

三峡大坝工程

众说纷纭的三峡大坝将在 2009 年的夏天竣工。建成之后，这段原先最险要的长江水域将一举成为便捷的航道。万吨级船队终于可以全年从上海一直扬帆远航，抵达重庆山城上巍然耸立的寸滩集装箱码头。两座城市之间的航运时间将最多只要 7 天，比原来缩短一半。

长江上游从四川宜宾至湖北宜昌流经丛山峻岭，向来以无数急流险滩而闻名遐迩。其中重庆和巴东之间 546 公里的河段竟有 100 多个险滩。这段曾经吞噬了许多生命的危险水域，如今已是三峡水库的一部分，水平如镜。

2004 年 1 月，三峡大坝和忠县之间的河段成为长江干线中采用航道定线制的两个河段之一，船舶可以昼夜航行。根据航道定线制，所有船只必须靠右侧行驶。通过排除那些长期以来困扰长江航运的险滩，减轻长江水位季节性波动，北京政府建成了一条常年通航的航道。这条长达 2600 多公里的航道从海上一直通到重庆，把中国广阔的内地与外部市场连成一片。

这个场景现在听起来很宏伟，但最初策划这项耗资 220 亿美元的工程时，并非是为了促进长江航运。三峡工程是中国前总理李鹏先生最看重的工程。在三峡工程策划者的眼里，三峡大坝的首要目的是为了防洪，使华中地区的广阔平原免遭千年历史上一年的洪灾。

其次，三峡大坝的另一个目的就是建设巨大的发电站。三峡水电站计划共安装 32 台水轮发电机组。2007 年的发电量为 616 亿千瓦时，比上年增长 25%。目前有 21 台机组已经投产。2008 年底将新增 5 台机组，另外，扩容计划内的 6 台机组将于 2012 年安装。

三峡水电站是迄今全球最大的水电站（比第二大发电设备巴西与巴拉圭交界处的伊泰普水坝高出 50%），占中国目前年装机容量容量的 3%。一旦三峡水电站全面完工投产，这个干净能源将相当于每年节省 5000 万吨煤。

三峡发电站是全国能源网的重点工程，从而使政府能够通过国内各地之间的电力分流来提高能效、结束区域性断电的局面。自发电站于 2003 年 7 月正式投产以来，该水利发电站已向全国 11 个省市自治区输送电量达 2070 亿千瓦时。

要把新水库发展成为航运通途和内地的经济纽带，现在看来至关重要，而令人难以置信的是，跟防洪和发电相比，当初并非举足轻重。由此导致大坝最早的设计者们在设计船舶通航的细节时思考欠周。现在，航运日益繁忙，而中央政府种种修正这一缺点的努力仍然显得收效甚微。

主要问题在于大坝的船闸系统的设计上。大坝的五级船闸总长 6.4 公里，位于与大坝平行的狭窄水道内，从水库到它下游处有落差 113 米，是世界同类船闸中规模最大的一个。船闸的注水耗时长，已无法满足现有的航运需要，更不要说未来预计的航运流量。每艘船平均需要 3 个多小时才能通过船闸。

船闸工程耗资逾 62 亿元，最后施工阶段于 2006 年 9 月启动。首先，南面通道因施工而停开，接着是北面通道。这使船闸的通航能力减少了一半。2007 年 5 月，船闸工程竣工后，才恢复双通道运营。

船闸每天双向进出的船流量为 230 艘左右，计划每

The Three Gorges Dam

BY SUMMER 2009, when the controversial Three Gorges Dam is completed, shipping will be made much easier on what was formerly the most treacherous stretch of the Yangtze. Throughout the year, barge fleets of up to 10,000 dwt will be capable of sailing all the way from Shanghai to the Cuntan container terminal in Chongqing. The journey times between the two cities will be halved to a maximum of seven days.

The upper reaches of the river, flowing through mountainous terrain from Yibing in Sichuan province to Yichang in Hubei, were once notorious for their many shoals and rapids and dangerously narrow bends. In one particularly dangerous section, a 546km stretch between Chongqing and Badong, there were more than 100 shoals. This perilous stretch, which in the past claimed many lives, now forms part of the calm waters of the Three Gorges Reservoir.

In January 2004, the stretch between the Three Gorges Dam and Zhongxian became one of two sections along the Yangtze to adopt a traffic lane system, enabling round-the-clock sailing. All vessels are now required to sail on the right-hand side of the river. By eliminating the notorious shoals and huge seasonal depth fluctuations that have long plagued traffic on the upper river, Beijing's planners have created a year-round shipping channel extending some 2,600km from the sea to Chongqing, linking China's vast interior with outside markets.

