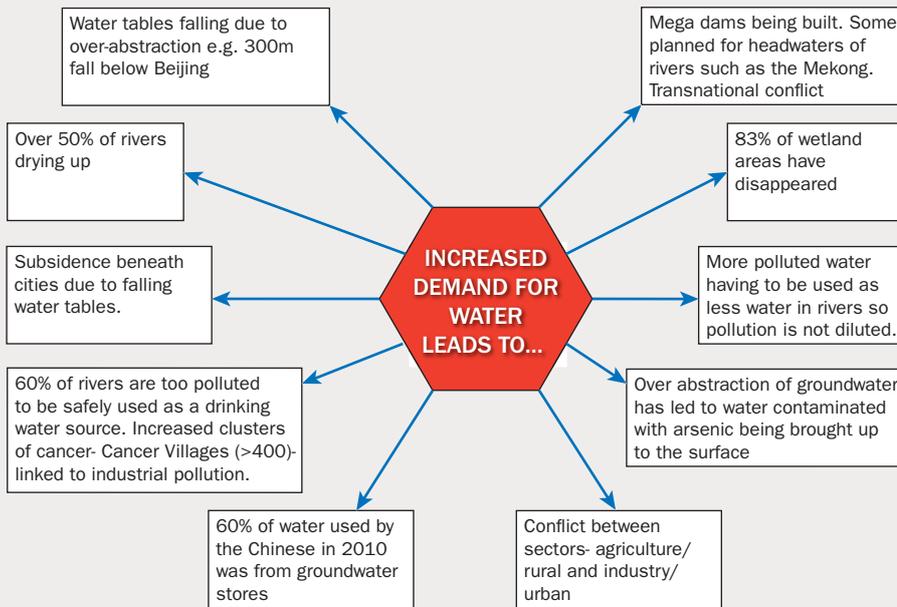
rivers. The natural environment is suffering, not just the river ecosystems but the drying-up of wetland areas. In the 1950s China had over 50,000 rivers – today there are fewer than 24,000 remaining. 75% of China's lakes suffer from eutrophication caused by run-off from agriculture and from sewage.

China's north is an important agricultural area, but suffers most from water shortage. Groundwater supplies are over-used, with over 3.5 million tubewells, and are not being recharged. Most of the water sources are contaminated by pollution, and yet China continues to develop. What can be done?

One solution for the Chinese is to build dams in the headwaters of rivers such as the Mekong (which flows into Laos, Cambodia and Vietnam) and the Brahmaputra (which flows into India and Bangladesh). Seven dams have already been built on the upper Mekong in China, altering the flows which are relied on in the countries downstream causing international tensions. Although built mainly for the provision of HEP, there are plans afoot to transfer water to the Yellow River. China has over 100 more dams planned around the country. Many are large-scale, like the Three Gorges Dam on the Yangtze River, near the city of Yichang (Figure 5). Although the main reasons for its construction are flood control and HEP production, water upstream of the dam is used for drinking water and for irrigation. Huge cities like Chongqing (32 million) empty their wastes into the river upstream of the dam and the water quality of the upper Yangtze is declining, being held back behind the dam. Below the dam, the pollutants from the riverside cities are not as diluted as before construction of the dam, and ecosystems are being negatively affected.



**Figure 3** Reasons for the increase in demand for water in China



**Figure 4** Problems associated with increased demand for water in China

### The Yellow River

Once known as ‘China’s Sorrow’, the Yellow River is now largely under control through a series of dams. Today issues of water scarcity are the problem, along with overuse of water resources and environmental degradation. The Yellow is the second longest river in China, after the Yangtze, running through nine provinces, supporting 9% of China’s population. From its source to when it enters the ocean, it falls 4500 metres. It cuts through the sandy loess plateau (made up of sand blown in from the Gobi Desert) in its middle reaches, which provides 90% of the

river’s very heavy sediment load. In the upper reaches, evaporation due to high temperatures can exceed the precipitation, and the river suffers low flow. In recent times, over-extraction of water from the river for industry and agriculture has sometimes resulted in no water reaching the ocean. Average rainfall along the basin is only 522 mm per annum. There are 10,000 reservoirs in the basin, with 380,000 tube wells which access the declining groundwater. Since the 1950s there has been a 440% increase in the consumption of river water, as this is an important wheat-growing area.

The drought years of the 1990s, when the river failed to discharge into the ocean, caused real concerns. Between 1995 and 1998 there was no river flow into the ocean for 120 days a year. This led to a more integrated being undertaken by the Yellow River Conservancy Commission, with allocations being organised for each sector and more careful monitoring of extraction. The allocations can be altered monthly, weekly or even daily, if conditions dictate it is needed. Although since the 1990s there have not been any no-flow years, the flows are often very low. The Yellow River is also heavily polluted as there is not enough water to dilute the industrial toxins or the sewage from the cities. However, the management is going in the right direction and enough flow is kept in the river to maintain the major ecosystems.

### Possible solutions

Figure 6 summarises some of the possible solutions to China’s water supply and demand problems. The government realises that something has to be done. The World Bank has estimated that if water abstraction continues at the present level and the climate continues to warm, China may have over 30 million environmental refugees in the north of the country by 2030, due to a lack of clean water.

