Snow Avalanche and its Impacts, Prevention and Challenges

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Abstract— Snow avalanche are a significant hazard in mountainous environments around the world. Snow avalanches pose a significant hazard to human populations and infrastructure in mountainous regions. Avalanche forecasting and hazard reduction methods rely heavily on the evaluation of snowpack information collected in the field. Hence understanding the spatial patterns of snowpack instabilities and their environment determinants is crucial. Avalanche impacts in India, include fatilities, and are summarize for public and residential area like ski areas, roads, and resource industries. Avalanche hazard methods, in which zoning, explosive control, forecasting. Problems of current avalanche hazard is solving these problem is identified with resources industries, backcountry recreation and residential areas. Snow avalanches are a significant natural hazard that impact roads, structures and threaten human lives in mountain terrain. Snow avalanche is not only the snow cover over the mountain side but also the later snowfall intensity. In this case study, we quantify the spatial patterns of the thickness and strength of an observed buried surface hoar layer and test for associations with spatial estimates of incoming radiation during the surface hoar formation period. In India, is attempt using terrain and satellite images and terrain characteristics with meteorology information. Contributory factors in retaining the snowfall a change and snow pack characteristics were rank and assign weightage the avalanche initiate based on the event in the region. Spatial distribution of snow accumulation zone, Snow fall area and snow pack stability assessment criteria was developed. Snowfall, temperature and wind are three factors that quickly change avalanche conditions.

Key words: Snow avalanche, avalanche risk, avalanche impacts, avalanche prevention

I. INTRODUCTION

Great masses of snow moves abruptly down a mountain slope. Avalanches are common phenomena throughout mountain areas. The snow avalanche, a common occurrence in snow covered mountainous regions, is a slide of snow mass down a mountain side. This is rapid down slope movement of a large detached mass of snow, ice and rocks. Small avalanche or sluffs occur in large numbers, which large avalanches that may encompass slope a kilometer or more in length with millions of tons of snow occur in frequently but cause most of the damage. Snow avalanches pose a significant hazard to human populations and infrastructures in the mountain region worldwide avalanche forecasting and hazard reduction methods rely heavily on the evaluation of snow pack in stabilities and these environmental determinants is crucial.

A. Types of Snow Avalanche:

There are three types of avalanches:

1) Loose Snow Avalanche:

The loose snow avalanches consist of loose crystals of snow admixed with air, the loose aggregate set in motion by snow storms.

2) Slab Snow Avalanche:

A slab avalanche is a portion of snow breaks loose as a slab and splits into pieces as it slides. Slab avalanche generally occur when packed portion of snow became loose.

3) Wet snow avalanche:

A wet snow avalanche is a mass of partially melted snow that moves slower than a dry snow avalanche.

II. FACTORS AND CAUSES OF SNOW AVALANCHE:

Avalanche is created when a mass of material overcomes frictional resistance of the sloping surface, often after its foundation is loosened by spring rains or rapidly melted by temperature, wind. Vibration caused by loud noises, such as thunder, blasting can create an avalanche.
There are different causes of snow avalanches:

A. Air temperature:

The second factors influencing occurrence of avalanches is the temperature of air and its diurinal variation. In Kashmir, where the snow pack is 3 to 5m thick, the diurinal variation is of the order of 6-10^{o}C, the maximum day temperature in sunny days being 5 to 10^{o}C.

B. Wind velocity:

Wind velocity is the third and very crucial factor in triggering fresh snow (Powder) avalanches. The wind blows the snow mass to the leeward side; sometimes giving to rise to overhangs and cornices, as very commonly in Laddakh, in upper Sind (between Gagangir and Shitkari) on the other side of the Zojila pass and in the Jhelam basin, where the wind blowing with a velocity of 15 km/hr in the valleys produces eddies and whirlwinds.

