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UGMS HAZARDS SECTION

Vehicles damaged by a snow avalanche in a parking lot near Alta. (Photo courtesy of Bruce Tremper, Utah Avalanche Forecast Center.)

SNOW AVALANCHES

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OVERVIEW

Snow avalanches occur in the mountains of Utah as the result of snow accumulation and unstable snowpack conditions. Avalanches are extremely destructive due to the energy of the rapidly moving snow and debris, and burial of areas in the runout zones. Avalanches can damage property, interrupt communications, block transportation routes and streams, and may result in injury and death.

Utah is one of six states with a severe avalanche hazard. Over the past 20 years, avalanches have caused more fatalities than any other natural hazard in Utah; averaging two people per year. The primary risk is in the Wasatch Range with its high recreation use and increasing development, but snow avalanches occur in virtually all of Utah's mountainous areas.

Avalanches occur in Utah every year. Mitigation measures are essential. Already in place is a central forecasting center, avalanche control work at ski areas and along canyon roads, and some zoning ordinances. Still, the risk from avalanches is increasing as recreational use and development in mountains expand. Continual emphasis on appropriate land-use management, effective building codes, control work, avalanche forecasting, public education, and rescue plans are all essential to public safety.

DESCRIPTION

A snow avalanche is a rapid downslope movement of snow, ice, and debris. An avalanche can cover a wide area or be concentrated in a narrow tract. Avalanche paths consist of a starting zone, a track, and a runout zone (figure 1). Avalanche paths may not experience serious avalanches for years or even decades, but the potential exists - especially in above average snowfall years. Part(s) of an avalanche starting zone may move, or all of an avalanche starting

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zone may release at once. The starting zone can be several miles wide.

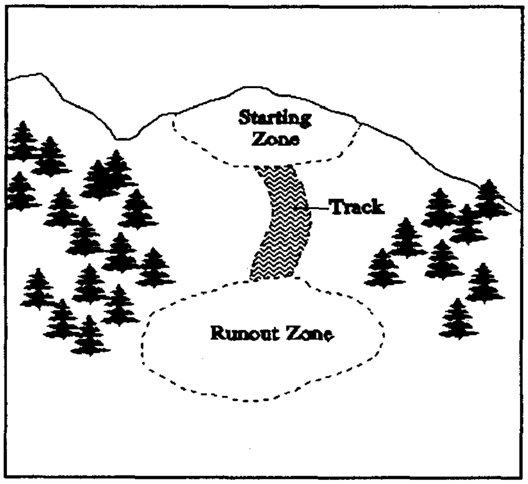

Figure 1. Diagram of an avalanche path, showing starting zone, track, and runout zone.

Avalanches may occur naturally, or they can be triggered by ground shaking (for example, earthquakes or explosives); by sound (for example, machine noises, sonic booms, or aerial detonations); or by a person treading in an avalanche area (skier, snowmobiler, or other winter recreationist).

Weather patterns and terrain combine in a complex relationship that affects avalanche conditions. Of the weather and terrain components, large frequent snowstorms combined with steep slopes are the two main factors contributing to avalanche activity.

Weather. Weather controls the timing and duration of avalanches; most avalanches occur during or within 24 hours after a storm. The amount of snow, rate of accumulation, wind speed and direction, moisture content, and snow crystal types all contribute to snowpack stability conditions. In Utah, the avalanche potential is greatest from January through April, although there have been large avalanches as early as mid-November and as late as early June.

Terrain. Terrain includes slope, elevation, aspect, shape, roughness, and angle. Elevation and aspect dictate the depth, temperature, and moisture characteristics of the snowpack. Slope shape and roughness contribute to stability; for example, bowl-shaped slopes are more prone to avalanching than ridges, and boulders, shrubs, and trees contribute to the slope's roughness and provide some stability. However, it is important to note that under extreme conditions, avalanches can occur in heavily timbered areas. Slope angle is the primary factor when considering avalanche probability. Avalanches can occur on slopes greater than 20 degrees, and optimum angles are between 30 and 45 degrees. On slope angles greater than 45 degrees, snow tends to sluff off continuously, thus preventing much snow accumulation.

Impacts

Both economic losses and loss of life can result from avalanches. At risk are some communities, individual structures, roads, ski areas, and people in the "backcountry" (backcountry skiers, snowmobilers, snowshoers, snowboarders, climbers).