However, grand as this picture may sound, the US\$22bn project as originally conceived had little to do with boosting river transport. In the eyes of its planners – it was the pet project of former Premier Li Peng – the dam was seen primarily as a means of flood prevention, sparing the vast plains of China's central provinces from the devastating annual bouts of flooding that have been a hallmark of Chinese history for millennia.

Another, secondary, purpose of the dam was the creation of a huge power-generating facility. The Three Gorges hydropower project, for which a total of 32 turbines are planned, generated 61.6bn kWh of electricity in 2007, about 25 per cent more than in the previous year. Currently, 21 turbines are operational; five more will be added by the end of 2008 and a further six will be installed by 2012, as part of an expansion plan.

By far the single largest electricity-generating facility in the world (at least 50 per cent larger than the next biggest, the Itaipu dam in Brazil/Paraguay), the project accounts for 3 per cent of China's current annual installed capacity. When it is fully completed, this clean source of power will be the equivalent of burning 50m tons of coal a year.

The complex will be developed as a lynchpin in a truly national energy grid, boosting efficiency and helping to end regional blackouts by allowing authorities to shunt energy from one part of China to another. To date, the hydropower station has transmitted 207bn kWh of electricity to 11 provinces, municipalities and autonomous regions since it started operation in July 2003.

Perhaps surprisingly, given the importance now accorded it, the development of the new reservoir as a shipping channel and economic conduit to China's interior took a backseat to the primary functions of flood prevention and power generation. As a result, early planners were rather neglectful when designing features into the dam that would allow ships to bypass it efficiently, a shortcoming that the central government is now struggling to correct as river traffic seeking to navigate the new waterway begins to increase.

The main problem lies in the design of the dam's shiplock system. Forming technically the largest such facility in the world, the dam's 6.4km, five-step shiplocks lie in a narrow stretch parallel to the dam and drop 113 metres from the reservoir down to the lower Yangtze. The locks are slow to fill and already cannot cope with existing shipping demand, let alone projected traffic flows. It takes an average of more than three hours for a vessel to pass the locks.

年通航能力为 5000 万吨。但是这个数字早在 2007 年就已达到。当年共有 4700 余万吨物流经此地，每年增幅为 20%。船闸管理部门在 2007 年的一份研究报告中表示，随着管理更加有效以及船舶标准化的实施，船闸的通航能力有望翻番，达到每年 1 亿吨。但是，由于运货量增长速度迅猛，估计在不久的将来，这个数字也会被轻松刷新。

目前，客轮优先通过。其次是载有鱼类和家禽等牲畜的鲜生货船。平均每天有 3 到 4 艘专用危险品船舶通过船闸，相当于 2000 吨危险品。这些危险品包括石油、原油、高锰酸钾及甲醇等货物。夏季船闸水面温度增长很快，因此危险品货船可以优先在上午 8 点前通过。除此之外，三峡管理委员会（受交通部长江航务管理局管辖）按“先到先过”的原则为船只安排过闸。

由于船闸通行效率低下，大坝两侧经常出现轮船与驳船的拥堵场面。许多货主不愿意排长队等候。为了节约时间，他们先将货卸下并通过公路运输，然后在最后一级船闸的上游或下游将货物再装回船上。这种做法被称为“翻坝”。

大坝的垂直升船机建成后，将为过坝客轮提供快速通道，从而适当分担船闸的压力。升船机宽 18 米、长 12 米、水深 3.5 米，是世界上同类升船机中最大的，能同时承载 2 艘 3000 吨级的船舶。

升船机的设计主要由两家德国公司牵头：拉麦尔国际咨询公司 (Lahmeyer) 和 K&K 公司 (Krebs und Kiefer)。长江水利委员会底下的设计院对德国的齿条和活塞提升系统技术深表赞赏，并于 2006 年让这两家德国公司承揽了该项工程。之前，工程设计经历了两次重大变更，致使升船机的投入运营计划至少拖延了一年。制造与测试工作将在 2008 年展开，并计划在 2010 年进入试运行阶段。

强风是影响船闸正常运行的另一个因素。2007 年 5 月的前 17 天，船闸因强风袭击而关闭了 7 次共计 32 小时，最长一次关闭时间达 16 个小时之久。强风会对过坝船舶带来危险。而强风天气的频繁出现更是引起了政府部门和商业机构的高度重视。专家们仍不能确定这种现象是否与水库的水位增高有关。

