China's Three Gorges Dam: An Environmental Catastrophe?

Even the Chinese government suspects the massive dam may cause significant environmental damage

By Mara Hvistendahl | Tuesday, March 25, 2008 | 27 comments

SHANGHAI—For over three decades the Chinese government dismissed warnings from scientists and environmentalists that its Three Gorges Dam—the world's largest—had the potential of becoming one of China's biggest environmental nightmares. But last fall, denial suddenly gave way to reluctant acceptance that the naysayers were right. Chinese officials staged a sudden about-face, acknowledging for the first time that the massive hydroelectric dam, sandwiched between breathtaking cliffs on the Yangtze River in central China, may be triggering landslides, altering entire ecosystems and causing other serious environmental problems—and, by extension, endangering the millions who live in its shadow.

Government officials have long defended the $24-billion project as a major source of renewable power for an energy-hungry nation and as a way to prevent floods downstream. When complete, the dam will generate 18,000 megawatts of power—eight times that of the U.S.'s Hoover Dam on the Colorado River. But in September, the government official in charge of the project admitted that Three Gorges held "hidden dangers" that could breed disaster. "We can't lower our guard," Wang Xiaofeng, who oversees the project for China's State Council, said during a meeting of Chinese scientists and government reps in Chongqing, an independent municipality of around 31 million abutting the dam. "We simply cannot sacrifice the environment in exchange for temporary economic gain."

The comments appeared to confirm what geologists, biologists and environmentalists had been warning about for years: building a massive hydropower dam in an area that is heavily populated, home to threatened animal and plant species, and crossed by geologic fault lines is a recipe for disaster.

Among the damage wrought: "There's been a lot less rain, a lot more drought, and the potential for increased disease," says George Davis, a tropical medicine specialist at The George Washington University (G.W.) Medical Center in Washington, D.C., who has worked in the Yangtze River Basin and neighboring provinces for 24 years. "When it comes to environmental change, the implementation of the Three Gorges dam and reservoir is the great granddaddy of all changes."

**Dam Quake**

When plans for the dam were first approved in 1992, human rights activists voiced concern about the people who would be forced to relocate to make room for it. Inhabited for several millennia, the Three Gorges region is now a major part of western China's development boom. To date, the government has ordered some 1.2 million people in two cities and 116 towns clustered on the banks of the Yangtze to be evacuated to other areas before construction, promising them plots of land and small stipends—in some cases as little as 50 yuan, or $7 a month—as compensation.

Chinese and foreign scientists, meanwhile, warned that the dam could endanger the area's remaining residents. Among their concerns: landslides caused by increased pressure on the surrounding land, a rise in waterborne disease, and a decline in biodiversity. But their words fell on deaf ears. Harnessing the power of the Yangtze has been a goal since Nationalist leader Sun Yat-sen first proposed the idea in 1919. Mao Zedong, the father of China's communist revolution, rhapsodized the dam in a poem. The mega-project could not be realized in his lifetime, however, because the country's resources were exhausted by the economic failures of the Great Leap Forward in the late 1950s and then the social upheaval of the Cultural Revolution from the mid-1960s a to the early 1970s. Four decades later, the government resuscitated Mao's plans. The first of the Yangtze's famed gorges—a collection of steep bluffs at a bend in the river—was determined to be the perfect site.
In June 2003, nine years after construction began, the state-owned China Yangtze Three Gorges Development Corporation (CTGPC) filled the reservoir with 445 feet (135 meters) of water, the first of three increments in achieving the eventual depth of 575 feet (175 meters). The result is a narrow lake 410 miles (660 kilometers) long—60 miles (97 kilometers) longer than Lake Superior—and 3,600 feet (1,100 meters) wide, twice the width of the natural river channel. Scientists' early warnings came true just a month later, when around 700 million cubic feet (20 million cubic meters) of rock slid into the Qinggan River, just two miles (three kilometers) from where it flows into the Yangtze, spawning 65-foot (20-meter) waves that claimed the lives of 14 people. Despite the devastating results, the corporation three years later (in September 2006) raised the water level further—to 512 feet (156 meters). Since then, the area has experienced a series of problems, including dozens of landslides along one 20-mile (32-kilometer) stretch of riverbank. This past November, the ground gave out near the entrance to a railway tunnel in Badong County, near a tributary to the Three Gorges reservoir; 4,000 cubic yards (3,050 cubic meters) of earth and rock tumbled onto a highway. The landslide buried a bus, killing at least 30 people.

