Public Safety and Unauthorized Extreme Activities at Spillways

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Public Safety and Unauthorized Extreme Activities at Spillways

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Abstract: One very important purpose for reservoirs is the recreational opportunities they provide to the general public. Unfortunately, some people engage in highly dangerous or extreme activities at dams and spillways that occasionally result in severe injury or death. In addition, some individuals purposely choose to ignore signage and safety fencing in order to access spillways and other hydraulic structures at the dam. Social media has become a means for advertising extreme activities that often occur on the physical structures at dams and spillways like surfing, wakeboarding, sledding, snowmobiling, skating, biking, diving, sliding, climbing, skateboarding, kayaking, wading and jumping. This only encourages others to ‘copy cat’ the activity, thereby endangering their own selves in the activity. This paper discusses the types of activities that are occurring at reservoirs, dams, and spillways and some suggestions for protecting the general public.

Keywords: Public safety, security of hydraulic structures, illegal activities, dams, spillways, accidents and fatalities.

1. Introduction

Flooding from severe storms between 1980 and 2009 has impacted an estimated 2.8 billion people throughout the globe. From over 4,000 floods, about 511,000 to 570,000 deaths occurred (Doocy 2013). Regions that experienced the greatest number of flood events during that period included the Americas, Western Pacific, and Southern Asia; accordingly, the regions with the highest flood mortality rates include Eastern and Southern Asia. About 4,560 flood-related deaths have occurred in the USA from 1959 to 2005 (Ashley 2008), with about 60% of those fatalities linked to motor-vehicles. Although dam failures occur periodically, many dams provide flood protection to the public and have performed as intended during significant storm events.

According to FERC (2011), approximately 35 dam failures have occurred in the USA, causing about 3,312 fatalities. The majority of these deaths occurred many decades ago, and in response to these early failures, a significant investment has been made into the research and design, engineering studies, inspections, monitoring, upgrades and rehabilitations, of dam construction activities. As a result, during the last 50 years an estimated 19 deaths from 11 dam failures have occurred. However, the American Society of Civil Engineers (ASCE) estimates that an additional investment of $45 billion is needed to address existing issues and deficiencies (ASCE 2017).

Accordingly, it is clear that 1) fewer deaths occur from dam failures than from flooding, and 2) a heightened awareness about dam safety issues, coupled with an increased level of safety for the public has resulted in fewer fatalities. In addition, when it comes to dam safety, if a community is impacted by a flood, it has proven to be helpful to identify the causes of death and injury and to clarify specifically whether the deaths and injuries are associated with a dam, large spillway release, or dam failure or if the deaths and injuries are associated with some other unfortunate cause.

Although many dams provide flood control, the primary purpose of a dam may be water supply, navigation, hydropower, or recreation. Most dams have multiple purposes, although the general public may only be aware of the recreational opportunities dams provide. Each year, many people visit dams to recreate and enjoy time with family and friends. Traditional recreational activities at dams include: swimming, fishing, and various types of boating (e.g., canoeing, motor boating, sailing, etc.). Indeed, it is common for the public to place high value on these activities at their local reservoir, hence, dam owners provide public access to portions of the reservoir and may also include public safety measures, such as restricted access to hazardous areas and postings of rules and regulations. Regrettably, each year a number of injuries and fatalities occur to persons engaged in these common and legal types of activities at dams. However, there are a number of cases were individuals and groups have recreated within or immediately adjacent to spillways, which is dangerous and unacceptable to owners.

Although fishing, boating, and swimming are some of the expected activities that occur at dams both near and within spillways, it should be noted that other more extreme activities are also taking place. Thrill seekers are climbing,
jumping, diving, wakeboarding, surfing, snowmobiling, sledding, skating, and biking in spillways (see Figure 1 for select examples from social media sites). A portion of these unauthorized hazardous activities are self-recorded and posted to social media. For example, YouTube (an American video-sharing website where users can create personal accounts and upload videos) includes a number of videos of people involved in thrill-related activities on and near spillways. As it applies to low head dams and spillways, Brigham Young University provides some information regarding fatalities where submerged hydraulic jumps have killed those that have gotten too close or captured by the reverse roller (Guymon). Thus far, about 550 deaths have been recorded (accessed Sept. 6, 2017). This statistic alone illustrates how significant this component of public safety is (i.e. protecting the recreating public), especially when comparing these number of deaths and injuries to those that occur when a dam fails.

