EFFECT OF SIMPLE TERRAIN PARAMETERS ON AVALANCHE FREQUENCY[1]

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Abstract.--Analysis of avalanche frequency as a function of topographic parameters in Colorado found that the path angle (P) and angle (R) in the last 100 m to the highway explained 80 to 90 percent of the variance. An exponential frequency model with R was developed and successfully tested on independent data from Colorado and Utah.

INTRODUCTION

Risk evaluation of snow avalanche sites requires information on the frequency of anticipated events above some minimum size. After a threshold snow depth occurs, the number of avalanches reaching various points on a path is basically a function of starting zone failure frequency, volume and mass of the initial sliding snow, slope gradient, and resistence to flow. The easiest and most accurate way to obtain frequency information is to examine a high quality, long-term record for each site; but, such records are seldom available. An interpretive study based on field evidence is often the only practical recourse; commonly the result is a broad range of expected frequencies that are never verified. Better and more accurate ways of estimating avalanche frequency are needed to minimize errors inherent in current evaluation techniques.

This paper deals with the relationship between simple terrain parameters and avalanche frequency determined from long-term records in the central Rocky Mountains. The idea for the work came from papers by Lied and Bakkehoi (1980) and Bakkehoi, Domaas, and Lied (1983), who estimated maximum avalanche runout distance with objective terrain parameters determined from topographic maps. Earlier work by Schaerer (1977) indicated a good correlation between avalanche frequency, slope gradient, and an index of drifting snow for 36 avalanche paths in Canada. But snow transport effects are difficult to quantify objectively, and a more direct means of making frequency estimates is desirable.

DATA

Long-term records on 99 Colorado and Utah paths were used in this study. The data, classified according to the USDA Forest Service avalanche classification system outlined by Judson (1970), were collected by Forest Service personnel and other trained avalanche specialists.

The avalanche paths were partitioned into two groups based on length of record, quality and completeness of data, and intensity of observation: the group with the best and longest record, which encompassed 77 Colorado avalanche paths, was used for analysis and model development; the second group, which contained 22 paths in Utah and Colorado, was retained as an independent data set for model verification. Records for the 77 paths span 33 winters from 1950-1983; these paths affect Colorado highways over Berthoud, Loveland, Red Mountain, and Wolf Creek passes. The 22-path test group, with a 20-year record beginning after 1950, consisted of 14 paths affecting a resort highway to Alta, Utah, and 8 paths that intersect an access road to the Urad-Henderson Molydenum Mine near Empire, Colorado.

Located on all aspects in diverse terrain above, at, and below timberline, these avalanche paths lie in three widely separated mountain ranges: the Front Range and San Juan massifs in Colorado, and the Wasatch Front in Utah. Starting zone elevations vary from 2500 to 4000 m above mean sea level. Detailed physical descriptions of the Colorado paths, except for those at the Urad-Henderson Mines, are given by Frutiger (1964), Miller, Armstrong, and Armstrong (1976), and Armstrong and Armstrong (1977). The Utah paths are illustrated in Hastings et al. (1969).

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All areas consistently receive sufficient snowfall for avalanches every winter, although large differences in the mean November-April snowfall occur in each mountain range: Loveland Pass, 580 cm; Berthoud Pass, 780 cm; Red Mountain Pass, 950 cm; and Alta, 1310 cm.[3] Dry-snow slab avalanches are the dominant type on every path selected for this study. In Colorado, starting zones of paths that frequently produce avalanches that cover highways are sporadically controlled; despite this, the majority of snowslides blocking traffic are precipitated by natural triggers. The 14 Utah paths are frequently controlled during and after snowstorms.

TERRAIN PARAMETERS

Terrain measurements were taken from 1:24000 scale maps. Pertinent features of the paths were identified on the maps with the aid of aerial photographs and field examination. The following parameters were selected for study:

(1) Angle[4] of path above road = P
(2) Aspect of starting zone = ϕ
(3) Aspect of track = Ψ
(4) Difference between aspect of starting zone and track = D
(5) Starting zone angle = θ
(6) Angle of path in final 100 m to road = R
(7) Area of starting zone = A

An explanation of the terrain parameters follows:

Angle of path above road P - the angle from the uphill edge of the road to the top of the starting zone computed as $P = \arctan H/L$, where H is the total vertical displacement and L the map distance shown in figure 1.

Aspect of the starting zone ϕ - the exposure of the center of the main starting zone to the nearest 10 degrees.

Aspect of the track Ψ - the average exposure of the main track to the nearest 10 degrees.

Difference between aspect of starting zone and track D - the absolute value of ϕ-Ψ was used as an indication of the energy required to turn the moving snow. A large value of D might result in a lower average annual incidence of snow crossing the road.

Starting zone angle θ - this parameter was measured over the first 50 m of vertical distance in the center of the main starting zone (fig. 1).

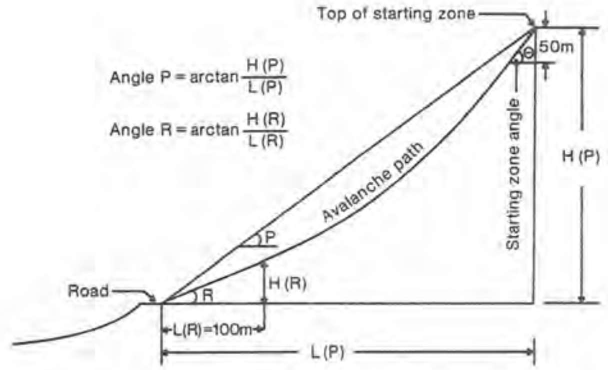

Figure 1.--Geometry of angles P, R, and Θ with respect to the uphill edge of the road, the last 100 m map distance to the road, and the top of the starting zone.

