Geo Factsheet

Number 114

The Three Gorges Project

Introduction

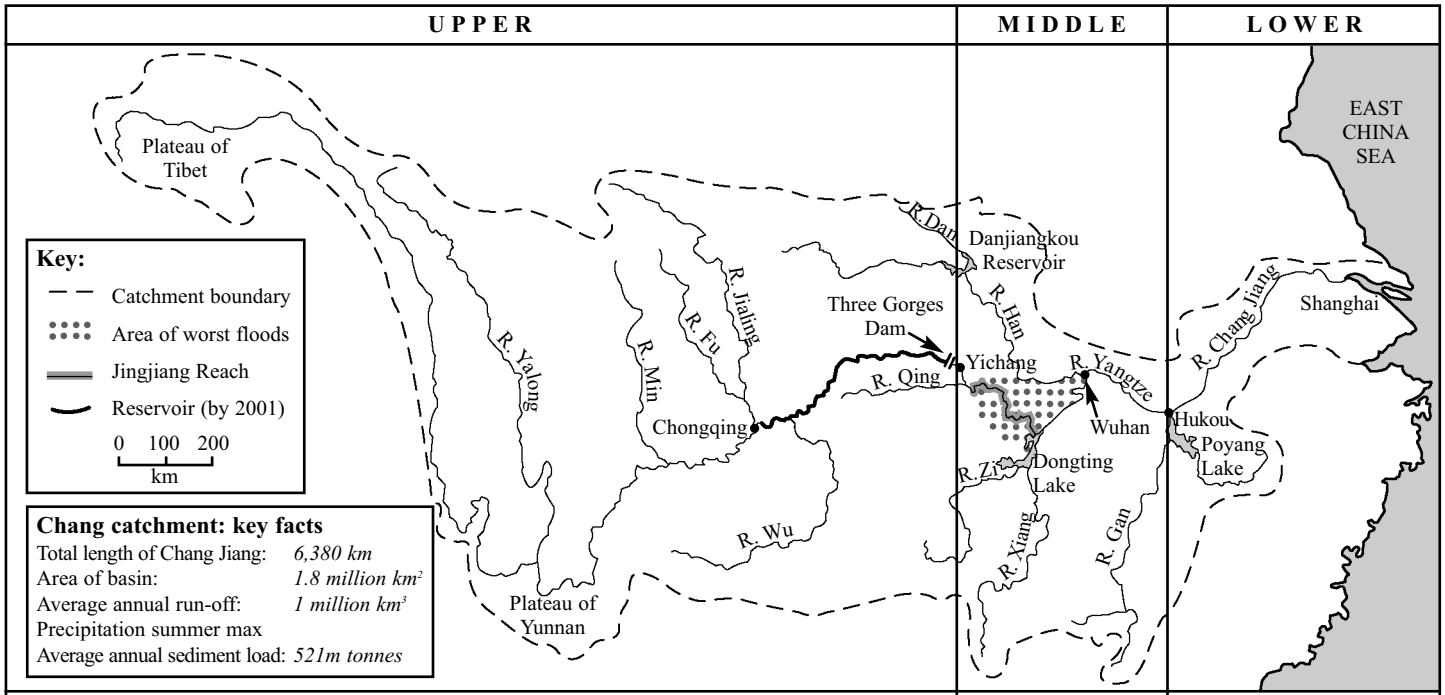
The Three Gorges dam under construction on the Chang Jiang (Yangtze) will, if completed, be China's, and the world's, largest dam. Approximately twice the size of Gezhouba, 40 kilometres downstream, this mega dam has become highly controversial worldwide. Although supporters of the scheme state unequivocally that the dam is essential to reduce escalating flood damage, water and power shortages, and hindrances to navigation, there is growing concern amongst opponents about both the social and environmental impacts.

Why build the dam?

The Chang Jiang is China's longest river. Its catchment covers one fifth of the country and significantly is rich in both water resources and hydropower, two resources vital for China's economic development. It has long been a key region, accounting for 40% of China's output. However, the most productive areas are the densely populated and highly urbanised middle and lower reaches of the valley which are prone to devastating floods, the costs of which are escalating in terms of loss of life, livelihoods, revenue and infrastructure.