Fan Xiao, a geologist at the Bureau of Geological Exploration and Exploitation of Mineral Resources in Sichuan province, near several Yangtze tributaries, says the landslides are directly linked to filling the reservoir. Water first seeps into the loose soil at the base of the area's rocky cliffs, destabilizing the land and making it prone to slides. Then the reservoir water level fluctuates—engineers partially drain the reservoir in summer to accommodate flood waters and raise it again at the end of flood season to generate power—and the abrupt change in water pressure further disturbs the land. In a study published in the Chinese journal Tropical Geography in 2003, scholars at Guangzhou’s South China Normal University predicted that such tinkering with the water level could trigger activity in 283 landslide-prone areas.

That is apparently what happened to the 99 villagers of Miaohu, 10 miles (17 kilometers) upstream of the Yangtze, who saw the land behind their homes split into a 655-foot- (200-meter-) wide crack last year, soon after the reservoir water level was lowered for the summer floods. Officials evacuated them to a mountain tunnel where they camped for three months.

One of the greatest fears is that the dam may trigger severe earthquakes, because the reservoir sits on two major faults: the Jiuyuanxi and the Zigui–Badong. According to Fan, changing the water level strains them. "When you alter the fault line's mechanical state," he says, "it can cause fault activity to intensify and induce earthquakes."

Many scientists believe this link between temblors and dams—called reservoir-induced seismicity—may have been what happened at California’s Oroville Dam, in the foothills of the Sierra Nevada. The largest earthen dam in the U.S., it was constructed on an active fault line in the 1950s and filled in 1968. Seven years later, when the reservoir’s water supply was restored to full capacity—after engineers lowered it 130 feet (40 meters) for maintenance—the area experienced an unusual series of earthquakes. U.S. Geological Survey seismologists subsequently found a strong link between the quakes and the refilling of the reservoir.

The Oroville area was sparsely populated, so little damage was done. But earthquakes have also been connected to past hydropower projects in China, where dams are often located in densely populated and seismically active river basins. Engineers in China blame dams for at least 19 earthquakes over the past five decades, ranging from small tremors to one near Guangdong province’s Xinfengjiang Dam in 1962 that registered magnitude 6.1 on the Richter scale—severe enough to topple houses.

Surveys show that the Three Gorges region may be next. Chinese Academy of Engineering scholar Li Wangping reports on the CTGPC's Web site that the area registered 822 tremors in the seven months after the September 2006 reservoir-level increase. So far, none have been severe enough to cause serious damage. But by 2009, the dam’s water level is set to be raised to its full 575-foot capacity and then lowered about 100 feet (30 meters) during flood season. That increase in water pressure, in water fluctuation and in land covered by the reservoir, Fan says, makes for a "very large possibility" that the situation will worsen.

Local news media report that whole villages of people relocated to make room for the dam will have to move a second time because of the landslides and tremors, indicating that officials failed to foresee the full magnitude of the dam's effects. Guangzhou's Southern Weekend late last year reported that villagers in Kaixian County were eager to move again, citing landslides, mudslides and ominous cracks that had appeared in the ground behind their homes. They also hoped that moving might resolve land allocation issues: Some said they received only half of the acreage they had been promised.