C. Slope gradient:

The mountain slope is the most important factor-The steeper the slope, the greater the potential-but only up to the limit of 60^{o}, for beyond this limit the slope cannot allow accumulation of snow. In the Laddakh and Himachal regions, the slopes range between 30^{o} and 45^{o} and are very prone to avalanches. The vegetal cover has a retaining influence on the moment of snow masses.

D. Snowstorm:

The heavy snowstorms are to cause avalanches. 24 hours later the snow storm is more difficult. The wind generally blow from one side of the mountain slope to another side.

E. Heavy snowfall:

Heavy snowfall is of the snow is unstable areas and puts pressure on the snowpack. It is create in summer month.

F. Effects of Avalanches:

This is little damage to ecological system cause by avalanche it is a part of nature, they are natural hazard for human population. Effect of snow avalanche is different types.

1) Damage to life and property:

A large number of causalities is take place after the snow avalanche hit heavily populated area. The infrastructure is damage and blockage caused, impact the livelihood of many. A powerful avalanche is to destroy building or houses and power supply can be cut off.

2) Flash flood:

Flash flood is to start when the avalanche is occurs, then down all the debris and can cause in low lying areas. Flash flood are seen occur after avalanche, in which a long term problem of many town peoples and villagers to deal.

3) Economic impact:

The avalanches can block anything in its paths and even restrict the simple movement of the traffic. Various ski resort depend on tourists to run their successfully. Snow avalanche may occur on any slope. Most avalanche of dangerous size therefore originate on slopes with inclinations of between 30^o and 45^o. On slope from 45^o to 50^o, small avalanche and sluffs are common, but snow seldom to collect and to occur high snow slide.

G. Avalanche Formation Factors:

There are different types of avalanche formation factors:

1) Snowpack factors:

Snowpack factors in which snow depth, snow layering, old snow surface is called snowpack factor.

2) Human factors:

Human factor is defined by altitude; physical is called as human factor.

3) Terrain factors:

Terrain factor in which slope steepness, slope profile, slope aspect is known as terrain factor.

4) Weather factors:

Weather factor is define by winds, temperature, storms, wet snow is called weather factor.

H. Avalanche Triggers:

There are three triggers for avalanches:

1) Slab and weak layer:

Avalanche is triggered in the starting zone from a mechanical failure in the slab avalanche when the forces on the snow exceed its strength but sometimes only with gradually loose snow avalanches.

2) A rapid change to snowpack:

- Variation in wind, temperature, humidity etc. during storm event.
- Wind, rain, humidity, sun, temperature etc. acting on the surface layers of the snow and changing from their original form.

3) A Trigger:

The avalanches are naturally triggered it means the weather is sun, wind, rain, snow of stress the snowpack to this breaking point. Such a tree falling in the woods for the most part, we only care about the ones that affect people. In 92 percent of avalanche accidents.

III. Prevention of Snow Avalanche:

Avalanche control is reduces the avalanche hazard sits to ecological system. Snow avalanche prevented by the climatic features likely to drainage, vegetation patterns, and seasonal snow distribution. The avalanche hazard is assessed by identifying ecological features likely as ski hills, buildings and roads. Prevention of avalanche hazard by formulating mitigation plan and prevention which then the executed in the winter season.

Prevention of snow avalanches are different types:

A. Steel retaining structures:

Avalanche protection by way of structural measures is two primary strategies, as outlined below. First the avalanche release is prevented by defensive structures and avalanche triggered is continuing and change the direction with structures likely to snow sheds and dams. Preventive measure team conduct and structural avalanche protection.

B. Snow Bridge:

A snow bridge is a rigid snow supporting structure for avalanche control. They can be made of timber, steel or prestress concrete frames. These structures can be fully enclosed, like an artificial tunnel. Snow bridge is maintain the passage in area where snow removal become almost impossible.

C. Snow net:

Snow net can be changed easily snow supported structure of avalanche prevention is built of nylon, steel or cables held through steel poles, provided with compress an anchors downhill. This is installing in the upper part of avalanche path to the control of snow from initial to slide into an avalanche. Snow net is the prevent of snow avalanche then the avalanche accident is less, Snow net installed in the avalanche zone and the net is made of nylon cables or steel.