三峡大坝正式投入运营后，水位将随着每年降水量的波动而得到调节。五月底六月初，水位将减至 145 米并保持到 9 月底。从 10 月开始，大坝将蓄洪，水位将升至 175 米，并保持到 12 月底。1 月到 4 月间的水位将减至 155 米。

三峡工程的建设对湖北宜昌至武汉的长江中游航道影响最大。该段全长 624 公里，大部分流经平原和山丘，河道迂回曲折，有近 20 处碍航浅滩。大坝定期的蓄洪排洪导致河床泥沙淤积的新变化，因而也加剧了枯水期航道维护的难度。

目前，宜昌到白尾河段的航道维护尺度为水深 2.9 米、宽 80 米、弯曲半径 750 米，1500 吨级的船舶通航。从白尾到武汉河段的航道维护尺度为水深 3.2 米、宽 80 米、弯曲半径 1000 米，3000 吨级以下的单船和万吨级的拖驳船队可以通行。

2008 年 9 月，三峡的水位将第一次上升到 175 米。专家们认为，大坝水位升高可能与当地越来越多的地震和山体滑坡有关，对过往船只和当地居民的安全都构成了威胁。2007 年 11 月下旬，大坝附近发生山体滑坡，一辆途经此地的客车被崩塌的岩石掩埋，车上的 30 多位

Work started in September 2006 on the final construction phase of the shiplocks, which cost more than Rmb6.2bn to build. First, the southern lane stopped operation for construction work and then the northern lane, more than halving the locks' vessel-handling capacity. Dual-lane operation resumed only in May 2007, when the shiplocks were finally completed.

The locks handle an average daily volume of 230 vessels in both directions. They are designed to allow passage of up to a total of 50m tons a year, but capacity was almost reached as early as 2007, when more than 47m tons of cargo passed across them, a year-on-year increase of 20 per cent. Following the production of a research report in 2007, the locks management claims that capacity could be doubled to 100m tons as a result of better management and the vessel standardisation programme. However, given the current rate of growth in cargo volumes, it will not be long before even this higher capacity level is breached.

Priority traffic

At the moment, priority is given to passenger cruises, followed by vessels carrying livestock, such as fish and poultry. On average, three to four specialised vessels pass through the shiplocks each day, accounting for 2,000 tons of dangerous goods, such as petroleum, crude oil, potassium permanganate and methanol. In the hot summer months, when the surface temperature along the locks rises sharply, dangerous goods vessels are given priority to pass before 8am. Otherwise, the Three Gorges Administration Bureau (under the Yangtze River Administration of Navigational Affairs, the Ministry of Communications) allocates passage slots on a first-come, first-served basis.

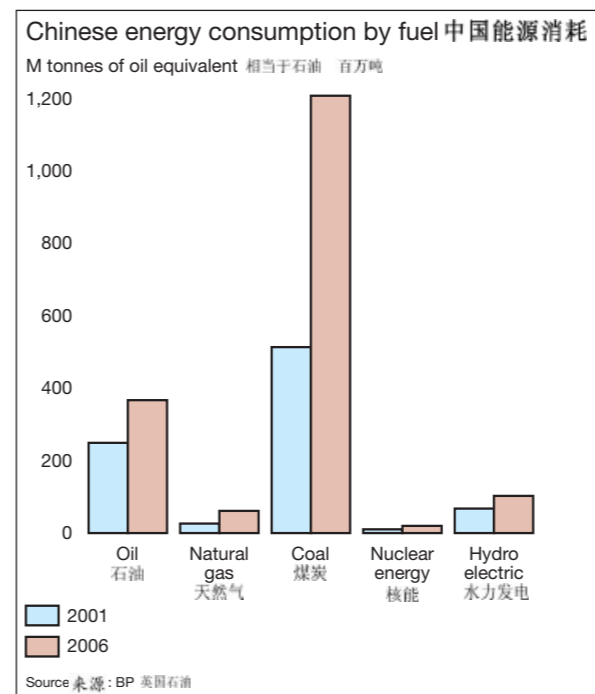
As a result of the locks' inefficiency, a logjam of ships and barges regularly develops on either side of the dam. Rather than wait their turn in the queue, many shippers opt to save time by unloading cargo and transporting it by road before loading the cargo back onto vessels further upstream or downstream beyond the final set of locks. This practice is known in Chinese as *fanba*.