**Water Displacement**

The dam is also taking a toll on China's animals and plants. The nation—which sprawls 3.7 million square miles (9.6 million square kilometers)—is home to 10 percent of the world’s vascular plants (those with stems, roots and leaves) and biologists estimate that half of
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China's animal and plant species, including the beloved giant panda and the Chinese sturgeon, are found nowhere else in the world. The Three Gorges area alone accounts for 20 percent of Chinese seed plants—more than 6,000 species. Shennongjia, a nature reserve near the dam in Hubei province, is so undisturbed that it is famous for sightings of yeren, or "wild man"—the Chinese equivalent of "Big Foot"—as well as the only slightly more prosaic white monkey.

That biodiversity is threatened as the dam floods some habitats, reduces water flow to others, and alters weather patterns. Economic development has spurred deforestation and pollution in surrounding provinces in central China, endangering at least 57 plant species, including the Chinese dove tree and the dawn redwood. The reservoir created by Three Gorges dam threatens to flood the habitats of those species along with over 400 others, says Jianguo Liu, an ecologist at Michigan State University and guest professor at the Chinese Academy of Sciences who has done extensive work on biodiversity in China.

The dam further imperils delicate fish populations in the Yangtze. Downstream, near where the river empties into the East China Sea, the land around the Yangtze contains some of the densest clusters of human habitation in the world, and overfishing there has already endangered 25 of the river's 177 unique fish species. According to a 2003 letter to Science by Wuhan University ecologist Ping Xie, many of these fish evolved over time with the Yangtze flood plain. As the dam decreases flooding downstream, it will fragment the network of lakes around the middle as well as lower the Yangtze's water level, making it difficult for the fish to survive. The project has already contributed to the decline of the baiji dolphin, which is so rare that it is considered functionally extinct.

The reservoir could also break up land bridges into small islands, isolating clusters of animals and plants. In 1986, Venezuela's Raúl Leoni Dam flooded 1,660 square miles (4,300 square kilometers) of land, creating the vast Lake Guri, along with a scattering of nonsubmerged land. The nascent islands lost 75 percent of their biological species within 15 years, according to research published in Science.

To determine the true toll, the Three Gorges Dam is taking on animal and plant species, Liu says, long-term data is needed, so that decreases in population totals can be compared with natural species fluctuation. But he cautions that many of the dam's effects may not be immediately apparent. The project is altering reproduction patterns, meaning it may already be too late for some plants and animals. "In the short term, you see the species still there, but in the long term you could see [them] disappear," Liu says. It is here that State Council representative Wang's allusion to "hidden dangers" rings especially true.

Disease and Drought

When officials unveiled plans for the dam, they touted its ability to prevent floods downstream. Now, the dam seems to be causing the opposite problem, spurring drought in central and eastern China. In January, the China Daily (the country's largest English-language newspaper) reported that the Yangtze had reached its lowest level in 142 years—stranding dozens of ships along the waterway in Hubei and Jiangxi provinces. An unnamed official with the Yangtze River Water Resources Commission blamed climate change, even as he acknowledged that the dam had reduced the flow volume of the river by 50 percent. To make matters worse, China is now plowing ahead with a controversial $62-billion scheme to transfer water from the Yangtze to northern China, which is even more parched, through a network of tunnels and canals to be completed by 2050.

Meanwhile, at the mouth of the Yangtze residents of Shanghai, China's largest city, are experiencing water shortages. The decreased flow of fresh water also means that saltwater from the East China Sea now creeps farther upstream. This, in turn, seems to be causing a rise in the number of jellyfish, which compete with river fish for food and consume their eggs and larvae, thereby threatening native populations that are already dwindling as a result of overfishing. In 2004, a year after the dam was partially filled, scientists noted a jellyfish species in the Yangtze that had previously only reached the South China Sea.

The effects of the dam's disturbance of whole ecosystems could reverberate for decades. G.W.'s Davis is part of a project researching the disease schistosomiasis (a.k.a. snail fever or swimmer's itch), a blood parasite transmitted to humans by snails; people can get it by swimming or wading in contaminated fresh water when infected snails release larvae that can penetrate the skin. (Symptoms include fever, appetite and weight loss, abdominal pain, bloody urine, muscle and joint pain, along with nausea, a persistent cough and diarrhea.) The snails used to breed on small flood plain islands where annual flooding prevented a population explosion. Now, the decreased flow downstream from the dam is allowing the snails to breed unchecked, which has already led to a spike in schistosomiasis cases in some areas.