Control of the Chang has been a much debated issue. Sun Yat-sen, the founder of modern China, proposed a dam at the Three Gorges site in 1919. It was again discussed in the 1950s. Feasibility studies were undertaken in the 1980s but it was the devastating floods of 1991 which were to trigger action. This multi-purpose scheme would not only control flooding but also provide hydropower, essential for further economic development not only in the valley but in the Northern Plain, the eastern seaboard and the south. Although both river and valley provide vital east-west communication in central China, navigation has always been hazardous and restricted, especially in the section between Chongqing and Yichang (Fig. 1). Improvements to navigation, by raising water level, would help promote economic growth of the valley from Shanghai–Pudong in the east and Chongqing in the west. The dam would also increase the viability of water transfer schemes from the Chang Jiang to the Northern Plain, which is very short of water.

Fig. 1 The Chang Catchment



Source: 6600m; fed by glaciers and snow melt and summer rain Drainage area: 55% of the basin Average annual discharge: 45% of basin Run off: 450 km³ Length: 4,529 km Major tributaries from Sichuan province; serious flood threat Steep sided valley cut through high mountains; vertical slopes in gorges Steep gradient down to Chongqing	Run off :450 km³ Summer rainfall max (monsoon) Very little gradient Flows across low, flat land in enormous meanders. Land 10m below river embankments. Lakes (e.g. Dongting & Poyang) provide important storage capacity	Run-off: 100 km³ Summer rainfall max Low flat land Islands and sandbars in course Numerous lakes act as stores

In 1992 the Three Gorges project was approved. In the same year the Chang Jiang valley was designated an Economic Growth Region which would now compete with the prosperous south east.

Is a mega dam at Sandouping the best solution?

The site at Sandouping (see Fig. 2) is near the eastern end of the Three Gorges just before the deep, narrow valley gives way to wide flat plains. Supporters of the scheme argue that this is the best solution. In their opinion that one megadam is the most cost effective way of addressing the four key issues, whilst any environmental and social problems that may arise can be overcome. Opponents however, feel that a series of smaller dams would be more effective in terms of flood control, more efficient in power transmission, cost less, and have fewer negative social and environmental impacts.

Flooding: the causes

For over 2000 years disastrous floods have affected the middle and lower reaches of the valley. Every decade they have caused serious loss of life and livelihoods. But flooding is becoming more frequent and population growth has resulted in higher flood damage costs. In 1995 these were put at £2.9 billion.

Table 1 Major flood events

Date	Comments
1870	Largest flood in 800 years. Affected most of basin. Especially severe upstream of Yichang but not high at Hankou
1931	145,000 killed. Very high level at Hankou.
1935	High level at Hankou, the result of a local rain event affecting the Hanjiang
1954	Worst flood of 20th century. 1 in 100 year flood. 300,000 killed. 18.9 million suffered from flood damage. Highest flood on record at Hankou. Occurred after the completion of the Jingjiang flood diversion project
1998	Worst since 1954. Hankou experienced 75 days above danger warning level; run off 50% above average in July, 70% above average in August 4,000 killed; millions displaced. Dams weakened increasing flood hazard. Many lessons learnt from flood event

The flood regime is complex because of the sheer size of the catchment. Although it is rainfall events in the **Sichuan basin** and the **upper Yunnan Plateau** which are the major cause of floods, localised rain events can also lead to flooding. Furthermore, timing and amount of rainfall in each sub basin varies. In 1998 flooding was made worse by a combination of extremely heavy winter snows on the Tibetan plateau and heavy rains from June to mid August which affected the middle and lower reaches of the valley. The intensity of these rainstorms was such that 1000mm fell in three days. The heaviest rainfall (2000mm) for that period fell in the catchment of the Lou Shui which flows into Dongting Lake but the Han catchment received only 600mm.

But the 1998 floods highlighted the role of **human activity** in increasing flood risk. It was not flood flow but the flood level raised by siltation on the river bed which was the main cause of damage that year. In the upper catchment, on the main stream and its tributaries, although geology in certain sub basins results in siltation, soil erosion is a major cause of flooding. In the past, economic development without regard for the environment led to the cultivation of slopes in excess of 35°.

