A WIDESPREAD CYCLE OF UNUSUAL AVALANCHE EVENTS[1]

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Abstract.--A large number of massive, unusually long-running avalanches destroyed thousands of acres of mature timber, damaged numerous houses and several ski lifts, inundated highways, and took at least one life in the Sierra Nevada during a three-day period. Photos and profiles of selected examples are shown. Related weather events are discussed.

INTRODUCTION

During mid-February 1986 a cycle of unusual avalanche events occurred in widely spread parts of the mountain West. During February and May the writer observed the aftermaths of a number of these events in what must be considered only a small portion of the Sierra Nevada mountains of California and Nevada. These observations, together with reports from others, indicate that the total area of major devastation of timber throughout the range must number in the thousands of acres. Verbal communications with other observers indicate that similar events occurred in parts of the Intermountain region and perhaps elsewhere.

The unusual characteristics of the observed events are:

1. Destruction of a great amount of mature timber. In many instances, broad swaths were cut through stands of mature conifers. Individual swaths observed were as much as 670 meters wide. In a number of observed instances, several broad slides, separated only by minor terrain features, originated along a single ridgeline.

2. Timber destroyed, either broken off, shattered, or uprooted, consisted of a great number of conifers up to one meter diameter at breast height (dbh), plus a smaller number with dbh in the range of one hundred and thirty centimeters. The writer counted growth rings on a number of trees where the break point was in condition that allowed reasonable counting. Counts showed a large percentage of broken trees in the range of one hundred twenty-five to one hundred fifty years of age. A smaller percentage of trees were in excess of 200 years of age. One two hundred eighty-five year old broken tree was observed just west of Lake Tahoe.

Broken trees of greater dbh were observed; but the breaks were such that ring counts would have been possible only by sawing a section of each tree.

Trees observed that were larger than approximately one meter dbh were usually uprooted, rather than being broken off near the ground.

3. Runout distances were unusually long. Lowest alpha angle observed was 13°. Low alpha angles were observed even where the avalanches traveled through, and destroyed, large areas of mature timber. Low alpha angles were acheived by slides that originated on generally low angle starting zones that included flat faces, cirques, and convex slopes; all where confinement was negligible. Track-runout zone transitions were gradual in every instance. Runout zones of these slides were often broad open valley bottoms, where confinement remained negligible.

It would be reasonable to state that, in the Sierra Nevada snow climate, alpha angles lower than 18° are considered unusual.

In several instances, very low alpha angles were reached by slides that fell less than three hundred meters.

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4. In several observed instances, avalanches originated within or immediately above mature timber. Destruction of timber often commenced within a very short slope distance from the highest possible fracture point.

The two hundred eighty-five year old tree mentioned earlier was found at a site where destruction of open mature timber commenced sixty-one vertical meters below the ridgetop, at a point where the slope gradient changes gradually from 29.5° to 16° and finally to level ground. Alpha angle of this avalanche was 18°.

DISCUSSION

The unusual character of the events described is clear. A further intersting aspect of the events is that they all originated in what could be described as high elevation starting zones. All were above 2550m; most were above 2750m; some of those observed were as high as 3700m.

It seems reasonable to assume unusual snowpack and/or weather conditions as cause of the subject avalanches. Detailed analysis of the conditions that existed has not been completed; however, they can be broadly described as follows:

1. Snow cover was substantial -- the slidepaths had been well covered for a significant period prior to the avalanche events. A "normal" Sierra snowpack existed, generally strong, but with the usual number of weaknesses, both near the surface and deep in the pack.

2. Moderate to heavy snowfall had been occurring at the starting zone levels for some six days prior to the events. (This was a time of major flooding in the lowlands of California.)

Winds were from the normal west to southwest direction during the storm and were frequently strong.

Temperatures were fluctuating -- alternating periods of rain and snow were observed below 2400m, with one brief period of rain reported as high as 2700m on 14 February. With the exception noted, precipitation was almost exclusively in the form of snow above approximately 2500m; but the snow at the higher elevations was periodically very warm and moist and of very high density (water content of 20% and greater).

The storm period yielded substantial, but not record, new snow amounts at observation sites; but much of the snow was of very high density.

It seems reasonable to assume a correlation between the warm snow/cold snow periods at higher elevations with the rain/snow periods at the lower levels.

A significant amount of destruction occurred during this period at at least two high elevation ski lift sites and at some of the (relatively) few populated sites at those elevations. At lower elevations, where the majority of subdivided and more heavily populated areas are, numerous destructive avalanches did occur; but these were generally confined to well-recognized slidepaths and none of those observed ran to an unusually low alpha angle.

CONCLUSION

The "unusual" avalanche events -- defined for the purposes of this paper, as avalanches that were unusually destructive and that ran to unusually low alpha angles -- originated above the level at which significant amounts of rain occurred, but at levels where reported and inferred snow densities were high and where temperatures varied from near the freeze point to well below the freeze point. This suggests that the particular combinations of wind, temperature fluctuations, snow densities, and perhaps snow crystal types that occurred at the higher elevations all combined to impart strength to the new snow sufficient to allow it to remain in place in the starting zones until massive amounts accumulated -- followed by widespread, massive releases, many of which were observed on 18 February. These great masses of snow-in-motion probably encountered and entrained layers of very wet snow in their lower tracks and runout zones. This combination had apparently not been achieved for many years prior to the event.

One could theorize: If the wind-temperature-snow regime that dominated at the higher elevations during this period had extended itself downward some 200m or 300m, to the levels of the lower starting zones, the cycle of unusual events could well have extended into the more heavily populated zones. In this instance, areas such as the Lake Tahoe Basin, Alpine Meadows, and Squaw Valley, plus many other populated areas in the Sierra Nevada, could have been affected.