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Three Gorges revisited by Fan Xiao

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The Three Gorges project has generated a great deal of international interest, along with concern about the impacts of building the world's biggest dam. Since the dam's reservoir was filled almost three years ago, many people have been wondering what changes may have occurred in the reservoir and surrounding area. With that in mind, **Fan Xiao**, a geologist from Sichuan province, travelled to the Three Gorges area in February of this year, and wrote the following trip report.

Sedimentation: Will silt build up faster than expected?

According to the original plan, the Three Gorges reservoir was to have been filled to 156 metres above sea level in 2007 and raised to its final level of 175 metres in 2013. But later the timetable was changed dramatically, with the reservoir now slated to rise to 156 metres in 2006, one year ahead of schedule, and to 175 metres in 2009, four years earlier than planned.

Why was the plan altered? The reason is simple: With the reservoir at 175 metres, the Three Gorges dam should be able to generate 2.65 billion kilowatt hours more hydropower annually than with the water level at 156 metres. The economic gain will be enormous.

But by speeding up the timetable, the buildup of silt in the reservoir will also occur earlier than originally forecast. Sedimentation-modelling experiments that were done for the Three Gorges project feasibility study forecast that silt accumulation in the reservoir would pose a threat to the port of Chongqing after the dam had been in operation for 20 years. For this reason, the municipality is building a US\$175-million port at Cuntan, 40 kilometres downstream of central Chongqing. The new port, scheduled for completion in 2010, is designed to replace Jiulongpo in downtown Chongqing, the largest port in the upper reaches of the Yangtze.



Water discharged into the river below the Three Gorges dam

The exact slope of the Three Gorges reservoir makes the situation more complicated. If there is a slope at the tail end of the reservoir near Chongqing, more land will be flooded and more people will have to be relocated than planned. On the other hand, if there is no slope at all to the

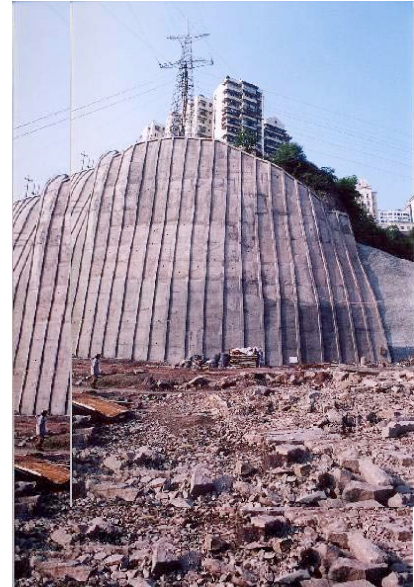
reservoir, the buildup of silt will be more serious than forecast. The exact slope of the reservoir has been the subject of much debate, with no consensus reached so far.¹

Landslides: 20 years needed for a good understanding

The Three Gorges area is not only prone to geological disasters such as landslides and earthquakes, but is also very densely populated. According to official statistics, 2,490 "slip masses" and 90 gullies created by mud-rock flows have been identified along the Yangtze and its tributaries.² Moreover, unlike many other large reservoirs around the world, which tend to be located in remote and sparsely populated areas, the Three Gorges reservoir area is so crowded that finding the space nearby to resettle people displaced by the dam has been difficult. Thus, even a moderate geological disaster in the reservoir area can entail enormous human and property losses.

This is why experts are really worried that filling the reservoir could activate the big landslide masses upstream of the Three Gorges project. The Shuping landslide, on the right [or south] bank of the Yangtze, 49 kilometres upstream of the dam, has a volume of 23.6 million cubic metres. One month after the June 2003 filling of the reservoir, the old landslide began deforming, with cracks on the mass growing ever wider. The deformation is still developing today. And so, while travelling on the river from Badong downstream to Maoping [the Zigui county seat], I was told by the captain that all boats going in both directions must sail on the north side as a safety precaution, in accordance with a warning issued by the navigation authority.

A more serious incident resulting from the impoundment of the reservoir took place at the village of Qianjiangping on the Qinggan River, three kilometres away from its confluence with the Yangtze mainstream. On the morning of July 12, 2003, just one month after the filling of the reservoir, cracks were discovered in the old Qianjiangping landslide. By evening, cracks had also appeared on the walls of a factory building and were growing rapidly. Most of the factory workers and villagers fled as the dangerous situation developed, though a few remained behind.



Slope protection project at the new county seat of Yunyang

Several hours later [at 00:20 on July 13, 2003], a huge block of the mountain, 24 million cubic metres in volume, slid into the Qinggan River, completely blocking the 100-metre-wide river. The landslide's crash into the river also created 20-metre-high waves that capsized 22 boats. Within minutes, four factories, 300 homes and more than 1,000 mu [67 hectares] of farmland were destroyed. According to the official count, 14 people were killed and another 10 listed as missing.