Much of this land was not terraced, nor was it contour ploughed. Equally disastrous has been the practice of excessive logging, drastically reducing forest cover which has been reflected in reduced infiltration rates, loss of water storage and soil cover resulting in massive downslope transport of soil and water. **Siltation** has thus led to the raising of both river and lake beds by nearly 2 metres in 30 years with the loss of valuable natural storage capacity in the middle and lower reaches.

Population pressure in these reaches has resulted in loss of land needed for flood control. Farmers have encroached onto the flood prone areas of river beds and wetlands, areas which should be reserved for **flood retention**. Rapid urban growth has reduced infiltration. Moreover lack of investment has resulted in poor maintenance of vital dikes. The strengthening of dikes should be a priority for urban protection as witnessed by the concern for Wuhan in the 1998 floods. Many dikes are only able to withstand a 1 in 10, or 1 in 20 year flood event, compared with European standards of 1 in 50 or 1 in 100 year flood.

Flood control

So what are the possible options?

- As flooding in the upper catchment is a major cause, opponents of the dam advise the construction of a number of smaller reservoirs in the upper reaches of the tributaries and main river but supporters point out that those already in place have not been effective so a major dam is needed.
- Furthermore, tributaries below Yichang also have heavy sediment loads which lead to flooding downstream, and there are plans for a dam also due for completion in 2009, on the Qingjiang.
- The 1998 floods reinforced the need to reduce soil erosion and a logging ban was subsequently introduced although a sustainable approach to forest management had already been adopted in Sichuan.
- In 2000 pilot projects were introduced to convert slopes in excess of 20° to forest, compensation being given to farmers involved.

In the middle and lower reaches the increase in discharge capacity would appear to afford improved flood control but population growth makes alternative measures difficult to implement. Supporters of the megadam solution point out that flood diversion routes would require massive resettlement, greater than will be necessary for reservoir inundation and that higher dikes would reduce much needed farmland.

Exam Hint: This is a complex case study so you need to put the essential facts on case study summary cards under headings such as for and against the Megadam. Learn a simple sketch map.

The Project

It is a massive project by any standard:

- *the size of the dam*
- *the area of impact*
- *the number of people affected both directly and indirectly (400million live in the valley)*
- *the economic, social and environmental costs*

Although it is a multipurpose dam, its prime function is flood control. Fig. 2 below summarises the main features.

Assessing the impacts

The impacts of the scheme need to be assessed in terms of the direct and indirect effects both in the reservoir area as well as upstream and downstream of it (spatially) and over time (temporally). This is a complex task especially with regard to social and environmental impacts, but it is the massive scale of every aspect of the project which makes evaluation so difficult. The estimated financial cost is $24 billion but is likely to escalate. Whatever the financial cost of any scheme it must be weighed against the cost of flood damages. Perhaps the main concern is now the social impact. China's has a poor reputation because of its displacement of people for other dam projects.

Current impacts include:

* **Chongqing** was created a municipality in 1997 (pop. 30 million) so that it could better handle the resources of the reservoir region.
- It is already a boom town taking on its new role as the key city in opening up the southwest, a region of some 300m but one of the lowest per capita incomes in China. The docks are being rebuilt ready to handle larger vessels.
- Flood defences along the river banks have been raised and new elevated roads, on the top of the river embankments, are under construction. A new Expressway links Chongqing to Chengdu.

* **Within the reservoir area** frenzied activity is also evident in the provision of new infrastructure. High level bridges across the numerous tributaries link the sections of road being hewn out of the valley sides. Two bridges now span the Chang, a third is still under construction. Multi-storey apartments rise from hill tops as towns are relocated above the 175m contour. For Fuling, for example, it means partial relocation to elevations between 350 and 400m.

The main perceived long term benefits and disadvantages are summarised below, but some are potential and difficult to predict at this stage. It will be noted that the disadvantages mainly affect the reservoir area whilst the benefits are reaped in the area downstream (see Table 2 on page 4).