One of the most controversial solutions is that of the South North Water Transfer Project. This project aims to make up the water shortage in the north by diverting and transporting water from the Yangtze in the wetter south. The Yangtze has an annual discharge of 956 km<sup>3</sup>p/a, and the amount diverted, when the project is completed, will be 44.8 km<sup>3</sup>p/a. Three routes are planned – the western, central and eastern routes, which are marked on Figure 1.



**Figure 5** The Three Gorges Dam Source: Sally Garrington

- Eastern route – uses much of the 1900-km ancient Grand Canal (built between 486 BC and AD 500) for part of its route towards the city of Tianjin. The water is pumped along the Grand Canal, under the Yellow River via a tunnel and then to large reservoirs. Much of this route is now complete but problems have already occurred, as the water from the Yangtze is so polluted it has been killing fish in lakes that are fed by the transfer.
- Central route – takes water from the Danjiangkou Reservoir on

the Han River (a tributary of the Yangtze). Only the northern part of this route is completed and feeds Beijing, travelling under force of gravity. So far this section has cost \$2 billion and the whole Transfer Project is now expected to cost over \$62 billion.

- Western route –still at the planning stage.

Although the north needs more water, many experts feel that more efficient use of water, along with quotas and water-saving techniques, could produce similar results, with

less impact on the environment and costing far less. People would not have to be displaced because of dam construction and the Yangtze could still fulfil its role as a major transport artery, even in years of low flow.

### Management

Three ministries share the management of water resources, but there is no single policy document for water supply. There are so many different agencies involved that it is difficult to work together to plan for the future. The river basins that have Conservancy Commissions are moving towards more integrated management of their rivers, but it is difficult to balance all demands. The Water Law of 2002 brought in a strict licensing law to allocate quotas to the agricultural, industrial and domestic sectors, but it has been difficult to monitor this. 2010 saw more stringent pollution laws being passed to try and reduce the amount of polluted water from entering the rivers without treatment. China has a programme of building more sewage treatment plants, but still only about 50% of all sewage is treated before being discharged into rivers. Cities without adequate systems will soon face inspections and be forced to implement improvements.

### Conclusion

There are great challenges in creating and maintaining an equitable water supply in China. The pressures of rapid development and the competing demands for water resources make it very difficult to achieve an equitable and sustainable supply. Policies need to be strengthened if water is not going to be a constraint on future development and to ensure an adequate supply for all citizens.

Solution	Description
Use of water quotas for the different sectors	Possibility of trading water quotas from the south where rainfall is more abundant, to the drier north.
Pricing of water to more reflect its true cost.	Unpopular and will affect the poor more but would provide capital for improving water systems. A tiered pricing system is to be introduced in 2015.
New dams and reservoirs on headwaters of Mekong and Brahmaputra rivers	Would access water in mountainous areas to be transferred to drier areas.
Improving irrigation techniques	Use of drip irrigation, covering irrigation channels with plastic to prevent evaporation.
Improved and integrated management of river basins	All elements of water supply and demand are managed as one. Better planning.
Education as to impact of excessive water use	Schools and public try and limit demand
Recycling and reuse of water	Systems built so that this is possible- such as using grey water (e.g. bath water) to water gardens.
Increased use of drought resistant crops in the north	Hybrid crops that need less water to grow.
Use of plastic covering and/or mulches on crops	Reduces evapotranspiration.
Desalination Plants	Located on coast to produce freshwater from seawater.
National initiative to reduce water wastage and leaks	Water supply system, where it exists, is in poor condition with high incidence of leaks. Repairing would reduce demand.
Treatment of domestic waste water	More sewage treatment plants so that river water can be better processed for drinking water.
Treatment of agricultural runoff and industrial effluent	Better monitoring and installation of treatment facilities.
Use of fines for polluters	Regular monitoring of discharges with accompanying fines if standards not met.
Growing food crops in other continents such as Africa and importing	Controversial but would save water in China if crops with high water demand were grown elsewhere- but how sustainable?
Transfers of water from the wetter south to the drier north of the country	South North Water Transfer project. Huge engineering undertaking which will have impacts on the lives and ecosystems of the rivers involved.

Figure 6 Possible solutions to the water crisis

### Focus questions

- 1 Outline with examples how accessing a resource can lead to conflicts.
- 2 Explain, with examples, the link between development and increased use of water.
- 3 Referring to Figure 6, suggest how can water demand be made more sustainable within a country.
- 4 The South North Water Transfer Project will be the largest and most expensive water supply system in the world when completed in 2050.
  - (a) Explain why the Chinese government thought it was necessary.
  - (b) Outline the likely impacts of this project – both positive and negative

### Learning checkpoint

While you're studying this unit, consider the following questions:

- How does rainfall vary across China?
- Why is the north so much drier than the south?
- Why is demand for water increasing in China?
- List the impacts of this increasing demand for water.
- How does water demand vary within the sectors of agriculture, industry and domestic?
- Figure 2 – suggest reasons for the change in share of water resources between 2005 and 2030.
- What is the aim of the South North Water Transfer Project and why was it thought necessary?
- Suggest more sustainable solutions to water shortages than the SNWTP.
- What conflicts could increasing water demand cause in China?
- Suggest how increasing global warming might impact on water supply and demand in China.