According to Davis, such alterations could precipitate a rise in other microbial waterborne diseases as well. "Once you dramatically
change the climate and change water patterns, as is now seen in the Three Gorges region," he says, "you change a lot of environmental variables. Almost all infectious diseases are up for grabs."

The official recognition of the dam's dangers suggests that the project's environmental and public health impacts are starting to sink in. Political analysts speculate that President Hu Jintao and Premier Wen Jiabao are eager to distance themselves from a project they inherited. Although halting plans at this point would be an admission of government error, the openness following the Chongqing meeting raised the hopes of worried scientists that officials would take action to minimize the project's environmental and public health fallout.

Government-funded institutions have been quietly assessing possible recourses. Officials say they've spent more than $1.6 billion on fortifying landslide-prone areas and will spend an additional $3.2 billion on water cleanup over the next three years. In January the CTGPC signed a memorandum of understanding with the Nature Conservancy allowing that organization to consult on species protection and river health in the dam area. China's Ministry of Health, meanwhile, is trying to control schistosomiasis infections with a combination of drugs and applications of molluscicides, pesticides that wipe out the disease's snail carriers.

But these measures may not be sufficient to avert disaster. In February China's State Environmental Protection Administration said reservoir water quality targets had not been reached despite a cleanup effort that had been underway since 2001. And fighting schistosomiasis requires a more holistic, multi-pronged approach—particularly now that ecosystems in the Three Gorges region have been altered. To ward off an outbreak, Davis says, the government would have to prevent the use of night soil as fertilizer, build cement irrigation ditches, and ensure area villagers access to clean water. So far, that hasn't happened.

**Government Oversight**

In the wake of media reports about the government's concerns, officials began to backpedal. In a November 2007 interview with state news agency Xinhua, State Council's Wang claimed that "no major geological disasters or related casualties" had occurred since the reservoir's water level was raised in 2006; five days later, the earth in Badong crumbled and the railroad tunnel landslide wiped out the bus and its passengers.

Following a brief period of openness, discussion of the dam's environmental effects has once again become largely taboo in China. Government officials fear that continued free discussion of the project's ramifications could lead to civil unrest. One internationally published Chinese scientist working in the Yangtze Basin declined to comment publicly, noting, "This is a very sensitive topic.... I can't give hypotheses."

Despite the Three Gorges dam's growing list of problems, however, hydropower remains an integral—and ostensibly green—component of China's energy mix. China still draws 82 percent of energy from coal, but large dams are crucial to the country's climate change program, which aims to increase its proportion of electricity from renewable resources from the current 7.2 percent to 15 percent by 2020. Over one third of that will come from hydropower—more than from any other source. Twelve new dams are planned for the upper Yangtze alone.

The logistical and environmental hurdles involved in executing these dams underscore China's commitment to hydropower. The Yangtze's newest dams include several smaller projects that are necessary to alleviate sedimentation caused by the Three Gorges reservoir. In his 2007 report to the National People's Congress, Prime Minister Wen Jiabao said that China had relocated 22.9 million people to make room for its large hydroprojects.

China's original goal was to fill the reservoir to its maximum level by 2013. Despite all the trouble, that target was moved up to 2009, Fan says, to boost hydropower output by an additional 2.65 billion kilowatt-hours each year.

"For the economic interests and profit of the Three Gorges Project Development Corporation," he says, "that's very important. But the function of any river, including the Yangtze, is not only to produce power. At the very least, [a river] is also important for shipping, alleviating pollution, sustaining species and ecosystems, and maintaining a natural evolutionary balance."

"The Yangtze doesn't belong to the Three Gorges Project Development Corporation," Fan adds. "It belongs to all of society."