SAFETY OF THE DAM AND ITS PERFORMANCES

It has been a bad year for dam safety.

In February, five dams in Pakistan burst after torrential rains swelled local rivers. The biggest of these – the 35-meter Shadikor Dam – killed at least 80 people, injured many more and left 4,000 families homeless. The Shadikor Dam was only two years old. It appears that no warnings were given to people downstream.

Two months later, at least 62 people died in a dam-created flash flood on the Narmada River in India. Again, there was no warning. The banks of the river were crowded with Hindu pilgrims a day ahead of the new moon, a period when many bathe in the holy river to wash away their sins. The tragedy occurred after the gates of the Indira Sagar Dam, about 60 miles upstream, were opened without warning. The dam operator, the Narmada Hydroelectric Development Corporation, denied responsibility, saying the releases were standard practice, and that state officials should have informed them about the festival.

In March, heavy rains caused the Band-e Sultan Dam in southeastern Afghanistan to burst, killing an unknown number of people. The governor of the province said that thousands of hectares of land were flooded and hundreds of shops destroyed.

Last August, India had to shut down the World Bank-funded Nathpa Jhakri Dam for a second time just months after it began operation. Operators feared that upstream flooding would overtop the dam. Construction on the 60-meter-high dam had been seriously delayed by rockslides in the project area before construction started, and later, by flash floods.

Two months earlier, a dam break in Brazil's northeastern state of Paraíba killed five people and destroyed hundreds of homes. Paraíba's current governor claimed his predecessor had rushed the Camará project to completion for electoral reasons, despite known construction problems.

So are dams getting inherently less safe?

Yes and no. Certainly, dam-construction techniques have improved over the past 50 years. According a survey by the dam industry group ICOLD, around 2.2% of all dams built before 1950 had failed by 1995, but only 0.5% of dams built between 1950 and 1995. (The picture is less sanguine in China, where some 3,200 dams have failed since 1950 – 4% of the 80,000 classified dams in the country).

Of the 300 behemoth projects defined by the industry as “major” dams, almost all of which have been built since 1950, only Vaiont in Italy has so far caused a major disaster. A couple of known near misses, however, shows that major dams, some of which have the potential to kill hundreds of thousands, even millions, of people, can in no way be considered as inherently safe (see box, below). As author Jacques Leslie puts it, "Dams are loaded weapons aimed down rivers, pointed at ourselves; they're proof of the gambling nature of the societies that build them.”

While individual dams built today are likely to be much more secure than dams built 50 years ago, the global stock of dams as a whole is ageing, and as dams get old they become increasingly more expensive to maintain. Around the world, 5,000 large dams are at least 50 years old; the average US dam is in its forties.

The American Society of Civil Engineers reported in March that there are around 2,600 "unsafe" dams in US. These are dams with “deficiencies that leave them highly susceptible to failure.” This represents a 23% increase since 2001. According to preliminary results of a study by the Association of State Dam Safety Officials, the total investment to bring US dams into safety compliance or remove those that are no longer needed tops $30 billion.

The lack of investment in maintaining or removing unsafe dams in the US means that numerous small dams are washed away in floods every year. New Jersey alone lost three dams during Tropical Storm Floyd in September 1999, four in a flood in the following August, and 12 during an unprecedented summer deluge in 2004.

Worldwide, as in the US, there is systematic underfunding of dam maintenance. No figures are available for the cost of making the world’s dams safe. But if securing US dams would cost $30 billion and the US has an estimated 10% of the world’s dams, a ballpark figure for the global under-investment in dam safety would be $300 billion.

The above calculation begs the question of what is a “safe” dam. This question is now virtually impossible to answer because of a new variable in the dam-safety equation: climate change. Engineers design dams and their spillways to cope with the extreme floods that they predict using past records of streamflow and precipitation. It is vital that spillways are adequately sized – if a spillway is overwhelmed there is a high risk of a dam break.

But the assumption that we live in a stable climate no longer holds. Streamflow patterns are changing and are almost certain to continue to change, and at an accelerating rate, over the lifetime of the world’s dams. As noted in a World Commission on Dams’ background paper: “The major implications of climate change for dams and reservoirs are firstly that the future can no longer be assumed to be like the past, and secondly that the future is uncertain.” While the climatic future is indeed filled with uncertainties, one trend upon which

climatologists almost universally agree is that we will see (and indeed are already seeing) more extreme storms and increasingly severe floods. And yet, alarmingly, the vast majority of dam proponents and operators deny that climate change is even relevant for dam safety. The president of a major dam engineering firm told this author last year that climate change is "a problem for dams in 20 or 30 years, but not now."