When it goes into operation, the dam's vertical hoisting shiplift will relieve pressure on the shiplocks by serving mainly passenger cruises. Measuring 18 metres wide and 120 metres long with a water depth of 3.5 metres, the shiplift is believed to be the largest of its kind in the world. It will be able to lift two 3,000 dwt vessels at the same time.

The shiplift has been designed with the involvement of two German companies, Lahmeyer and Krebs und Kiefer. The design institute at the Yangtze Water Resources Committee were particularly impressed with German technology for the rack and piston hoisting system and awarded the contract to the two German companies in 2006. Previously, its design has undergone two major changes that have delayed its opening schedule by at least a year. Manufacturing and testing will begin in 2008, and pilot operation is expected to start by 2010.

Strong winds are another factor affecting the smooth operation of the shiplocks. In the first 17 days of May 2007, the locks were closed seven times due to strong winds, for a total period of 32 hours and with the longest closure lasting 16 hours. Strong winds are hazardous for ships attempting to pass the locks, and their high frequency has become a major concern to government agencies and commercial operations. Experts are still unsure whether the phenomenon has something to do with the raised water level of the reservoir.

When the Three Gorges Dam is fully operational, the water level will be manipulated over the course of the year to take account of fluctuating rainfall patterns. The level will be reduced to 145 metres at the end of May/beginning of June and maintained at that level until the end of September. From October, the dam will store floodwater by raising the water level to 175 metres and keeping it at that level until the end of December. Between January and April, the water level will be reduced to 155 metres.



乘客不幸遇难。此前的 4 月份，长江宜昌航道局秭归航道管理处接到当地居民提供的警报，长江岸边 64 公里开外出现长 200 米、宽 1 厘米的裂口。得知这一消息，该处立即派人设置浮标，向过往船只发出滑坡预警信号。自 2003 年水位升至 135 米以来，单是水库地区被标为危险区的地方就有 30 多处。

另一个棘手的问题是三峡大坝和葛洲坝之间的航道条件。建于 1988 年的葛洲坝总投资额为 48 亿元，电站装机 21 台，总发电量达 2715 千瓦时。葛洲坝水电站是长江上第一个水电站，也是中国当时最大的水电站。三峡大坝与葛洲坝仅隔 38 公里。两坝之间的航运情况异常复杂。各自的蓄洪泄洪周期使两坝之间的水流形成新的急流。目前有关部门正在展开调查，对两座大坝之间的水流进行监控。

但是，最大的问题是葛洲坝下引航道地基大部分是基岩和卵石，无法将河道内的淤积彻底清理干净。至 2007 年，葛洲坝下引航道的水位进一步下降，成为长江航道的一个新的瓶颈。

降雨量不稳定也是一大问题。2007 年 10 月至 12 月，航运业遭遇 50 年一遇的最低水位。长江上游地区的长时间干涸造成中游水位下降至 2 米，而整个水域的平均水位下降了 1.5 米。10 月至 12 月间，水库按计划蓄水，使水位低的问题更加恶化，以致吃水 2.7 米以上的船只一概被禁止通行。仅 10 月和 11 月就有 40 艘船搁浅，严重影响了航运交通。

12 月中旬，为了缓解枯水危机，大坝开始泄洪补水。宜昌河段的水位上升了 0.5 米。直到 2008 年初，人们尚不清楚此举的效果究竟如何、对水电站的运行产生了怎样的影响。每天平均有 170 艘货船在宜昌至武汉之间的河段航行。目前有 1000 多名工人、100 多艘工作船和 18 艘挖泥船在清理河床淤泥，维护这段航道。

有关部门还加大了对超载船舶的惩罚力度，增加了常规巡逻和突击检查的次数，要求船舶必须获得更多的许可方可驶入各类复杂河段。任何超载船舶必须将部分卸载。长江海事局的官方网站还新出现了“羞耻簿”一栏。仅 2007 年 10 月就有 35 艘超载船在“羞耻簿”上曝光。

The building of the Three Gorges complex has had the greatest impact on the middle reaches of the river, between Yichang and Wuhan in Hubei province. This 624km stretch flows largely through plains and hills, and is famous for its many bends and some 20 major shoals. The regular storing and releasing of floodwater from the dam has changed the silting pattern of the riverbed, thereby exacerbating the difficult task of maintenance during the dry season.

At the moment, the minimum maintenance standards are 2.9 metres draught, 80 metres width and 750 metres turning radius for the Yichang-Baiwei stretch, accommodating 1,500 dwt vessels. From Baiwei to Wuhan, the minimum maintenance standards are 3.2 metres draught, 80 metres width and 1,000 metres turning radius, allowing individual barges of up to 3,000 dwt and barge-tug fleets up to a total of 10,000 dwt.