![Figure 1. Individuals engaged in unauthorized and hazardous recreational activities in spillways; spillway jumping (left) and spillway boogie boarding (right).](image)

It can be particularly challenging for those concerned with dam safety to record and track injuries and deaths that occur at dams and in spillways because of the following reasons:

- Activities are often performed inconspicuously
- Activities may not be recorded on video surveillance or caught by on-sight security personnel
- Only a small portion of activities are posted to social media and posts can often be modified or deleted
- Multiple news agencies may report the same event differently and may not even reference the injury or death to a dam or spillway
- Reports of activities may not be complete or sufficiently accurate.

Clearly, the number of deaths caused by dam failures during the past 50 years (19 in the USA) is much less than the number of deaths caused by recreational activities at dams (550 just from the BYU study, but certainly much higher than this). Pioneering research by the late Dr. Bruce Tschantz indicates that there are about nine times more deaths at dams than deaths caused by a dam failure. From 1980 and 2016, 94% of incidents in his dataset resulted in death: 347 reported drownings at dams versus 40 deaths from dam failures (Tschantz). Equally concerning is the exponential increase in fatalities per year also noted in Dr. Tschantz’s work. The authors believe that this statistic is due in part to two factors: 1) There are more people recreating at dams each year due to population growth, and 2) each year there is newer or improved equipment and products available for public use as they recreate at dams.

Therefore, greater emphasis on public safety is needed for activities at a dam and particularly as it applies to dangerous and unauthorized recreational activities occurring in spillways. Of course, efforts to increase public safety must consider dam integrity and downstream hazards, but the types of activities being performed at dams should not be left out of the dam safety equation. Public safety efforts would greatly benefit from comprehensive databases of recreational incidents at dams that result in injury and death so that security and surveillance, public education and other successful mitigation strategies can be implemented to 'protect the recreating public’.
2. Recreational Activities at Dams

Well-documented and categorized incidents at dams facilitate improvement measures for public safety and the corresponding risks (Bennett, 2014). In other words, sound solutions can be implemented through insight. Therefore, a categorization system for the many types of activities occurring at dams and the adjacent areas upstream and downstream has been developed by Crookston and Barfuss (in Press). Categories include swimming (by location), boating (motored, sailed, self-propelled), fishing (by location), jumping, diving, climbing, traversing, surfing, sliding, and wheeled equipment (bicycles, skates, skateboards, scooters, motorcycles, cars, snowmobiles, etc.). Although there are cases where persons have died due to injuries sustained while recreating on dry or low water flow hydraulic structures, the majority of recreation-related deaths are due to drowning.

According to the Canadian Dam Association (CDA), many drownings occur because the public is generally unaware of the dangers associated with spillways and dam operations (CDA 2011). However, there are also numerous instances where victims ignored safety devices, including signage, fencing, and safety booms, in order to recreate in spillways. One recent example (see Figure 2) occurred on Sept. 11, 2017 when the first successful swim was made across the turbine intakes at Hoover Dam (Wilkins 2017). These intakes first began operation in March 1937. Previously, swimmers had been pulled towards the intakes by strong currents; gratefully, officials noted that during this man’s 30-min swim, only one of ten turbines were operating. Even then, the man reported great difficulty escaping the current from the single turbine. Although law enforcement was glad he survived, the man was given a hefty penalty and concern exists that ‘copy cats’ learning of his stunt through the internet may attempt this same suicidal activity.