Angle of the path in the final 100 m to the road R - the vertical and horizontal displacements (H/L) were measured for the final 100 m map distance to the edge of the highway (fig. 1).

Area of starting zone A - area was determined with a planimeter.

ANALYSIS

The average annual incidence of slab avalanches across the highway centerline (I) served as the dependent frequency variable in this study. Point release snowslides and slabs that moved less than 100 m slope distance were excluded from the analysis to minimize noise caused by small-scale aspect and gradient anomalies not represented by the independent variables chosen for study. To further isolate the effects of terrain parameters on I, six separate stratifications were made for the position of the starting zone with respect to timberline, and for differences in the observed starting zone failure frequency:

	Starting zone	
Group	Timberline reference	Failure frequency
1	above	HF ($\geq$ event/year)
2	above	all (frequencies)
3	above/below	HF
4	above/below	all
5	below	HF
6	below	all

The "above" group included all paths whose starting zones and primary fetch areas were essentially treeless; some of these starting zones were below true timberline; the "below" group included paths with enough trees, either on the fetch or in the rupture zone, to significantly minimize snow transport and deposition. Starting zones producing an average of one or more slab avalanches annually were designated HF for high frequency; the remaining frequency groups included all paths. Strength of the relationships between I and terrain parameters within groups by size categories was tested with regression techniques that evaluated the possibility of both linear and nonlinear trends.

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[3]Based on USDA Forest Service or University of Colorado records for winters 1971-72 through 1982-83, except for Red Mountain Pass (1971-72 through 1980-81).

[4]The convention of assigning a positive sign to downhill gradients and a negative sign to uphill gradients was maintained in this study.

RESULTS

Avalanche size had no apparent effect on relationships between I and any of the terrain parameters, so, I was computed based on occurrence of avalanches greater than size 1. I was correlated with P and R for all above timberline paths (groups 1 and 2) and for the combined above/below timberline group in the HF failure stratum (group 3). The number of avalanches across highways from the below timberline group was poorly correlated with P and R, and scattergram patterns for I as a function of the remaining parameters ϕ, Ψ, D, θ, and A were weak and amorphous.

Exponential relationships between I, P, and R for group 1 data are shown in figures 2 and 3. This group includes paths with above timberline starting zones that fail annually. Data from the Front Range (F) passes over Berthoud and Loveland pass, and for U.S. 550 along and south of Red Mountain Pass (M) appear evenly distributed about the central axis of the curve without notable bias for any of the three locations. There is little reason for choosing one parameter over the other based on pattern structure, although R is statistically superior with a correlation coefficient of 0.95 versus 0.91 for P.

Group 2 data, which include above timberline starting zones with all·failure frequencies, are shown in figures 4 and 5, where the letters F and M indicate HF data for previously defined locations; G, N, and X stand for paths with less than annual failure frequency in the Front Range, at Red Mountain Pass, and from Wolf Creek Pass, respectively. Although pattern structure is sustained, separation of paths by failure frequencies shows two populations: the high frequency failure group (F, M) and the low frequency failure group (G, N, X), which appear in separate clusters, are best illustrated in figure 5. The low frequency failure group increases scatter and decreases the correlation. The data continue to be equally distributed about the central curve axis, even though the paths are located in areas with different snowfall regimes.

Group 3 data, which include both above and below timberline starting zones that fail annually (HF data), are shown in figures 6 and 7. Below timberline paths in the Front Range and near Red Mountain Pass are designated by G and N. The bulk of the correlation between I and the terrain parameters P and R is carried by the above timberline group. Bias toward any of the four mountain passes represented by these data continues to be neglibile.

