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# Dam Safety

## PROTECTING COMMUNITIES AND ECOSYSTEMS FROM DAM FAILURE

The safety of dams is often taken for granted until a high profile event reveals the associated risks. In the United States, the failures of Buffalo Creek Dam in 1970 and Teton Dam in 1976 resulted in dozens of deaths, hundreds of millions of dollars in property damage, and the loss of aquatic wildlife and habitat. Public reaction to these failures resulted in new legislation addressing dam safety, and since that time there have been just a few dam failures in this country, with damage primarily in the form of property destruction and environmental degradation. The lack of a high profile event has created a sense of security with our nation's dams, but the risks associated with unsafe dams have not been eliminated. The American Society of Civil Engineers (ASCE) emphasized this concern by giving dams a grade of D in their "1998 Report Card for America's Infrastructure" – citing age, downstream development, dam abandonment, and lack of funding for dam safety programs.

Dams are not designed to last forever; their deterioration is inevitable. It is imperative that we take a proactive approach to dam safety now, before the next major dam failure occurs. This means we must have a complete inventory of dams and their safety conditions, and, where significant safety risks occur we must ensure that the resources are available to either remove or repair that dam.

### Why are many dams unsafe?

Very simply, our dams are getting old. The Association of State Dam Safety Officials (ASDSO) estimates that the life expectancy of a dam is 50 years.[1] Currently, 25% of all U.S. dams are more than 50 years old, and by the year 2020 that figure will reach 85%.[2] Water is an erosive and corrosive agent, which means that over time dams incur structural wear and tear that make them susceptible to failure. Structural integrity may be threatened on a regional basis by factors such as freeze/thaw conditions, vegetation growth, and seismic disturbances. As time goes on, aging dams require more frequent inspections and repairs.

Development continues to increase downstream of dams. As our population continues to grow, more people find themselves in potentially hazardous locations, downstream of a dam. Presently, there are approximately 1,600 significant hazard dams within one mile of a downstream city. A significant hazard dam is one "likely to pose a significant threat to human life or property in the event of its failure."[3]

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1 "Regulatory Facts." The Association of State Dam Safety Officials (ASDSO). http://members.aol.com/damsafety/asdso.htm. June 1998

2 "1998 Report Card for America's Infrastructure." American Society of Civil Engineers (ASCE), Issue Brief – Dams. March 5, 1998.

3 Dam Safety Act of 1986, P.L. 99-662, Title XII-Dam Safety, Sec. 1201

Dam safety programs are poorly coordinated and underfunded. It is not always clear who has jurisdiction over which dams, and therefore the responsibility to ensure their safe operation. Individual state dam safety offices, the Bureau of Reclamation, the Federal Energy Regulatory Commission (FERC), and the US Army Corps of Engineers all have responsibilities for dam safety, depending on who built the dam and under what regulatory authority it is operated.

Even when jurisdiction is clear, lack of funding can cripple a dam safety program. In the state of Texas, which is home to more dams than any other state, the dam safety team has been reduced from 45 staff members to 6 staff members within the last twenty years. As a result, the team now inspects only about 2 percent of the approximately 7,200 dams in the state and inspects dams in populated areas once every 15 to 30 years (as compared with federal recommendations that they be inspected once every 5 years).[4]

There are a number of dams across the country, most built more than 50 to 100 years ago, whose owners cannot be identified. These dams have outlived their useful purpose, and are now abandoned in the river. Although some states do a better job than others, many of these abandoned dams have not been inventoried and are not inspected or regulated. In some cases, these aging dams are washed out in heavy storms, resulting in downstream erosion, sediment deposition, and the destruction of aquatic habitat and subsequent loss of fisheries. There are an unknown number of these dams across the country with no one to pay for their repair or removal. In many cases the burden is on the states to remove or repair these dams, and often the cost is passed on to taxpayers.

Funding is not readily available for the repair or removal of aging and abandoned dams. One of the biggest issues regarding dam safety is who should pay if a dam must be removed or repaired. If a dam has an identified owner, it is clearly their responsibility to undertake the repair or removal or to identify other funding sources. However, the state of disrepair of many dams underscores the dam owners' inability to pay for repair or removal.

Abandoned dams make funding repairs or removal more complicated. Most often, the obligation to pay for repair or removal of unsafe abandoned dams falls to the state. Unfortunately, only a limited number of states have established emergency dam repair funds and only a handful have the authority to remove the dam if removal is less expensive than the repairs.

Completing dam safety modifications is an expensive venture. A study of several hundred North American Dams, released by Ontario Hydro, indicates that on average hydropower operating costs rise significantly after 25 to 35 years of operation, due to the increasing need for repairs.[5] Current estimates put the average cost of dam safety modifications between $500,000[6] and $1.5[7] million per dam.

The existing dam safety inventory is not comprehensive, and has not resulted in significant improvements. The National Inventory of Dams (NID), overseen by the Army Corps of Engineers, is taking the lead in this endeavor. However, the NID only includes dams meeting certain height and impoundment criteria, which omits many small dams from the inventory. In addition, it is likely that many abandoned dams were not reported in the NID data collection process simply due to a lack of information on the state level regarding these structures. The lack of a more extensive inventory of all dams, including abandoned dams, makes it difficult to assess the extent of necessary repairs and removals.