In September 2008, the level is expected to be raised to its final operating level of 175 metres for the first time. Experts believe that the increasing incidence of earthquakes and landslides in the area may be caused by the rise of water levels in the dam reservoir, and that this could prove dangerous for shipping as well as for local residents. In late November 2007 a landslide near the dam buried a passing bus and killed more than 30 passengers. Earlier, in April, local residents reported to the Zigui office of the Yichang Waterway Bureau a crack on a road 64km away from the riverbank measuring 200 metres long and 1cm wide. The authorities put up a floating buoy immediately to warn passing vessels of the danger of a possible landslide. Since 2003, when the water level was raised to 135 metres, more than 30 locations have been marked as dangerous in the reservoir area alone.

Another thorny problem involves shipping conditions between the Three Gorges Dam and the Gezhouba Dam. Completed in 1988 with a total investment of Rmb4.8bn, Gezhouba boasts 21 generators with a total capacity of 2,715MW. It was the first hydroelectric dam along the Yangtze and the biggest in China at the time. The fact that the two dams are only 38km apart has complicated shipping conditions between them. Due to the storing and releasing cycles of both dams, the currents have become new rapids. Research is being carried out to monitor the water flow between the two dams.

The biggest concern, however, is the lower approach channel in the Gezhouba Dam, where the foundation is largely bedrock and pebbles, and dredging cannot completely clear the accumulated silt. By 2007, the draught of Gezhouba's lower channel had been reduced further, rendering the dam a new bottleneck for shipping along the Yangtze.

Erratic rainfall levels are yet another area of concern. Between October and December 2007, the shipping industry experienced its lowest water levels in 50 years. A prolonged dry spell in the area around the river's upper reaches reduced water levels in the middle reaches by up to 2 metres, while the average water level decreased by 1.5 metres. The decision to carry on raising the reservoir's water level from October until December exacerbated the problem, triggering a complete ban on vessels with a draught of 2.7 metres or more. During October and November alone, 40 vessels were stranded, severely affecting the shipping channel.

In the second week of December, water was discharged back into the river to alleviate the drought. Water levels in the Yichang section went up by 0.5 metres. How effective this action was and what impact it would have on the operation of the hydropower station were still unclear in early 2008. An average of 170 cargo ships a day use the section between Yichang and Wuhan. More than 1,000 workers, 100 boats and 18 dredgers are currently digging out silt in the riverbed to maintain this section.

The authorities are also coming down hard on overloaded vessels, stepping up the number of patrols and random checks that are carried out and requiring vessels to obtain more permits for various difficult stretches. Any vessels found to be overloaded are forced to partially unload their cargo. A new 'name and shame' scheme has also appeared on the official website

第五章

这些超载船多数在下水航行,其中有 15 艘装载的是黄沙、11 艘装载的是煤炭,还有 1 艘装载的是肥料。

为了解决这些问题,政府部门正在力求改进船闸的运营管理。当务之急是中央政府正在三峡水库和上游河段推进的船舶标准化工程,最大限度地扩大一次过闸的船舶数量和吨位。2006 年,交通部拨款 10 亿元在该地区实施此项规划。多数款项因强制淘汰不合格的船舶而用来补偿船东。

新的船舶设计规格和图纸也已免费派发给各家船东。80% 的新设计针对万吨级的驳船船队,其余的则适用于 3000 吨级的船队。自 2003 年 10 月以来,挂浆机船、水泥船或木船、以及新造的或经改装而成的任何不合格的船只均不得驶入三峡水库和上游河段。

按交通部计划,到 2010 年,进入这部分水域的船平均载重吨将达 1000 吨,标准化达 75%。到 2020 年,该比例将上升至 95%,船只的平均载重吨也将达到 1500 吨。各类过闸船只目前的平均载重吨为 623 吨。

官方也承认,耗费托运方额外开支的翻坝作法将长久地持续下去,对于合适翻坝的集装箱、滚装船和部分客轮更是如此。

三峡大坝本身的泥沙淤积问题又是一个危险。长江是全球淤泥最为严重的河流之一,淤积量世界排名第五。长此以往,淤积的泥沙将会对三峡水库造成不利影响,而且,泥沙淤积的问题还将日趋恶化。为了增加国内更多的可更新清洁能源、促进地区经济发展,国家正在水资源丰富的西南地区建设更多的水利发电站。