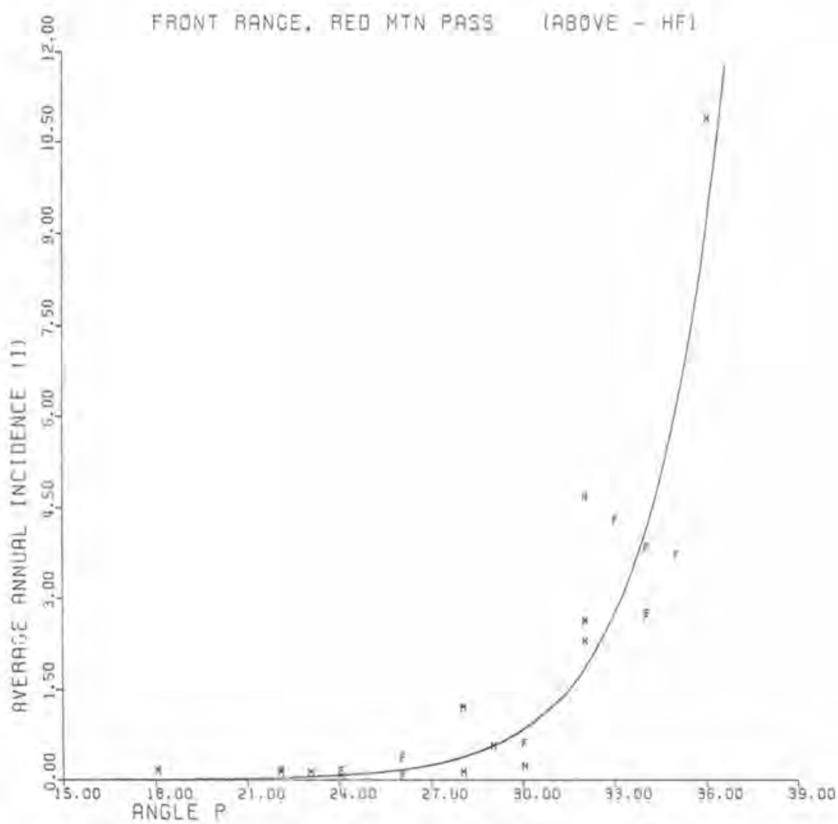

Figure 2.--Relationship between the average annual incidence of avalanches across the highway centerline (I) and the angle from the highway to the top of the starting zone (P) for the above timberline, HF stratum. F and M indicate paths on Berthoud and Loveland Passes, and Red Mountain Pass, respectively.

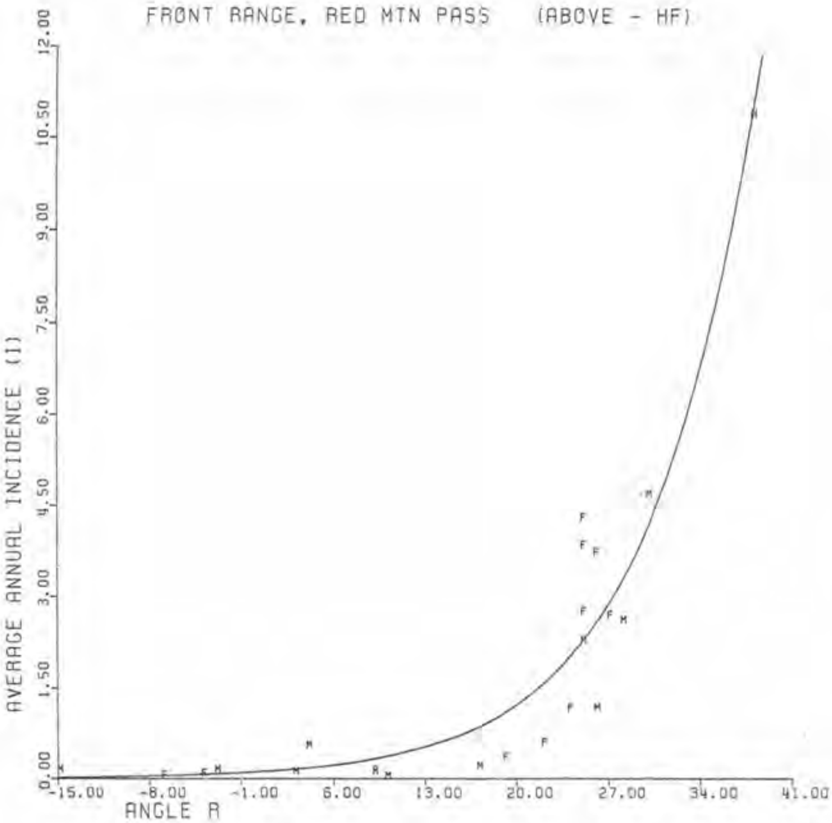

Figure 3.--Relationship between the average annual incidence of avalanches across the highway centerline (I) and the angle in the final 100 m map distance to the highway (R) for the above timberline, HF stratum. F and M indicate paths on Berthoud and Loveland Passes, and Red Mountain Pass, respectively. Downslope gradients are positive.

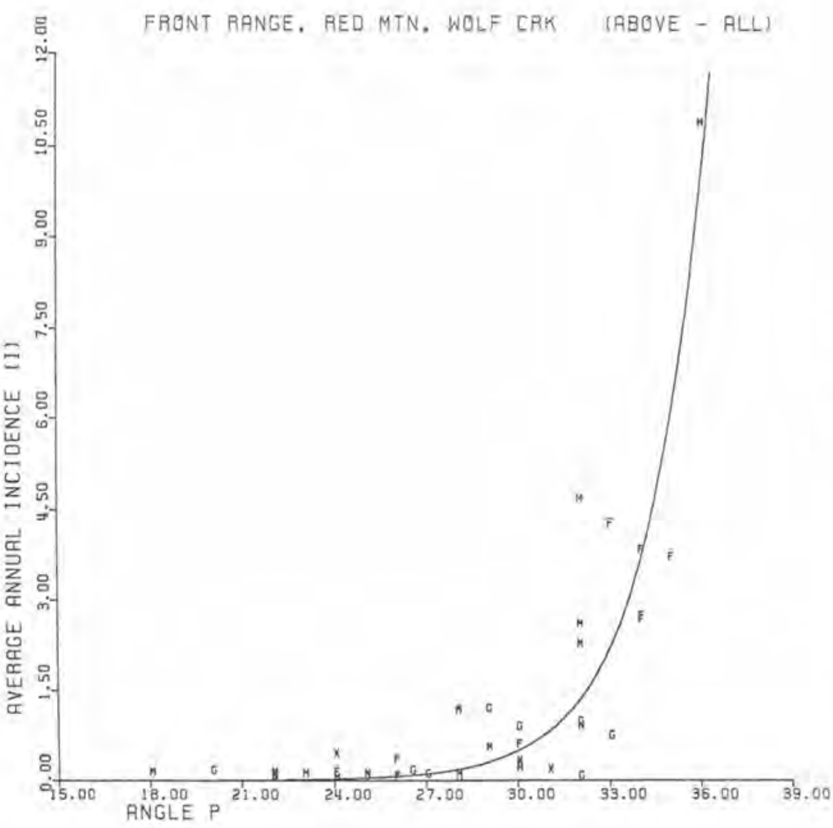

Figure 4.--Relationship between the average annual incidence of avalanches across the highway centerline (I) and the angle from the highway to the top of the starting zone (P) for the above timberline, all failure frequency stratum. F and M signify HF paths; G, N, and X indicate lower failure frequency paths on Berthoud and Loveland Passes, Red Mountain Pass, and Wolf Creek Pass, respectively.