![Image](image_url)

**Figure 2.** Drunk man first to survive swim across Hoover Dam intakes (www.dailymail.co.uk/news).

In addition to swimming, boating can also be extremely hazardous. In the USA, many boaters have been caught in a submerged hydraulic jump or reverse roller that can form at the toe of low-head dams (Schweiger 2017). The reverse roller features a strong rotational flow pattern that pulls boats, people, and objects towards the spillway. In addition to the strong current that can disorientate and be extremely difficult to escape, cascading flows capsize boats and buoyancy is greatly reduced due to highly aerated flows at the dam toe. Many run-of-river dams with reverse rollers are called ‘killer dams’ and ‘drowning machines’ (see Figure 3) because of the number of deaths that are reported each year. Unfortunately, boaters are often unaware of the danger concealed beneath the water surface; some seeking adventure ignore safety placards and of their own volition enter the dangerous currents.
Figure 3. Example of a warning sign at a low-head dam (https://c2.staticflickr.com/4/3427/3908093233_de4b8c44af_b.jpg).

A wide variety of other activities have also been documented near and within spillways. Fishing, particularly in the stilling basin, is quite common even when discharges are large. Individuals jumping off the dam into the spillway, sometimes with only a few inches of water in the chute or plunge pool, have been documented. Participants often have no understanding of the various hydraulic structural features beneath the water surface, such as gates, intakes, and baffle blocks, that they could impact or that could pull them beneath the surface. Surfing and sliding activities appear to be increasing in popularity. Riding the chute or waves via bodysurfing, surf boards, wake boards, boogie boards, and various types of tubes have been documented. Thrill seekers are quite creative and use ropes, pulleys, and motors to be pulled across and even up a spillway chute. Ogee crested spillways and smooth spillways are not the only type of spillway targeted. One instance involved a labyrinth spillway; a wake boarder was pulled by a rope and motor, skipping from inlet cycle to inlet cycle; no flow was passing over the crest of the labyrinth weir. Also, social media has documented daredevils slack-lining across the vertical shaft of a siphon spillway, riding BMX bikes down a morning glory spillway, riding a motorcycle across a spillway crest, or even in winter, riding a snowmobile up a spillway and the near-vertical sidewall.

3. Unauthorized Activities

While many recreational activities at dams are legal and authorized by dam owners and managers, many of the ones noted above are not. Trespassing, ignoring warning placards, scaling fencing and safety barriers to gain access to the dam or its’ hydraulic appurtenances clearly is unauthorized. These activities may or may not be noticed by an owner or local law enforcement because dams are commonly located in remote locations and may not have adequate security, such as video surveillance. Therefore, many activities are performed incognito, and subsequently, it is difficult to accurately document all unauthorized activities for a dam owner, let alone those that occur in another country or region. Typically, local media will report some injuries and most, if not all fatalities, but it is expected that many are not reported and the news reporter may not include details of interest to those tracking these activities, such as linking the injury to the dam or spillway itself. It is apparent that to comprehensively document all activities at all dams may be unreasonable and impossible. It is a daunting challenge to gather just the instances noted online or in local or worldwide newspapers, etc., let alone being aware of the unreported injuries and deaths related to recreational activities at dams and spillways.

It should be noted that daredevils are highly motivated by the thrill of the activity and also the attention that can come by posting photos and videos to social media. As a result, many videos posted online of extreme unauthorized activities at dams have gone viral. Those who post their adventures understand the social media reward structure and that invariably, attention online can result in revenue. Also, marketing strategies of some companies includes paying professional athletes to record and post a variety of extreme activities (e.g., Red Bull) to be viewed by millions, which
have included death-defying feats such as biking down a steep spillway into a full stilling basin or base jumping. This of course only perpetuates the problem, because many viewers want to experience the same thrills that are presented in each posting. Problematically however, these viewers may not possess the same athletic abilities, use the same safety equipment, or take the same safety precautions as the professionals that posted the activity and, therefore, place themselves in very high-risk situations if they choose to ‘copy cat’ the activity.

A small and recent sample by the authors of unauthorized activities at dams and in spillways was collected from the internet-based, video-sharing platform known as YouTube. Clearly, this sample size is insufficient to draw conclusions regarding the total number of extreme activities occurring at dams in the U.S. or any other country, all types of extreme activities, or their frequency of occurrence. However, the data does provide insight into how individuals are accessing spillways and other restricted areas at dams, what they are doing in those areas, and what their motivations may be.