Fig. 2 The Three Gorges Project (Reservoir area; dam)

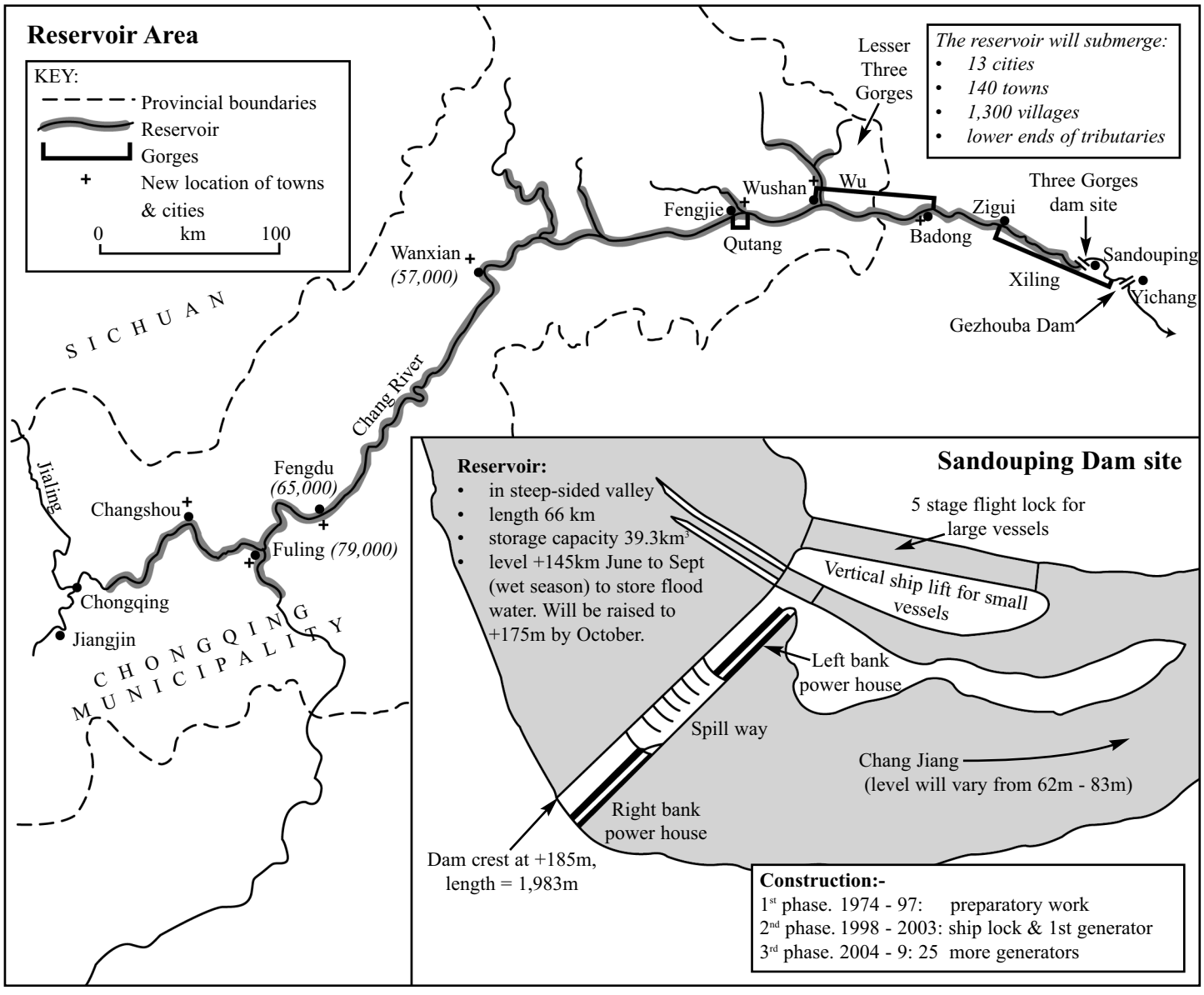


Table 2 Cost benefit analysis

BENEFITS	DISADVANTAGES
Socio-economic ***Flood control*** *in middle and lower reaches is the key benefit:* * *will afford protection from 1 in a 100 year flood* * *will save lives and livelihoods in the densely populated Jingjiang and Dongting Lake plains, the area most prone to devastating floods* **Economic** ***Flood control*** *below Yichang losses will only be incurred in the event of a greater than 1 in 100 flood event* ***Hydropower*** *18,200MW capacity; sale will fund project cost* • *will provide about 10% of China's current needs* • *well placed to transmit to Beijing and to east and SE coastal provinces* • *will create jobs and promote economic growth in valley and other regions* ***Navigation improvements*** *important in area where communication by land restricted:* • *will enable 5,000 t vessels to reach Chongqing at all times of year, 10,000 t. vessels for 6 months It will become a major port of China* • *will boost growth of Pudong and valley upstream to Chongqing* • *other major growth points will be Wuhan-Yichang and Chongqing* ***Water:*** • *water supply for towns in the valley* • *will facilitate transfer of water to water short Northern Plain via Danjiangkou Reservoir to Beijing (middle route)* **Environmental** ***Reduced air pollution*** *as hydropower replaces thermal power. At present coal fired stations produce 80% of the country's electricity.* ***Reduced siltation*** *in lakes in middle and lower reaches*	**Socio-economic** ***Re-location:*** *will involve at least 1.2m* • *some settlements will be completely submerged e.g. Fengdu* • *some displaced people will have to be re-settled in physically different and distant regions* • *within the valley re-location involves movement to higher altitudes with steeper slopes, poorer soils and climate - consequently poorer quality of life.* • *new settlements will impact on residents of hill villages; will occupy large areas of land and loss of former land use* ***Loss of farmland:*** • *most fertile cropland and areas of citrus groves will be submerged* • *will result in urban migration for many, some of whom will lack necessary skills and mind set to cope with new jobs* ***Loss of cultural heritage:*** • *over 1200 sites will be drowned; only a few have been saved* • *removal of people from ancestral home – believe in living in same area as born* ***Loss of social tradition:*** *belief in living in same area as born* ***decreased tourism*** *as Three Gorges will not be so spectacular* **Environmental** ***Increased pollution*** *from sewage and industrial effluent in reservoir area as flow will be reduced. Chongqing particularly concerned - toxic pollution from chemicals from drowned factories will also reduce water quality.