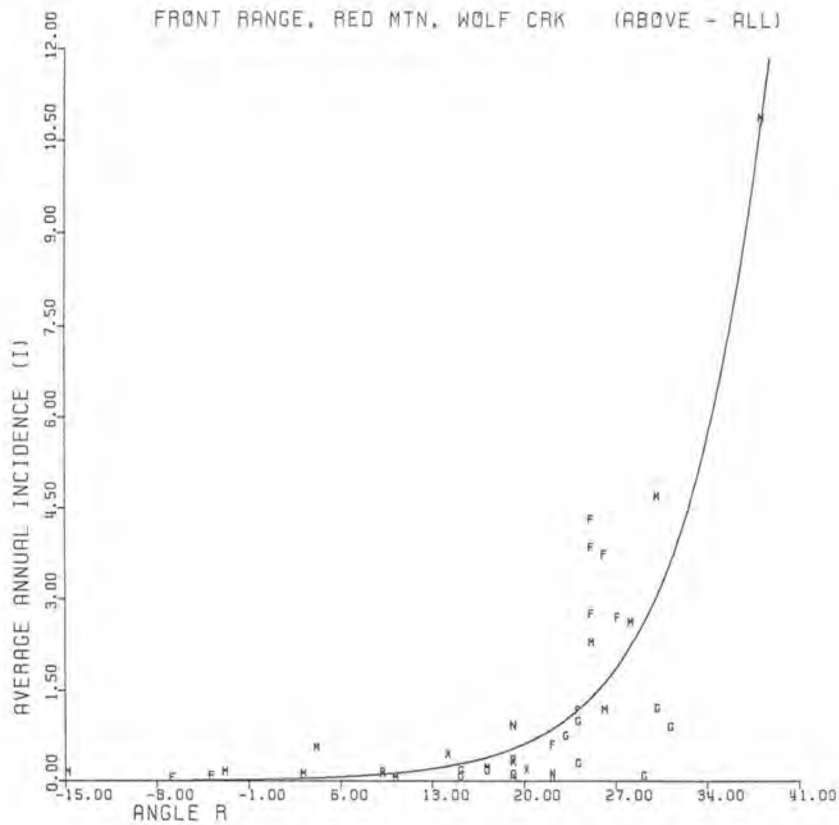

Figure 5.--Relationship between the average annual incidence of avalanches across the highway centerline (I) and the angle in the final 100 m map distance to the highway (R) for the above timberline, all failure frequency stratum. F and M signify HF paths; G, N, and X indicate lower failure frequency paths on Berthoud and Loveland Passes, Red Mountain Pass, and Wolf Creek Pass, respectively. Downslope gradients are positive.

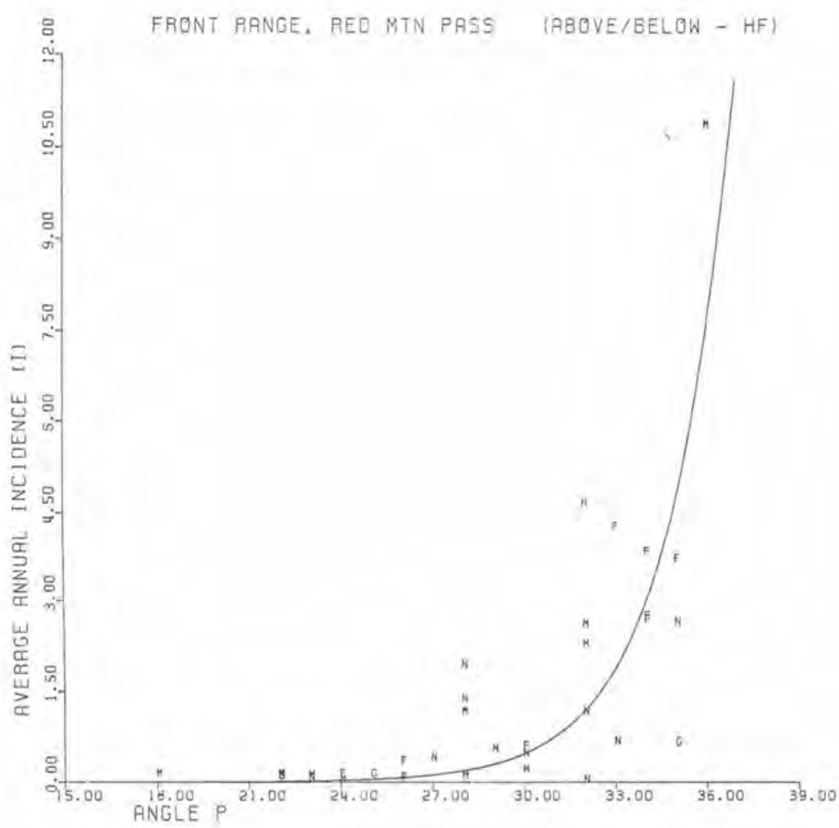

Figure 6.--Relationship between the average annual incidence of avalanches across the highway centerline (I) and the angle from the highway to the top of the starting zone (P) for the above/below timberline, HF stratum. F, G, M, and N signify: Berthoud and Loveland Pass above timberline below; Red mountain Pass above and below, respectively.