First, participants in this sample behave fearlessly and are quite creative regarding the types of activities performed at dams and reservoirs. As previously noted, one individual navigated a snow machine through an ice-covered spillway chute and up a near-vertical face, nearly toppling backwards in what could have been a fatal accident. BMX bikers not only accessed a morning glory spillway (when not operating) but they also succeeded in performing vertical and horizontal loops within the shaft. Motors have been implemented to pull surfers up flowing spillways. If a recreational activity exists, then there is potential for someone to attempt the activity at a dam. Figure 4 describes a wide range of activities (sampled from YouTube) that are occurring at dams.

Second, those that engage in unauthorized activities at dams have been observed to ignore safety barriers and warnings; they exhibit creativity and fearlessness in order to gain access to the structure. Generic warning buoys, safety placards, and fencing (even with barbed wire) and similar barriers are in many instances insufficient. For example, research by the Canadian Center for Addition and Mental Health (CAMH) surveyed a number of individuals thrill-seeking at dams. Some respondents indicated that they would ‘never’ obey safety messaging (Giesbrecht and Schmidt 2009, CDA 2011). Indeed, for the videos in this sample, over 75% of these activities appeared to have no security measures, as shown in Figure 5 below. As shown in Figure 6, participants were willing to jump, swim, climb, etc. to restricted areas of dams and spillways for recreational purposes. As might be expected and as a point of interest, the majority of participants that post their activities on social media sites appear to be between the ages of 18 and 30.
Figure 5. Unauthorized dam and spillway activities self-reported on YouTube during the past 12 years (total sample size = 80).

- Signs, 11
- Fence, 13
- None Visible, 61
- Barbed Wire, 1
- Buoys, 2
- Rangers, 1
- Wooden Barriers, 1

Figure 6. Access methods for 40 unauthorized activities self-reported on YouTube.

- Walked through tunnel, 4
- Jumped into water, 8
- Climbed fence, 10
- Climbed railing, 7
- Paddled through buoys/barriers, 3
- Climbed ladder, 1
- Towed up side of dam, 1
- Cut fence, 1
- Rappelled, 1
- Walked onto spillway crest, 4
finally, although the data presented above is a limited sampling, it does in fact clearly demonstrate the need to provide more specific warnings onsite and better educating recreationalists. For example, the general public appears to be largely unaware that inclement weather or dam operations can quickly create hazardous conditions. Also, many appear to be unaware of drowning machines, weight capacities of service hoists, and dangerous features beneath the surface such as turbine intakes, submerged gates, and chute and baffle blocks. Truly, in the majority of cases where fatalities have occurred, the individual(s) would still be alive if they had been sufficiently deterred from recreating at the dam or in the spillways by proper signage. The authors of this paper believe that education and communication are the most effective means of improving safety at dams and spillways.

Self endangerment is not limited to Millennials and Generation Z (groups most commonly posting their antics on social media). For example, an older fisherman may ignore fencing and placards to frequently fish in a stilling basin. He or she may be completely unaware of the dangers of wading downstream of a spillway. It is essential that placards effectively communicate the dangers and consequences if one enters a hazardous and restricted area.

4. Conclusions

Dam sites are inherently dangerous to those that desire to recreate on them. Fast moving currents, steep slopes, large hydraulic forces and high falls are common features of dams and spillways, but as a result, these features are also huge enticements for thrill seekers who want to be carried faster or jump from higher places. Many injuries or deaths are being reported in the news each year as a result of legal as well as unauthorized activities at dams. The authors want to emphasize that it is in the best interest of dam owners and operators to use effective safety measures, including warnings and barriers to help educate recreationists of dangers, mitigate hazards, and discourage unauthorized activities.

Seven primary hydraulic hazards can be found at dams or in the rivers immediately downstream of dams (Schweiger 2017). These include: hydraulic rollers, swift currents over spillways, strainers, sudden downstream releases, flow into conduit openings, entrapment from flow control structures and flow under gate openings. Each of these dangerous hydraulic conditions injure or kill people each year when they either purposely or accidentally become a victim to the flow condition. One commonality in each of these hydraulic conditions is that the water flow rates are usually significant. As noted previously, drowning is still the number one cause of death to those that recreate in or near a hydraulic structure.