An avalanche can reach speeds up to 200 miles per hour, and release enough energy to destroy everything in its path. An air blast may precede an avalanche, and can also cause damage. Another consequence of avalanches is burial of structures, roads, vehicles, and people in the runout zone. Tens of feet of snow and debris may be deposited. Flooding may result if a stream is dammed.

Most avalanche accidents occur in back-country areas that are not regularly controlled. Ninety-five percent of the time the person caught in the avalanche is the individual who triggered the avalanche.

Case histories

Numerous destructive avalanches have occurred in Utah. Historically, the largest death toll from Utah avalanches was suffered by early miners, with an estimate of over 200 lives lost. When people moved to mining communities in the mountains during the late 1800s and early 1900s, the interaction of avalanches and people was inevitable. In January 1881, March 1884, and February 1885, avalanches nearly destroyed the town of Alta. A total of 42 people were killed during those events. In the Bingham Canyon mining community, 25 homes were destroyed and 40 people were killed in one avalanche (February, 1926). The community was rebuilt in the same place, and in 1939, four more people were killed and four others injured by another avalanche.

After the mining era, skiing became popular and ski area development in the late 1930s in the Wasatch Range renewed concerns about avalanche hazards. To some extent, avalanche hazards were taken into account during construction. Control work, such as artificially pre-releasing avalanches, was and still is practiced. However, there is always an inherent risk from avalanches in the mountains. Some avalanche paths endanger many of the Snowbird and Alta ski-area parking lots and structures. Once, all three floors of the Alta Lodge were filled with snow from an avalanche, which also deposited a car on the roof. In January 1974, three lodges at Alta were damaged, two people injured, and 35 cars damaged or destroyed. In May 1983, an avalanche destroyed the Alta chapel. At Sundance ski area, an expensive home built in an avalanche path was completely destroyed in 1986.

Even established ski runs at ski areas cannot always be guaranteed safe from avalanches. In 1986, a skier was killed when an unplanned avalanche at the Alta ski area covered a ski run with tens of feet of snow, broken trees, and other debris.

Canyon roads, and the people traveling on them, are at risk. Numerous times, cars and even busses have been knocked off roads by avalanches. Although control work is practiced along the roads in Big and Little Cottonwood Canyons, there is always the chance of an unplanned avalanche. For example, avalanches issuing from the Tanner slide area in Little Cottonwood Canyon crossed the highway 11 times in 14 years; only one was released by control work. During a large snowstorm in 1991, several avalanches crossed the road in Big Cottonwood Canyon. The largest, near Storm Mountain, buried the road with over 20 feet of snow and debris. Luckily no vehicles were there at the time. It took 10 hours to clean away the debris and open the road. Other, smaller avalanches further up canyon did push several cars off the road.

Many other canyon roads are threatened by avalanches, and no control work is performed in those areas. Provo Canyon was the site of three confirmed deaths due to avalanches in 1897 and 1924. In February 1986, a large avalanche from the Bridal Veil Falls area crossed the road and blocked the Provo River. The river then eroded part of the road. Other canyon roads affected by avalanches include: Ogden Canyon, North Ogden Pass, Powder Mountain access road, Brian Head access road, Sundance access road, American Fork Canyon, Daniels Canyon, Spanish Fork Canyon, and Price Canyon. Several residential areas susceptible to avalanches are in Summit Park, Centerville, Spanish Fork Canyon, and Big Cottonwood Canyon.

In the backcountry there have been numerous deaths; averaging two deaths per year for the last 20 years. From 1987 to 1991, there were no reported backcountry deaths and much of this improvement is attributed to the forecasting and education efforts of the Utah Avalanche Forecast Center. However, in 1992, a tragic event in the La Sal Mountains illustrated the reality that there is always an inherent risk from avalanches in the mountains. Six backcountry skiers were caught in an avalanche; four members of the party died.

MITIGATION

Avalanche mitigation measures include appropriate land-use management and effective building codes in avalanche-prone areas, control measures including defense structures and artificial pre-release of avalanches, avalanche hazard forecasting, public education, and rescue plans. Mitigation becomes more critical as the recreation use and development in mountainous areas increases.

Land-use and building codes. The most cost-effective and safe measures to prevent property damage and save lives is to avoid land use and construction in avalanche paths and runout zones. Avalanche-prone areas can be easily delineated in many cases, because avalanches tend to run down the same paths year after year. Paths can often be identified by lack of vegetation or a predominance of quick-growing aspen and low shrubs. However, under extreme conditions, avalanches can overrun normal path boundaries or create new paths. In those conditions, avalanches can occur in heavily timbered areas.