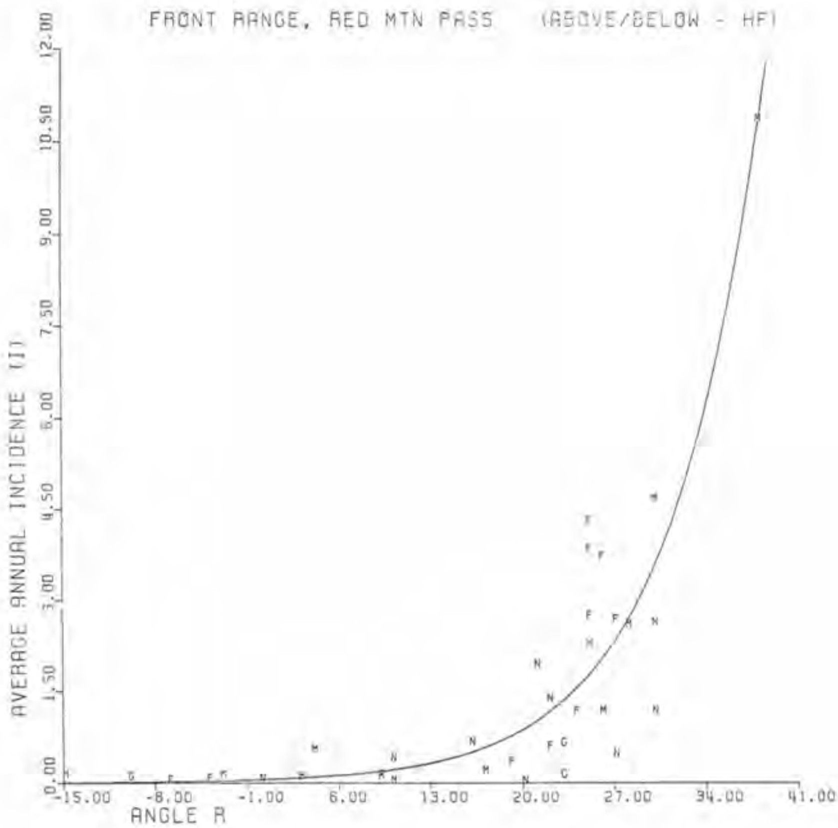

Figure 7.--Relationship between the average annual incidence of avalanches across the highway centerline (I) and the angle in the final 100 m map distance to the highway (R) for the above/below timberline, HF stratum. F, G, M, and N, signify: Berthoud and Loveland Pass above timberline and below; Red Mountain Pass above and below, respectively.

Beyond the relationship shown in figures 2-7, a simple combined limit on P and R was found to identify low frequency paths. The limits: $P<30$ and $R<20$ are characteristic of paths with less than one road closure per winter; in fact, all paths in this study, which fit the criterion, produced less than one event per year. It should be noted that some paths with angles outside the limits also produced less than one event per year.

Data for all groups are summarized in table 1, where strong correlations are confined to the first three groups and the comparatively weak ones are restricted to groups 4-6. These low correlations occur in the below timberline group, where I is quite variable on steep gradients. We could not address this problem directly because of insufficient data; but, most of the increased variance probably stems from complex interactions between forest and snowcover. Specifically, I is sensitive to variations in stand density and forest composition that affect interception, influence snow transport and deposition, and determine the amount of mechanical support available to the snowcover by individual tree stems; these interactions, are beyond the scope of this paper.

MODEL SELECTION AND TEST

The group 1 P and R models (table 1) are best suited for field use, because they give slightly higher frequency estimates and therefore provide a better safety margin than do the other models. Coefficients of the above timberline HF - R model have relatively much smaller standard errors than those of the P model. Mathematically, this indicates more stable estimates of the R model coefficients; because this model also exhibits the best fit to the observed data, it is the first choice for practical use. The model

$$\hat{I} = 0.109e^{0.121R}$$

has a correlation coefficient $r = 0.95$ and a standard error of 0.79.

The model was tested against the independent data from Alta, Utah, and the Urad-Henderson paths in Colorado (fig. 8). In this figure, which includes 95 percent confidence bands for an individual observation: A indicates above timberline at Alta; B indicates below timberline at Alta; U indicates above timberline at