1997 年,长江因建造三峡大坝而截流。10 年后,为了建设全球第二大水利工程——溪洛渡水电站,长江再次截流。金沙江是宜宾上游段的长江。金沙江溪洛渡水电站的工程造价逾 500 亿元。2007 年 11 月 8 日,随着最后一车岩土倾入大坝位置所在的河段,长江上游截流成功。溪洛渡大坝位于三峡大坝的上游、西南两省云南和四川的交界处。截流成功标志着工程筹备工作的结束,工程主体施工阶段正式开始动工。

溪洛渡水电站计划于 2015 年投入运营,总装机容量达 12600MW。金沙江的另一个水电站——向家坝水电站也正在施工当中。该水电站也计划于 2015 年竣工投产,总装机容量将达到 6000MW。

对于长江上游如此大兴土木是否有可能继续恶化三峡地区和其下游河段泥沙淤积的问题,中央政府尚未公布任何信息。不过,有一点是可以肯定的:三峡大坝的开通改善了重庆至宜昌的航道状况,解决了一些老问题,也造成了不少新问题。政府是否有能力解决当前的困难,并且按照规划者们梦想的那样达到开放长江的目标,我们唯有拭目以待。

of the Yangtze Maritime Bureau. In October 2007 alone, 35 overloaded vessels, most of them sailing downstream, were exposed in this way. Of these, 15 carried sand, 11 coal and one fertiliser.

In an attempt to address these issues, the authorities are seeking to improve operational management of the locks. The central government is pushing ahead with the vessel standardisation programme in the Three Gorges reservoir and the upper reaches of the river as a matter of priority, to facilitate the greatest number and size of vessels that can pass the locks at any one time. In 2006, the Ministry of Communications allocated Rmb1bn for the implementation of the programme in this area. Most of the money was to be spent on compensating ship owners for the compulsory withdrawal of sub-standard vessels.

Specifications for new vessel designs and drawings are distributed free to ship owners. About 80 per cent of the new designs are for barge fleets of 10,000 dwt, with the remainder applying to fleets of 3,000 dwt. Since October 2003, oar-carrying motorboats, vessels made out of cement or wood, and newly built or renovated but non-standard vessels of any kind have been banned from entering the Three Gorges Reservoir and the upper reaches of the river.

The ministry is aiming to standardise 75 per cent of all vessels passing this area by 2010, with an average vessel size of 1,000 dwt. By 2020, the proportion will increase to 95 per cent, with an average vessel size of 1,500 dwt. At the moment, vessels passing the locks come in various sizes, averaging 623 dwt.

Officials also accept that *fanba*, the practice of bypassing the locks, will remain in place for the long term, at extra cost for shippers. This will be especially true for container cargo, ro-ro and some passenger ships, which are best suited to the practice.

Silting concerns

Silting in the Three Gorges Dam itself is of course another danger. One of the world's most silt-laden rivers, the Yangtze ranks number five globally in terms of sediment discharge. This raises concerns that, over time, silt accumulation will afflict the Three Gorges reservoir. The problem is set to get worse as China looks to build more hydropower stations in the water-rich southwest of the country, in a bid to increase its sources of clean, renewable energy and to stimulate economic growth in the region.

In 2007, a decade after the Yangtze was blocked for construction work on the Three Gorges Dam, the flow of the river was blocked once again to prepare for construction of what will be the world's second largest hydropower project. The Xiluodu power station, which will cost more than Rmb50bn to build, is located on the Jinsha River, as the Yangtze is known upstream of Yibing. Water flow was stemmed on the river on 8 November, when the last truckload of rocks was dumped into it at the dam site, a gorge upstream of the Three Gorges, on the border of the southwestern provinces of Yunnan and Sichuan. It marked the end of the preparatory work on the project and the beginning of the main construction phase.

Xiluodu will have an installed capacity of 12,600MW when it is operational in 2015. Another hydropower station, Xiangjiaba, is also under construction on the Jinsha River and is expected to be finished in the same year. This will have a capacity of 6,000MW.

The central government has yet to release information on how likely this dam-building spree on the upper reaches of the Yangtze is to exacerbate the silting problem in the Three Gorges area and further downstream. One thing is already known, however: the opening of the Three Gorges Dam may have improved the flow of river traffic between Chongqing and Yichang, but it has created as many problems as it has solved. Only time will tell whether the authorities can overcome the current difficulties and open up the river to the extent that planners originally conceived.