Another “natural” phenomenon that is expected to pose an increasingly severe risk to dams in high mountain areas is Glacial Lake Outburst Floods (GLOFs). Glacial lakes are formed when rivers are blocked by natural ice dams. Catastrophic flash floods can be caused if these ice dams melt. Global warming is causing a rapid melting of the world’s glaciers and seems to be increasing the number of GLOFs. Dams in Nepal and elsewhere in the Himalayas are at particular risk.

The world’s more than 45,000 existing large dams have not been built to allow for a rapidly intensifying hydrological cycle. In this sense, *all* dams should now be considered unsafe. The several hundreds of billions of dollars that may be necessary to make existing dams “safe” under our existing climate would likely be dwarfed by the expenditure needed to upgrade the world’s stock of dams to allow for floods far bigger than predicted by hydrological history.

New dams could allow for larger floods than predicted from the historical record. But there are so many societal, technological, ecological and climatological variables to consider that we cannot know with any degree of precision the likely magnitude of future extreme floods. And so we cannot know with any degree of precision what should be the capacity of spillways for new dams.

There is no indication that governments and dam operators are willing to invest in bringing existing dams to what might be considered safe under the obsolete assumption of a stable climate. Perhaps even more alarming is that the vast majority of dam proponents and operators deny that climate change is even relevant for dam safety. International Rivers is unaware of any examples of dams currently planned or under construction that are designed to take account of the fact that future hydrologies will not be like the past. (This is ironically true even for hydro projects that are claiming subsidies through carbon credits: their developers are benefiting from the need to address global warming while they pretend that global warming is not actually happening.)

Things Fall Apart

A huge number of things can go wrong with a dam. The two main reasons for dam failures are “overtopping” (responsible for around 40% of failures) and foundation problems (around 30%). Embankment dams, which make up about four-fifths of the world's dams, are most

vulnerable to being washed away when water flows over their crest. There are usually a number of interrelated reasons why any particular dam collapses. A dam may be overtopped, for example, because of the inadequate capacity of its spillways to discharge floodwaters, because of a spillway blockage with flood-borne debris, or due to mechanical or electrical problems which prevent the spillway gates being opened in time. The spillway gates may also be opened late because of poor operator judgment or incorrect predictions of the size of flood entering the reservoir. Internal erosion caused by leaks through the core of a dam can also cause it to slump and be overtopped.

Building a totally safe dam is simply not possible. US dam-safety expert Robert Jansen says that dams “require defensive engineering, which means listing every imaginable force that might be imposed, examination of every possible set of circumstances, and incorporation of protective elements to cope with each and every condition.” This is clearly an unattainable target. In the real world, the degree of “defensive engineering” applied to the design of a dam will be decided by economics. The safer a dam – the greater the capacity of its spillways to cope with floods, the better the quality of its construction materials, the more extensive the exploration of the local geology – the more it will cost. ICOLD itself recognizes the conflict, stating in its 1987 guidelines on dam safety that: “For every dam project, a balance has to be found between dam safety and economy.”

There will always therefore be pressure for dam builders to cut corners on safety. A confidential 1991 World Bank report notes that because of “financial factors and local pressure to take shortcuts or ignore poor quality work,” construction quality in India is “deficient for a number of dams, posing serious potential risk to downstream populations.” The report explains how during construction “large illicit profits can be made by using substandard materials.” There are more than 4,000 large dams in India, with hundreds more under construction.

Even the most high-profile projects can suffer from “cut corners,” which can lead to safety issues later on. In 1998, top Chinese officials criticized shoddy construction on the massive Three Gorges Dam, saying that corruption and technical short cuts led to the use of concrete with the strength of "mashed tofu" on the 185-meter-high dam.

Safety Precautions Missing

Despite the massive risk to human life and property posed by large dams, few countries have comprehensive dam safety legislation. Such laws should cover the engineering criteria that new dams must meet; the regular inspection and repair of old dams; and the preparation of emergency evacuation plans for people living downstream.

Studies in the US have shown that where early warning systems and evacuation plans are in place, the fatalities caused by dam bursts are on average reduced by a factor of more than 100. However, such plans have been made for only a handful of the world's dams, mostly in the US, Canada and Australia. The first step in an emergency plan should be to draw up and make public a detailed “inundation map” of areas at risk if a dam should burst. Yet of the few countries that have produced adequate inundation maps, some regard them as so confidential that they do not allow even the emergency services to see them. This obsessive secrecy is sometimes due to concerns over the maps being used by the enemy in times of war: in other cases the authorities simply do not want to admit that all dams are potential threats to people living below them.