Qinggan River blocked after the July 13, 2003, landslide

Three days after the disaster, the Three Gorges Office of Hubei province quickly announced that the reactivation of the Qianjiangping landslide had been caused by days of heavy rainfall and had nothing to do with the filling of the dam's reservoir. However, an investigation conducted by several research institutes and survey teams concluded that the impounding of the reservoir had in fact been one of the main triggers. After the Three Gorges reservoir was filled to 135 metres [in June 2003], the water level of the Qinggan River rose by more than 30 metres. Now immersed in water, the bottom of the slip mass softened, causing instability in the old landslide. Continuous rain from June 21 to July 11 was also a factor, as rainwater had permeated cracks in the landslide mass.

Lessons need to be drawn from Qianjiangping: Some landslides that are not identified as dangerous can produce disastrous results. This is why there is a saying in the geological community in Europe and North America _ that it takes 20 years of observation to acquire a good understanding of a landslide.

Earthquakes: Will significant seismic activity result?

After the reservoir was filled to to 135 metres in 2003, seismic activity increased in several sections of the Three Gorges reservoir. There is good reason to be concerned about two main fault lines: the Jiuwanxi Fault and the Zigui-Badong Fault. Both are considered likely to produce earthquakes that could have an impact on the dam site, because they are very close to it.

A few minor tremors were recorded along the Jiuwanxi Fault, which is located just 17 kilometres upstream of the dam. But much more seismic activity occurred along the Zigui-Badong Fault, which lies about 80 kilometres upstream of the dam, with the biggest tremor since the 2003 reservoir impoundment recorded at 3.4 on the Richter scale. Historically, this fault has produced earthquakes in the 5 to 6 range on the Richter scale.

Another category of earthquake can be caused by the collapse of limestone [karst] caves, and holes left over from mining activities. For example, in the Wu Gorge, where there are many limestone caves, and in the Xiangxi valley, with its concentration of coal mines, minor tremors were recorded after the filling of the reservoir. On Dec. 18 and 19, 2003, minor tremors of 1.8 and 2.5 on the Richter scale were recorded at Mazongshan, Guandukou township, Badong county [80 km upstream of the dam] and in Peishi township, Wushan county [120 km upstream of the dam]. In the case of Mazongshan, cracks appeared on the walls of 22 houses. With this

kind of quake, the tremors are usually shallow, occurring close to the earth's surface, but the degree of damage to lives and property can be tremendous.

During my visit to the Three Gorges area, I met Zeng Xinping, head of the seismological and geological team of the Three Gorges Survey Institute of the Changjiang Water Resources Commission, which is responsible for seismic monitoring in the reservoir area. Mr. Zeng showed us several monitoring stations and told us the network consists of three main components: digital remote sensing, observation of crust deformation and monitoring of water dynamics. In the reservoir area, a digital remote sensing network is employed to record minor tremors of less than 4 on the Richter scale, while two special observation stations focus on recording any shocks bigger than that.

In the Three Gorges project feasibility study, experts researched the impact of earthquakes on the dam project. Based on the results of those studies, they predicted that the biggest earthquake in the river section where the Jiuwanxi and the Zigui-Badong faults are located would be around 6 on the Richter scale.

But the question remained: Could the filling of the reservoir to its final height in 2009 trigger earthquakes larger than those ever recorded in the area or anticipated by the experts? Some experts believe that reservoir-induced earthquakes are likely to be as much as 1 or 2 Richter points bigger than the recorded high in a region. Others are worried about the Three Gorges dam for the following reason: In the case of Tangshan in northeast China, no significant tremors had previously been recorded there until a massive quake measuring 7.8 on the Richter scale occurred in 1976 [killing more than 242,000 people, according to the official toll].³

Reservoir: Pollution in the water and on the land

In Chongqing, I interviewed Wang Liao, a professor at Chongqing University's School of Resources and the Environment, whose research focus has been environmental protection of the Three Gorges reservoir. She says two wastewater-treatment plants have been built in metropolitan Chongqing at a total cost of US\$375 million, and 18 wastewater-treatment plants (with a total budget of US\$262 million) are also in place or under construction in other cities and counties in the reservoir area.

Metropolitan Chongqing now has the capacity to treat 60 per cent of its wastewater, while this same capacity is now at 67 per cent in the rest of the reservoir region.



Still water in the reservoir behind the dam

However, despite all this new capacity, low treatment rates persist due to the fact that subsidiary projects have lagged far behind. In Wanzhou district, for instance, we discovered that only half

the wastewater treatment system at the Mingjingtian treatment plant was in use, due to a lack of wastewater-collection pipes in some areas. In the same district, Shenmingba, the largest treatment plant in Wanzhou district, has not yet been finished. In the county seat of Wushan, 120 km upstream of the Three Gorges dam, the treatment plant beside the Yangtze is still under construction, and so untreated domestic wastewater is still going directly into the river.