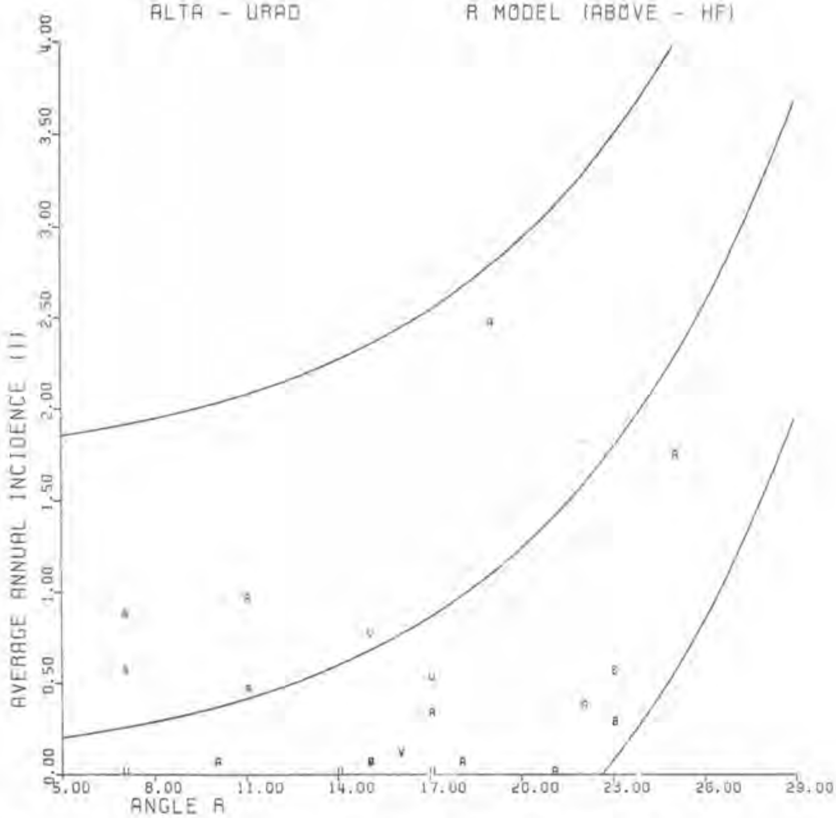

Figure 8.--Test of the model I versus R against independent data from Alta, Utah and the Urad-Henderson Mines in Colorado. A, B, U, and V indicate Alta, above timberline and below; and Urad-Henderson above and below timberline, respectively.

Urad-Henderson, and V indicates below timberline at Urad-Henderson. All points are contained within the confidence bands; but, although the model follows the general trend of the data, the lack of high frequency paths at either location precludes an adequate evaluation of the upper portion of the curve. Little or no bias is evident for the Utah paths; but the model overpredicts I at Urad.

A better perspective of the model is available in figure 9, where all HF path data are depicted with the 95 percent confidence bands. Despite substantial differences in winter snowfall (maximum of 226 percent) and variations in control intensity that range from none on the majority of Colorado paths to persistent and heavy on the Utah sample, the effects of R on I are clearly evident without significant bias for any of the five avalanche regions in the Colorado and Utah Rocky Mountains. The paths appear to belong to a single population.

The combined limits of $P<30$ and $R<20$ correctly identified $I<1$ for 9 paths from the independent set that met this simple terrain criterion.

APPLICATIONS

The group 1 R model and the combined P, R limit appear to have predictive potential as objective estimators of I in the central Rocky Mountains at spots where the relative frequency is desired but unknown. Use of the models in other regions should be conducted with extra caution until more data are available: very wet or slush avalanche sites may exceed I given by either R or the double limit.

To partially protect the user from underestimating the frequency of avalanche snow at sites where R exceeds 10 degrees, the authors recommend use of the upper confidence band to estimate I (fig. 9). The upper band can be computed as:

$$\hat{I}_{UB} = \hat{I}+2.08\hat{\sigma} \qquad (2)$$

where $\hat{I} = 0.1092e^{0.1214R}$, and $\hat{\sigma}^2 =$

$$0.6298+e^{0.2427R}(1.229\times10^{-3}-7.128\times10^{-5}R+1.066\times10^{-6}R^2)$$

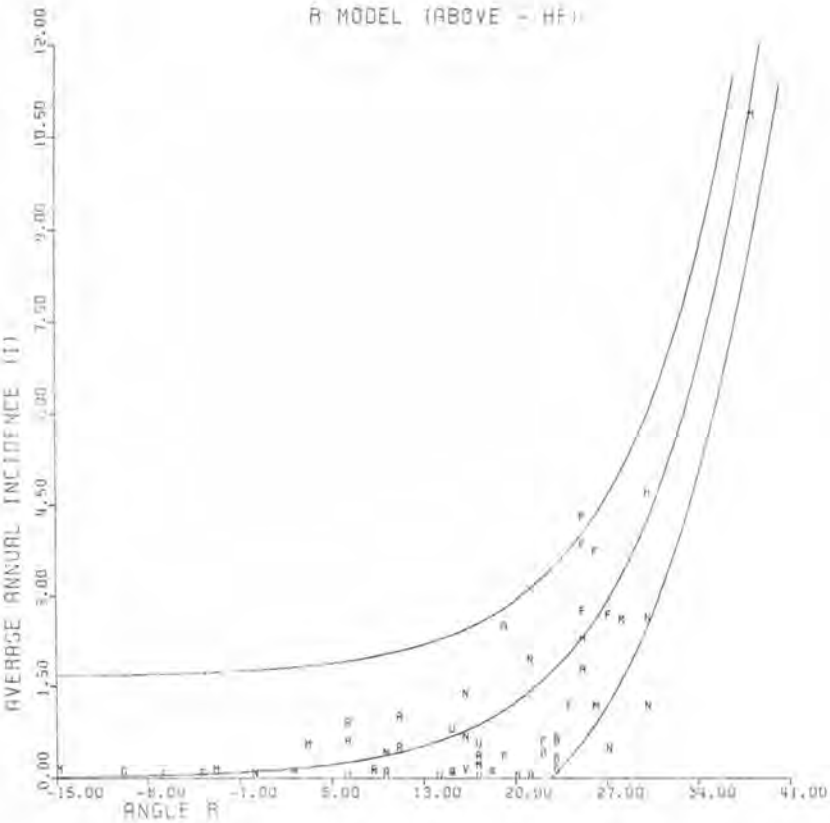

Figure 9.--Overview of the annual incidence model with F and the 95 percent confidence intervals. Data from the above and below timberline, HF stratum for the Colorado and Utah avalanche paths are superimposed and appear evenly distributed around the central axis despite important differences in seasonal snowfall in various mountain regions.