* ***Siltation*** *of reservoir* ***Increased scour*** *below the dam; larger bank protection works may be needed in middle reaches.* ***Landslips*** *in reservoir area: slope stabilisation necessary in some areas of new settlement e.g. Zigui* ***Earthquake threat*** *large dams can cause earthquakes* ***Ecosystems*** *some habitats may well be affected e.g. River Dolpin* **Political** ***War:*** *dam a vulnerable target*

Conclusion

This case study provides information which addresses issues raised in units on the hydrological cycle, river management, river environments, environmental issues, managing rural environments, challenge of human environments. Re-read the case study, writing down key points under headings given in the guidance notes of your particular specification. Exam questions can therefore focus on several aspects of the Three Gorges project. An example is shown below.

Exam Question

Explain how human activities affect the flow of rivers, with reference to one or more river catchments you have studied.

Answer (using Chang Jiang)

Introduction:

Human activities may either increase or decrease discharge [define] both temporally and spatially. The 1998 floods highlighted the role of human activity. In the Chang Jiang, with the completion of the reservoir, further changes will occur. Examine the impact of each of the following activities showing how each affects (if appropriate) surface run-off sediment load and channel efficiency:

Settlement/urbanisation:

- effect of loss of land due to reservoir as well as urbanisation
- effect of low infiltration surfaces
- storm drains;
- water abstraction for domestic, industrial and agricultural uses
- water transfer – E. Route – to N. Plains

Reservoir: effect of seasonal regulation of releasing water

Flood protection: role of channel modification

Agriculture: (many points here)

- effect of soil erosion
- farming wetlands and alluvial lowlands

Forestry:

- effect of soil erosion
- infiltration loss
- reduced storage

Conclusion:

As population pressure increases and economic development progresses in the Chang valley, human activity will impact increasingly on river flow.

Web site

http://www.dams.org This is a very useful site with much information about the issue of large dams. There is also information relating to dams in China.

Further reading

Jones J.A.A. *Global Hydrology* (1997, Longman) Chapter 7: 7.4 to end (impact of human activities) Chapter 9; chapter 10: 10.1 and 10.2 (managing runoff, includes dams and diversions)

Acknowledgements;

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