Professor Wang said that water quality in the Yangtze is generally fine, as the official media has reported, but that the water in the tributaries is worsening because of the intrusion of pollutants from the main channel.⁴ Water quality in the tributaries is much worse than in the main channel, ranging from Grade 4 to Grade 5, and urgent action is needed.⁵

Another major concern is the trouble zone created by the future operation of the Three Gorges dam. After the project is completed in 2009, the water level in the reservoir is to be kept at 175 metres above sea level during the dry winter months, and lowered to 145 metres for the summer flood season. The 30-metre-high strip of land between those two levels will be covered with water in winter and exposed in summer. This wide ring around the Three Gorges reservoir and along the banks of upstream tributaries could become geologically unstable, seriously polluted and a dangerous source of epidemic disease.⁶

Professor Wang and her team have recently completed a survey of this pollution belt that was funded by the Development and Reform Commission of Chongqing municipality. They calculated the total area of the belt to be around 305 square kilometres, with one of the biggest strips being in Kai county along the Xiaojiang, a Yangtze tributary.

This zone presents a dilemma for local people. It would provide good farmland when the water recedes and exposes fertile soil. When the water rises again in winter, however, the chemical fertilizer and pesticides used on the fields would go into the river water, posing a serious pollution problem. Experts have argued that no farming should be allowed in this zone, in order to protect the environment in the reservoir area. As Professor Wang points out, this remains a difficult problem to tackle.

Navigating the dam: A transport bottleneck?

It takes just one hour to fly from Chongqing to Yichang, but making the trip by water can be onerous. The filling of the reservoir changed the transportation pattern on the Yangtze, particularly from Chongqing to Yichang. Passengers going to Yichang can save a great deal of time by going around the dam by land transport rather than by boat. It takes two hours to get to Yichang by bus from the port of Maoping on the upstream side of the dam, whereas it can take seven or eight hours to make the same trip by boat, which has to get through the dam's shiplock.

Going downstream, trucks on roll-on/roll-off ships have to be unloaded at Maoping, driven around the dam, and then loaded onto a second ro/ro ship at the port below the dam. The procedure is reversed for freighters going upstream, and has been routine since the end of June 2004, when ro/ro ships were banned from using the shiplock.⁷

The shiplock went into trial operation in mid-June 2003, about a week after the reservoir was filled. However, boats trying to get through the dam in the second half of that year encountered delays on 119 days [out of almost 200 days]. In some extreme cases, those delays stretched for as long as five days and nights. The fundamental problem is that the actual capacity of the Three Gorges shiplock is only 36 million tons annually, which falls well short of its anticipated, designed capacity of 50 million tons.

The distance between Chongqing and Yichang is shorter by river than by road, so transporting goods by boat is more cost-effective. About 43 million tons of freight were transported downstream from Chongqing and Sichuan in 2004, official statistics show. However, that volume is expected to increase to more than 80 million tons by 2030.

For this reason, the government of Chongqing is said to have asked for an additional five-step shiplock to be built at the dam. Obviously, this request seems unrealistic at this stage. And so I wonder whether some freight will have to be moved overland around the dam on a permanent basis, and the shiplock of the Three Gorges dam will turn out to be a transport bottleneck on the upper reaches of the Yangtze forever.⁸



A chamber of the five-step shiplock

Three Gorges Probe footnotes:

¹ For more on this issue, see [The slippery slope: Confusion surrounds shape of the reservoir](#).

² Slip mass: Soil and rock material deposited by old landslides or riverbank collapses; often unstable and liable to move again.

³ For more on seismic hazards, see [Dam on dangerous ground](#).

⁴ Differing characteristics (such as water velocity) in the Yangtze mainstream and branches may account for pollutants becoming more concentrated in the slower-moving tributaries.

⁵ According to China's system of water standards, Grade 4 is not suitable for drinking or even swimming, and is restricted to industrial use, while Grade 5 can only be used for irrigation.

⁶ For more on the 30-metre pollution belt, see [Experts scramble to tackle a colossal trouble zone](#).

⁷ For safety reasons, roll-on/roll-off vessels have been barred from using the Three Gorges shiplock since June 30, 2004. The measure was introduced out of concern that dangerous goods the ships might be carrying, such as gasoline and chemicals, could explode while inside the shiplock.

⁸ According to an article in China Economic Weekly ("Shiplock becomes a bottleneck: Water-land-water could be the best choice," Aug. 15, 2005), moving freight around the dam by land was intended as a temporary measure during construction of the shiplock. However, because the capacity of the shiplock has turned out to be much smaller than anticipated, it now appears that freight transported by roll-on/roll-off ships will be moved overland around the dam on a permanent basis.

Translation by Three Gorges Probe.