Frequency estimates for R above 40 degrees might best be described as "greater than I at R = 40." The user should realize that the actual frequency is probably less than I_{UB}, particularly when a lower angle slope lies just above the 100 m segment used in the computation; this is frequently the case at cliff sites or at other short, oversteepened sections of a path. A complete summary of I, P, R, the timberline reference, and starting zone failure frequency for all 99 paths is given in table 2.

CONCLUSIONS

The angle of an avalanche path (P) and the slope in the last 100 m map distance (R), are strongly correlated with avalanche frequency, and can be used to estimate the annual incidence of avalanche snow at specific points on Central Rocky Mountain paths. R provides a better estimator than P on slopes between 35-40 degrees, cliff sites excepted; but, either parameter overestimates I on slopes over 40 degrees. Estimation errors are greatest at tree covered sites because of complex interactions between forest and snow cover; but, the average number of avalanches from such areas is about one-half that at treeless slopes. A simple limit of $P<30$ and $R<20$ degrees should identify paths where I is below unity.

The effects of size, aspect, and starting zone angle, and aspect of the track are unrelated to the incidence of avalanches in the sample. More information than was available would be needed to analyze possible interactions among all the potential factors.

REFERENCES

Armstrong, B. R., and R. L. Armstrong. 1977. Avalanche atlas, Ouray County, Colorado. University of Colorado. Institute of Arctic and Alpine Research, Occasional Paper No. 25, 131 p. Boulder, Colorado

Bakkehoi, S., U. Domaas, and K. Lied. 1983. Calculation of snow avalanche runout distance. Annals of Glaciology 4:24-29.

Frutiger, H. 1964. Snow avalanches along Colorado mountain highways. USDA Forest Service Research Paper RM-7, 85 p. Rocky Mountain Forest and Range Experiment Station, Fort Collins, Colorado

Hastings, E.A., and others. 1969. Alta avalanche control and safety plan, by E. A. Hastings, W. B. Bassett, B. Sandahl, M. R. Lindquist, and H. A. Harrison. USDA Forest Service. Wasatch National Forest.

Judson, A. 1970. A pilot study of weather, snow, and avalanche reporting for the western United States. Canada, National Research Council, Associate Committee on Geotechnical Research. Technical Memorandum No. 98, p. 123-34.

Lied, K., and S. Bakkehoi. 1980. Empirical calculations of snow-avalanche runout distance based on topographic parameters. Journal of Glaciology 26(94):197-207.

Miller, L., B. R. Armstrong, and R. L. Armstrong. 1976. Avalanche atlas, San Juan County, Colorado. University of Colorado. Institute of Arctic and Alpine Research, Occasional Paper No. 17, 229 p. Boulder, Colorado

Schaerer, P. A. 1977. Analysis of snow avalanche terrain. Canadian Geotechnical Journal 14(3):281-287.

Table 1.--Summary results for the relationship between the dependent frequency variable I and terrain parameters P and R for each stratum.

Group no.	Parameter	Starting zone Timberline reference	Starting zone Failure frequency	r	s.e.	$\hat{I}$
1	P	above	HF	0.91	1.08	$5.190 \times 10^{-6} e^{0.399P}$
	R			0.95	0.79	$0.109 e^{0.121R}$
2	P		all	0.90	0.91	$1.583 \times 10^{-7} e^{0.498P}$
	R			0.85	1.06	$0.026 e^{0.158R}$
3	P	above/below	HF	0.78	1.38	$4.926 \times 10^{-7} e^{0.459P}$
	R			0.89	0.97	$0.054 e^{0.139R}$
4	P		all	0.59		
	R			0.43		
5	P	below	HF	0.47		
	R			0.61		
6	P		all	0.30		
	R			0.31		

Table 2.--Data summary for 99 avalanche paths in Colorado and Utah include: location, the annual incidence of avalanches crossing the highway centerline (I), terrain parameters P and R, starting zone timberline reference (T), and strata for failure frequency in the rupture zone (f).

No.	Name	I	P	R	T[1]	f[2]
		FRONT - BERTHOUD PASS				
1	Lower Stanley	0.12	26.5	15.0	A	1
2	Dam	0.03	26.0	-4.0	A	1
3	Aspen	0.03	32.0	15.0	A	0
4	Campground	0.00	31.5	15.0	B	0
5	Berthoud Falls	0.00	26.0	-7.0	A	1
6	Stanley	1.12	28.0	24.0	A	1
7	Floral Park	0.61	35.0	23.0	B	1
8	Eighty	0.85	30.0	31.0	A	0
9	One Ten	0.09	25.0	23.0	B	1
10	One Twenty	0.03	22.0	29.0	A	0
11	Two Hundred	0.12	20.0	17.0	A	0
12	Two Forty	0.09	33.0	31.0	B	0
		FRONT - LOVELAND PASS				
13	Pinkerton	0.06	27.0	19.0	A	0
14	Cloud Gulch	0.03	25.0	15.0	A	0
15	Bard Shoulder	0.00	28.0	22.0	A	0
16	Sleeper	0.24	30.0	24.0	A	0
17	Seven Sister 1A	0.70	33.0	23.0	A	0

[1]Starting zone timberline reference: A, above; B, below.