D. Snow drifts control structure:

Snow drift control structures help in changing the wind-flow and preventing of snow on vulnerable avalanche slopes. A snow fence is a type of fences that forces wind blows, drifting snow is to collect in a desired areas.

This is primary employee to smallest the amount of snow drift on railway or roadway. The farmers and large farm of a cattleshed is use temporary snow fences and snow fences use in the avalanche.

A permanent snow fence simply builds of pole set into the ground with line of closely spaced shrubs.

E. Concrete wedges:

Concrete wedges not only serve as a bracking device but deflect the following mass of snow and thus protect buildings and structures of the village.

IV. Result and Analysis:

In the present study, the data of snow avalanches which have been occurred in Uttarakhand, Jammu & Kashmir in the past years were collected from various sites and researches. All the data is in Table form and the Graph of avalanche different parameters are shown.

In the recent past few avalanches occurred in Uttarakhand which are shown in table below:

Year	Location	Deaths
June 2008	Uttarakashi	1 person died
June 2008	Uttarakashi	6 died
Sept 2008	Uttarakashi	3 person killed
Sept 2010	Chamoli	2 army officers killed in an avalanche
June 2013	Uttarakashi	1 person killed
July 2013	Uttarakashi	1 person killed

Table 1.1: Major avalanches in Uttarakhand
Source: SASE, DRDO

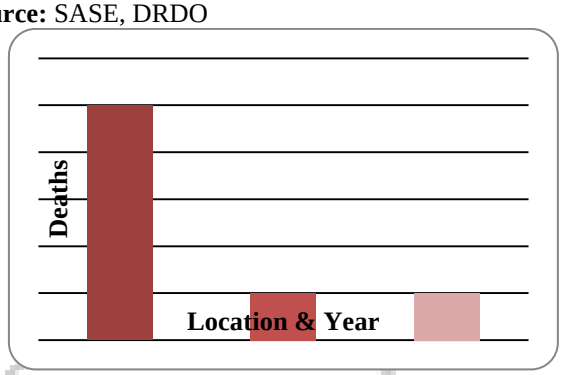

Fig. 6.1: Comparison of occurrences with location

This graph represents the locations where the avalanche has been occurred with respect to the occurrences of avalanche. Avalanche has occurred two times in the Kedarkharak, Uttarkashi.

V. Conclusions

Great masses of snow are called avalanches moves rapidly abruptly down a mountain slope. Avalanches hazard is prevented through trigger smaller avalanches artificially at chosen times under controlled conditions before the snow masses grow big enough to cause natural unpredictable avalanches. The artificial triggering is done by hurling explosive projectiles enough guns. The other way is to deflect or divert the moving mass by building wind baffles, snow fences, snow nets, breaking barriers, Gabion wall. So that the snow masses do not accumulate to dangerous proportions. Retaining walls, fences and avalanche wedges can ward off hazard to building and installations. It is very important for human being because everything that lives on land. Therefore more and more plantation required. We will need better technology and wider adoption of snow avalanches. Snow avalanche vulnerability assessment involves, snow holding capacity of the terrain, seasonal snowfall and cover characteristics. Significant parameters related of terrain, meteorology and snow were assigned weightage towards the accumulation and avalanche event based on reported events in Himalayas. Geospatial information was used in identifying avalanche origin. Slope profile is generated could be used in estimating the run out distance.

VI. Scope for Further Study

Great masses of snow moves abruptly down a mountain side, Avalanches are common phenomena throughout mountain areas, snow avalanche is created through temperature of air, wind velocity, slope gradient. Snow avalanche is prevent or control to steel retaining structures in the upper part of the slope, snow bridge, snow nets. It is very important for human being because everything that lives on land. Therefore more and more plantation required

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