Most of the time, however, since the spillway on a dam normally operates only during a flood release, large flow rates or dangerous flood conditions are not usually present in the spillway on a dam and subsequently, it may appear to the general public during these periods that the dangers associated with recreating in or near the structure are minimal. This, however, is not the case. Although deaths are not as frequent, injury reports and on-line videos indicate that "sunny-day" injuries occurring to those that choose to recreate on or near the hydraulic structure or spillway of a dam are frequent. Although many of these injuries are minor in nature, some are even quite serious and some do cause death. It is important to note that these "sunny-day" injuries are almost always related to injury due to impact. This may include injuries due to an excessive fall to a concrete surface, an injury caused by hitting a stilling basin after riding on a board on a spillway slope at high velocities, an injury caused by diving into water that is shallower than expected or contains submerged structures that are unseen from above like baffle blocks, or an injury due to slipping on a mossy slope and falling, to name just a few possibilities.

On the FEMA website in which “Public Safety Around Dams” is discussed (FEMA 2017), it reads: ‘The nature of public interaction with dams is changing and guidance is needed to increase public safety around dams. Public interaction with dams is increasing for several reasons, including lack of awareness of hazards, public interest in “extreme” sports, recreational vehicles improving access, a perceived right of public access to sites, and the remote operation of dams. Dam owners need to consider how the public interacts with and around their dam, and establish appropriate procedures, restrictions, and safety measures.’ The site also has several references that discuss the topic of this paper and associated recommendations for improving public safety around dams.

The authors of this paper believe that 1) effective warning methods, 2) educating the public, and 3) the threat of legal action are three methods that are most effective for mitigating risk to the public as they recreate near hydraulic structures. It is apparent that when dam owners do not have these safety measures in place to protect and/or prevent the public from these hydraulic conditions, injury and death are much more prevalent. Although, these methods will not stop all individuals from illegally accessing a dam for recreational purposes, they will however provide sufficient warning and protection to most.
4.1. Visual and Audible Warnings

The Canadian Dam Association has prepared specific instructions for improving the safety at dams. This can be found in the bulletin entitled “Guidelines for Public Safety around Dams (2011)” (CDA 2011). The authors suggest that dam owners and operators implement signage, booms and buoys, and audible and visual signals to help protect the general public from personal injury and possible death. It is believed that unauthorized activities are occurring more frequently at dams where safety and protective measures are inadequate or non-existent. Dam owners and those concerned with public safety at dams have observed that adequate warnings of the dangers and penalties resulting from illegal access are effective deterrents. Other highly effective deterrents are security cameras or periodic patrols of restricted areas.

4.2. Education

Education is perhaps the most effective means for protecting the general public from injury or harm at dams. Many States in the U.S. (like Indiana DNR) have implemented educational programs to help people understand the inherent risks associated with dams. Like driving a car and the associated driver’s training, those that recreate on and near dams will always be safer when they are taught the dangers that are inherent at dams and spillways. Education will help recreationalists know that when they do not yield to warning signs and when dangers are ignored, they put themselves in high-risk situations. Because most injuries and deaths occur to individuals ages 18-30, it is expected that providing education to children and teenagers will be most effective.

4.3. Legal Action

Social media has been found to not only be a forum for an individual to advertise his extreme or unauthorized activities at dams and spillways, but it can also be helpful in preventing those who may view the post and want to ‘copy cat’ the dangerous activity. Authorities who find social media posts of unauthorized activities at their dam have found success in contacting the individual who posted the activity and strictly warning them that if anyone ‘copy cats’ their activity, the individual(s) who originally posted the activity will be held legally responsible for any injuries or deaths that might occur to others. This approach has had great success in removing social media posts that might encourage others to duplicate the activity. Signs that explicitly warn potential trespassers of specific hazards and penalties such as hefty fines and jail time also are helpful in discouraging illegal recreationalists from entering the property.

5. References