[2]Starting zone observed failure frequency: 1 = averages one or more avalanches per winter; 0 = averages less than one avalanche per winter

No.	Name	I	P	R	T[1]	f[2]
			FRONT - LOVELAND PASS			
18	Seven Sister 1	2.64	34.0	27.0	A	1
19	Seven Sister 2	2.70	34.0	25.0	A	1
20	Seven Sister 3	3.79	34.0	25.0	A	1
21	Seven Sister 4	3.67	35.0	26.0	A	1
22	Seven Sister 6	4.24	33.0	25.0	A	1
23	Seven Sister 7	0.94	32.0	24.0	A	0
24	Five Car	1.15	29.0	30.0	A	0
25	Grizzly	0.09	24.0	9.0	A	1
26	Little Professor	0.30	26.0	19.0	A	1
27	Associate Professor	0.09	29.0	14.0	B	0
28	Palavicini	0.06	22.0	-10.0	A	1
29	Black Widow	0.55	30.0	22.0	A	1
30	Happy End	0.27	33.0	23.0	B	0
			SAN JUAN - RED MOUNTAIN PASS[3]			
31	Water Gage	0.10	28.0	17.0	B	0
32	Old South Mineral Rd	0.03	34.0	15.0	B	0
33	Pit	0.00	32.0	20.0	B	1
34	Zuni	0.03	22.0	19.0	A	0
35	Lower Cement Fill	0.07	30.0	19.0	B	0
36	Cement Fill	1.13	28.0	26.0	A	1
37	Barton North	0.23	28.0	19.0	B	0
38	Blackburn	0.33	32.0	27.0	B	0
39	Benny Long	0.43	30.0	27.0	B	1
40	Cemetary	0.37	27.0	10.0	B	1
41	North Mineral Bridge	0.17	30.0	17.0	A	1
42	East Guadalupe	0.07	23.0	9.0	A	1
43	Slippery Jim	0.63	33.0	16.0	B	1
44	East Riverside	4.63	32.0	30.0	A	1
45	Jackpot	0.33	33.0	25.0	B	0
46	West Riverside	0.50	29.0	4.0	A	1
47	West Guadalupe	0.07	28.0	3.0	A	1
48	Ironton	0.03	23.0	0.0	B	1
49	Galena Lion Gulch	0.07	22.0	9.0	A	1
50	Governor Gulch	0.00	24.0	10.0	A	1
51	Willow Swamp	1.90	28.0	21.0	B	1
52	Blue Point	10.83	36.0	38.0	A	1
53	Silver Ledge Mill	0.90	34.0	35.0	B	0
54	Porcupine	0.67	35.0	40.0	B	0
55	Eagle	2.57	32.0	28.0	A	1
56	Telescope	2.23	32.0	25.0	A	0
57	Muleshoe	0.87	32.0	19.0	A	0
58	Imogene	0.10	22.0	-3.0	A	1
59	Battleship	0.10	18.0	-15.0	A	1
60	Peacock	0.50	36.0	35.0	B	0
61	Champion	2.60	35.0	30.0	B	1
62	Deadwood	0.03	30.0	29.0	B	0
63	King Mine	0.07	25.0	22.0	A	0
64	Waterfall	0.47	34.0	23.0	B	0
65	Springs	0.27	32.0	36.0	B	0
66	Swamp	1.33	28.0	22.0	B	1
67	Henry Brown	1.13	32.0	30.0	B	1
			SAN JUAN - WOLF CREEK PASS[3]			
68	Palisades	0.70	32.0	24.0	B	0
69	Coyotes	0.90	33.0	24.0	B	0
70	Boulder Creek	0.40	24.0	29.0	B	0
71	Snowflake	0.57	26.0	26.0	B	0

[3]Includes avalanche paths located on Coal Bank Hill and Molas Divide after case number 59.

No.	Name	I	P	R	T[1]	f[2]
	SAN JUAN - WOLF CREEK PASS					
72	Camp	0.07	25.0	9.0	B	0
73	Pit	0.67	30.0	39.0	B	0
74	One Sixty West	0.17	31.0	20.0	B	0
75	One Sixty	0.40	24.0	14.0	A	0
76	One Sixty East 1	0.27	30.0	19.0	A	0
77	One Sixty East 2	0.13	31.0	20.0	A	0
	WASATCH - ALTA					
78	Lisa Falls	0.05	28.0	10.0	A	1
79	Tanners Flat	0.55	24.5	7.0	A	1
80	White Pine	0.95	31.0	11.0	A	1
81	Little Pine	0.45	32.0	11.0	A	1
82	No. 10 Spring	0.27	29.0	23.0	B	1
83	Maybird	0.05	29.0	18.0	A	1
84	Superior	2.45	31.0	19.0	A	1
85	Little Superior	0.86	31.0	7.0	A	1
86	Little Superior East	0.05	27.0	15.0	A	1
87	West Hellgate	0.55	36.0	23.0	B	1
88	East Hellgate	1.73	34.0	25.0	B	1
89	Cardiff Bowl	0.00	22.0	21.0	A	0
90	Flagstaff Basin	0.36	22.0	22.0	A	1
91	Flagstaff Mountain	0.32	24.0	17.0	A	1
	FRONT - URAD-HENDERSON					
92	One A	0.00	29.0	7.0	B	0
93	One B	0.00	25.0	7.0	A	1
94	One C	0.52	31.0	17.0	A	1
95	One D	0.05	31.0	15.0	B	0
96	One E	0.76	33.0	15.0	A	1
97	One F	0.10	30.0	16.0	B	0
98	H Five	0.00	20.0	17.0	A	1
99	One H	0.00	26.0	14.0	A	0