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4 "Task Force Affirms Danger Posed by Inadequate Dams", Austin American-Statesman, July 28, 1998

5 McCully, Patrick. "Taking Down Bad Dams," World Rivers Review (International Rivers Network) August 1997. Vol. 12, No. 4

6 "1998 Report Card for America's Infrastructure." American Society of Civil Engineers (ASCE), Issue Brief – Dams. March 5, 1998.

7 Federal Energy Regulatory Commission, Office of Licensing and Compliance.

An inventory of dams is useful only if a proper evaluation of dam conditions is conducted and the data are used to correct the problems. Many of the dams in NID are overdue for safety inspections. Thirty-five percent of high hazard dams – those posing a significant threat to human life or property if they fail –were last inspected prior to 1990.[8]

## What are the repercussions of unsafe dams?

Unsafe dams may result in the loss of life. Most dams store water. In the event of their failure, they may unleash large volumes of water extremely quickly. Downstream residents and river users may not have sufficient warning to avoid the surging flow. Particularly at risk are those residents who live in the floodplain, and anyone downstream of a dam where there is not an early warning system.

Unsafe dams may result in the destruction of property. Along most rivers, large portions of the floodplain have been developed for residential, commercial, or agricultural use. Increased flows from dam failures quickly advance to the floodplain, and often beyond, eroding riverbanks, washing away structures, and inundating croplands.

Unsafe dams may harm the downstream river environment. The sudden and uncontrolled increase in flow associated with dam failure often triggers dangerous riverbank erosion or slumping. Eroded material is transported downstream and redeposited, impacting the quality of aquatic habitat. In addition, the water stored behind a dam often contains low levels of dissolved oxygen. A dam failure would result in a rapid release of this water, with the potential to literally suffocate aquatic organisms downstream.

The failure of unsafe dams may release toxic sediments. Sediment build-up in the reservoir created by a dam may threaten water quality vital to downstream communities and fish and wildlife. Sediment-carrying flow is slowed by the impoundment, allowing the sediment to settle to the river bottom. Toxic substances such as heavy metals, dioxins, and PCB's, present in the water column, may accumulate in this sediment over the life of the dam. Failure of a dam with toxic sediment buildup would likely flush out these sediments, resulting in suspension and downstream movement, exposing water supplies, fish and wildlife, and recreational users to potentially hazardous levels of toxics.

Unsafe dams put river users at risk**.** Clear signage and warnings are critical for river users in the vicinity of dams. Without advanced warning, river users may not recognize their proximity to a dam in time to avoid potentially life-threatening hazards. This problem is of particular concern at dam sites that have been abandoned, without an owner to be responsible for issues of liability.

Unsafe dams may jeopardize the delivery of critical services to communities. Dams often provide services such as water supply, power generation, flood control, and irrigation that communities count on. The failure of a dam could strand local residents without one or more of these services.

## What can be done?

There are three general solutions to an unsafe dam. First, one could leave the dam as is. Risk-reduction measures may be implemented, such as moving residents out of the floodplain, lowering the level of the reservoir, installing an early-warning system, and increasing the frequency of safety inspections. However, these measures only reduce risk, they do not eliminate it. Second, one could repair the dam. The critical issue in this option is a cost / benefit analysis – do the benefits of a repaired dam warrant the expense? Third, one could remove the dam. If repairing the dam costs an equivalent amount or more than dam removal, this may be a preferred option, depending on the use of the dam.

[8] "1998 Report Card for America's Infrastructure." American Society of Civil Engineers (ASCE), Issue Brief – Dams. March 5, 1998.

Funding targeted at dam safety should be increased**.** Recognizing that financing of dam safety repairs needs to be a priority, the Federal Emergency Management Agency (FEMA) has since 1996 administered a National Dam Safety Program. The program received full funding for FY98 at $2.9 million. However, this figure falls well short of the $1 billion identified by ASCE as necessary to rehabilitate our nation's dams.[9] The Chairman of the National Performance of Dams Program estimates that "It would take a billion (dollars) a year for the next 20 years to bring every dam up to speed."[10]

Many states have made creative efforts to ensure funds are available to address dam safety. In Texas, a task force evaluating the state's dam inspection program recommended policy changes that would grant soil and water districts the authority to impose taxes, impact fees and capital development fees to finance improvement of dams for which the districts are responsible.[11]

In addition, state and federal dam safety funds need to be more flexible in the way funds can be used to address safety problems. Many state dam safety funds provide funding if the dam is repaired but not if the dam is removed, even if removal is the more cost effective option.

Monitoring and record keeping on dam safety should be improved. A more closely coordinated monitoring and evaluation program must be in place to ensure that dams are inspected with regularity. An effort should be undertaken to build on the National Inventory of Dams, ensuring that records containing critical information are available for all dams nationwide. This must include an effort to identify abandoned dams and attempt to assess responsibility for their management.

More research is needed about the engineering, socio-economic, and biological impacts of dam safety. In every case, it is important to have an accurate estimate of the cost over time of maintaining and repairing aging dams. Estimates should include biological and social costs, in addition to economic costs.

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[9] "1998 Report Card for America's Infrastructure." American Society of Civil Engineers (ASCE), Issue Brief – Dams. March 5, 1998.

[10] "Aging Dams Pose Problems Across State", Associated Press Alert – Municipal, August 2, 1998

[11] "Task Force Affirms Danger Posed by Inadequate Dams", Austin American-Statesman, July 28, 1998