Currently, only a few locales in Utah have avalanche zoning ordinances. The town of Alta, which is threatened by avalanches from all sides, has an avalanche zoning plan administered by the Salt Lake County Planning Department. The zoning plan controls development in avalanche zones through building permits. Salt Lake County also includes avalanches in its Natural Hazards Ordinance, which requires a hazard study by an avalanche expert prior to construction in avalanche hazard areas. Avalanche experts should always be consulted in evaluating avalanche-prone areas.

Control measures. Structural controls include erecting snow fences to keep snow away from starting zones; building snow sheds over particularly dangerous sections of roads; building diversion structures, like wedges, to divide avalanches and minimize their impact; and constructing concrete buildings to withstand avalanche forces. Such measures are often effective in reducing the risk from avalanches in developing areas.

The planned explosive release of snow accumulations is the most commonly used control technique in the Wasatch Range. This method pre-releases avalanches when no one is in the runout zone, and reduces the risk from unplanned avalanches in ski areas and along roads. Explosive charges can be delivered by hand, artillery, or mechanical conveyance. The Utah Department of Transportation (UDOT) took responsibility for forecasting avalanches along Big Cottonwood and Little Cottonwood Canyon highways in the 1980s. UDOT closes the roads while performing explosive and clean-up work; the procedure can often be accomplished in 6 to 12 hours. UDOT uses a combination of military weaponry and helicopter bombings. Helicopters are useful in areas beyond the reach of military artillery. Control work may be impeded, however, when bad weather prevents helicopters from flying.

Avalanche forecasting. The Utah Avalanche Forecast Center (UAFC) provides valuable information about current mountain conditions to help people avoid or minimize exposure to avalanches. The UAFC supplies information on weather, snow stability, and avalanche hazard ratings within an area, and specific data regarding the range of elevation, slope angle, and slope aspect. The forecasters communicate extensively with UDOT, U.S. Forest Service, ski areas, Wasatch Powderbird helicopter guides, and backcountry skiers. Forecasts are available for the central and northern Wasatch Range, and the La Sal Mountains.

Public education. Educating the skiing and other outdoor recreational public is important. Avalanche warning signs need to be posted at ski areas and along highways. The UAFC, with their forecasts, as well as their contributions to education, plays an important role in increasing awareness and reducing risk.

Rescue plans. Ski areas have rescue personnel and equipment to implement rescue operations. Rescue is a last resort, and can be a tragic experience because more than 50 percent of the victims buried by an avalanche die within 30 minutes or less.

Problems

No national program is in place for avalanche prediction, mitigation, research, or education. Formerly, the U.S. Forest Service (USFS) assumed responsibility for avalanche research and administration. However, they relinquished this responsibility in 1985, due in part to restricted funding. Without a federal agency taking a lead role in avalanche work, there is inadequate communication, regulation, and support. Lack of funding also inhibits the development and use of innovative technologies.

The continuance of military weaponry supplies for avalanche control work is not guaranteed. The UDOT is especially concerned about limited supplies because 85 percent of their control work along Big and Little Cottonwood highways is performed with military weaponry.

Only a small budget is allowed for the Utah Avalanche Forecast Center, which is solely funded by the USFS. The UAFC plays an important role in avalanche hazard reduction, and minimal funding can adversely limit their needed services.

Where to find additional information

For recorded messages on avalanche and weather conditions:

Tri-Canyon area
(Salt Lake City) 364-1581
Park City area (Park City) 649-2250
Mt. Ogden south to the Tri-Canyons
(Ogden) 621-2362
Northern Wasatch area (Logan) .. 752-4146

Sundance/Mt. Timpanogos area
(Provo) 374-9770
La Sal Mountains (Moab) 259-7669

Maps of avalanche-path special-study areas in Big Cottonwood, Little Cottonwood, and Millcreek Canyons are available at the Salt Lake County Planning Department. Currently, Salt Lake County requires an "avalanche expert" to investigate potential development areas located in these special study areas.

Maps of avalanche paths along Big and Little Cottonwood Canyon highways are available at the Utah Department of Transportation. They are contained in two snow avalanche atlases (see following reference list). Another avalanche atlas is being prepared for Provo Canyon.

Attempts are in progress to re-establish a Center for Snow Science at Alta; funding is currently a major problem. Contact Rand Decker, Department of Civil Engineering, University of Utah for more information.

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