Clearly, there is an urgent need worldwide for dam safety legislation to be introduced, improved, and acted upon. In developing countries, in particular, a lack of funds is a major constraint to making existing dams safer. Such funds should be provided under the climate adaptation programs that developed countries are obligated to finance under the UN’s climate convention. Dam operators should also have to set aside part of their operating revenues to create a fund to be used for dam maintenance and, eventually, decommissioning.

These suggestions were discussed at a workshop on “Addressing Existing Dams” in Nairobi in 2004 sponsored by the UN Environment Programme’s Dams and Development Project. Representatives from the dam industry, NGOs, governments and international agencies agreed on a set of recommendations, including:

- Governments should put in place dam safety legislation;
- Financial institutions should support dam safety programs in developing countries.
- Initial project cost estimates should include the cost of dam safety programs, which should be paid out of future revenues.
- Emergency preparedness and evacuation plans should be put in place by the lowest feasible level of government for every dam involving risk to downstream populations.
- Local communities should be involved in drafting disaster management and evacuation plans and should be provided with relevant information on dam-break risks.
- The impacts of climate change should be considered in dam safety assessments and dam safety should be considered in climate change adaptation planning.
- An international study is needed on the impacts of climate change upon dam safety.

Unsafe dams kill. The dam industry must take seriously its responsibilities on the issue of dam safety, and it must stop denying the reality of a warming planet. Dam industry associations, and in particular the International Commission on Large Dams (ICOLD) should issue recommendations on how to incorporate the increased hydrological

uncertainties due to climate change into the dam-design process. Dam funders, in particular the World Bank, need to make much greater efforts to help borrowers to implement dam safety legislation and to make existing dams safer. They also must ensure that any new dams they support allow for the new hydrological uncertainties and that feasibility studies should include funds for ongoing monitoring and maintenance, and eventual decommissioning. Untold thousands of lives depend on the industry and its funders taking these actions.

A Brief History of Dam Failures

There have been 48 dam failures that killed more than 10 people outside of China in the past 100 years. (Inside China, an estimated 3,200 dams have failed since 1950.) The following is a brief history of some of the world's worst dam failures, and a couple of near-misses.

Teton Dam, US (1976). A 20-story-high wall of water poured out of the failed dam, destroying 4,000 homes and 350 businesses in three small towns, and damaging thousands of acres of farmland. Killed 11-14 people. Death toll would have been much higher but for the timely evacuation of 12,000 people the morning before the dam broke.

Vaoint Dam, Italy (1963): A reservoir-induced earthquake contributed to this deadly dam disaster. The 261-meter dam set off earthquakes as soon as its reservoir began to fill. One tremor set off landslides that plunged into the reservoir, creating a huge wave that overtopped the dam by 110 meters. About two minutes later, the town of Longarone was leveled and almost all its 2,000 inhabitants killed.

Henan Province dams, China (1975): As many as 230,000 people died in this domino-effect collapse of dams on the Huai River, some 85,000 in the flood waves and the rest from resulting epidemics and famine. The disaster began with the failure of the large Banqiao Dam in a typhoon, which resulted in the collapse of as many as 62 dams downstream. The Chinese government kept the incident secret for about 20 years, but information on the disaster was eventually leaked to the outside world.

Tarbela Dam, Pakistan (near-miss): This 143-meter-high embankment of earth and rock is perhaps the world's most problem-stricken major dam. Only an expensive program of emergency repairs and continual monitoring and maintenance have prevented its reservoir from bursting through the embankment and devastating the densely populated Vale of Peshawar below. The full story of how close the mammoth dam came to being breached has never been fully revealed, but a leaked document reveals a catalogue of mishaps, beginning with the first reservoir impoundment. The hugely expensive operation to stabilize the dam almost doubled the cost of the project.

Glen Canyon Dam, US (near-miss): Heavy floods caused the rock sides of one of the dam's two spillway tunnels to partially collapse in 1983. Operators had to close the spillways fearing that erosion of the tunnel sides could weaken the rock holding the dam in place. The reservoir would have overtopped the gates of the spillways had not plywood boards obtained from a local lumberyard been fastened to the top of the gates, holding back the reservoir for a few more nerve-wracking days. Government engineers thought there would be an “uncontrolled release” if the reservoir reached 3,708.40 feet above sea level. The reservoir finally peaked at 3,708.34 feet. Less than an inch saved the lower Colorado from probably the most massive flood in human history.

Source : http://www.internationalrivers.org/and-the-walls-came-tumbling-down