1999 Landslide at Avalanche Pass

Interpretation and Extrapolation of Geologic Data

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Abstract:

As part of a University of Vermont Geomorphology project, we conducted field measurements and observations on October 31, 2003 at the landslide located at the north end of Avalanche Pass in the High Peaks Region of the Adirondack Park in New York. The volume of debris that slid was 199,000 cubic meters and covered and area 400 meters by 105 meters. The slide removed the thin soils vegetation exposing an anorthosite bedrock. This information was later used to explain why the landslide occurred, and to determine the approximate volume, and contents of materials moved. Weather information was also gathered. The weather information included precipitation averages, extreme precipitation events, and precipitation in the region at the time of the landslide. The area that slid during the landslide was steep, and had received a 10%(4.25 inches) of its yearly precipitation in less then 24 hours before the slide occured.

Introduction:

This paper will discuss and attempt to discern the reasons why a major landslide occurred in September of 1999 at the north end of Avalanche Pass. This landslide presented very little threat to people as the area affected was unpopulated. Under different circumstances, a similar slide could cause massive devastation, loss of property and life. The weather in the area, at the time of the slide, may be an important factor relating to the 1999 landslide in Avalanche Pass. Better understanding the factors that played roles in resulting the landslide would lead to better mitigation and prediction of future landslides in this area.

The High Peaks Region of the Adirondack Park is well known to hikers and climbers for having steep, rugged terrain. Many visitors come yearly to the pristine and unique Adirondack Park. Few other places in the northeastern United States present such a wild area that is so easily assessable to visitors. About 130,000 people live in the Adirondack Park permanently, none however, live in the High Peaks area that is under study in this paper, but this region does receive hundreds of thousands of visitors a year in all seasons (APA website).

The region consists of an anorthosite basement bedrock(Fig 1). According to Dr. Franzil of Plattsburgh State College the mountains in the Adirondack Park are rising as a result of geologic doming at a rate of 1.5mm yearly (Franzil 2000). According to Stewart Sharp, in Landslides and Related Phenomena, many of the high mountain peaks in the Adirondacks are riddled with scars from debris avalanches.

Methods:

On October 31, 2003, Mary Blackwell and Andrew Duling, hiked into the Avalanche Pass area to take measurements of the landslide area. The slope of the landslide surface was determined through elevation readings gained from an altimeter in correlation with a hand held GPS unit and a topographic map. Perimeters of the slope were plotted using the GPS unit and were later plotted onto a map(Fig 2-4). Soil depths were measured at the shearing edge of the slide. Most of the readings were acquired along the northeastern edge. These were the only soil depths measured due to the inherent danger of climbing the steeper sections of the landslide. The accessible sides of the landslide were not applicable candidates for measuring soil depth due to the debris levees, which were present along both sides. Measurements of length and width of the debris, which collected in the Avalanche Pass valley floor, were taken(Fig1). Height measurements of the debris were a desired measurement but proved to be rather difficult to determine. Estimations of valley debris height, based on altimeter and GPS readings in relation to pre-landslide topographical maps were found(Fig 2-4).

Weather data were found by searching the Paul Smith's College weather station archives and a more extensive data set collected from the National Oceanic and Atmospheric Administration (NOAA). The weather data was used to gain information about precipitation amounts prior to the 1999 landslide in Avalanche Pass, and to ascertain information about large Adirondack rainfall events in general(Table1-4).

Results:

The debris avalanche (landslide) had removed all soil from the slope and bare anorthosite bedrock was all that remained in the landslide zone(Fig 1). The measurements of soil thickness ranged from 0.3 meters to 1.5 meters with an average of 0.9 meters. The slides surface area covered 229,530 square meters. The calculated volume of material removed from the rock was 199,700 cubic meters. The estimated amount of material collected in the valley was 157,000 cubic meters. The landslide was 400 meters across elevation from top to bottom was 105 meters. The slide had a slope of 25 degrees(Fig 2). Hurricane Floyd struck the area on September 16, 1999, directly prior to the landslide, becoming the largest one-day precipitation event within the NOAA data set for Lake Placid(Table 2).

Discussion:

The High Peaks region of the Adirondack Park is littered with similar landslides, mostly of indeterminant ages. The 1999 slide is unique in that it slid within human time frame and in a highly visible area. Over 10% of the yearly Adirondack precipitation, fell during Hurricane Floyd, and is the likely culprit for the landslide(Table 4). Hurricane Floyd was the single largest precipitation event ever recorded in the 71 years the weather station at Lake Placid has been operational(Table 1). It is probable that the precipitation, from Hurricane Floyd, also caused structural instabilities and landslides in other areas of the High Peaks region, many of which went unrecorded and unnoticed by humans.

It is also probable that the precipitation deposited from Hurricane Floyd would have been a large enough event to result in many other major landslides, but due to the bedrock dynamics and thin soils, many of the slopes in the Adirondack Park that would have been placed in landslide hazard potential by Hurricane Floyd, had slid previously and were stable at the time of the storm.

The type of landslide was best classified by Sharpe. According to Sharpe, debris-avalanche is a flowing slide generally with the same characteristics of a snow avalanche. This type of slide is water-dependent and usually exposes a slip surface. In Sharp's debris-avalanche, bare bedrock was exposed after the landslide had occurred. This debris avalanche model perfectly fits the 1999 landslide at Avalanche Pass.

Summary:

The 1999 landslide in Avalanche Pass slid due to the steep slope of the anorthositic bedrock, the precipitation rate in the area previous to the slide, and the composition of the soils and bedrock in the area of the landslide. The major cause of the landslide was that the region received close to 10% of its average yearly rainfall in the 24 hours prior to the slide, being the single largest rain event in 71 years.

The slope where the landslide occurred was a steep enough slope that with different bedrock or soil formation, this slide could have occurred in a very different manner. The extremely course texture of the anorthosite increased the cohesion at the bedrock soil interface and held soils in place until Hurricane Floyd struck and the soil saturation overcame all resistance factors and the materials slid. In other areas under similar conditions, landslides could occur much more regularly. The physical characteristic of the anorthosite was one of the more important features preventing the landslide from occurring previous to 1999.

The potential for more landslides in the region is not a large threat due to the rarity of the unusually large precipitation events. The area where the 1999 landslide occurred will not present a major landslide threat until soil reforms in the area. However, with the steep slope and lack of snow anchors in the landslide area, snow avalanches are a hazard.

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Fig 1 The 1999 Debris Avalanche at Avalanche Pass

Sharp's Image from <u>Landslides and Related Phenomena</u> showes what he describes as a debris-avalanches. A steep slope that slipped whne ground became saturated. Sharp Classified a debris-avalanche as a type of rapid flowage (sharp 61-63)

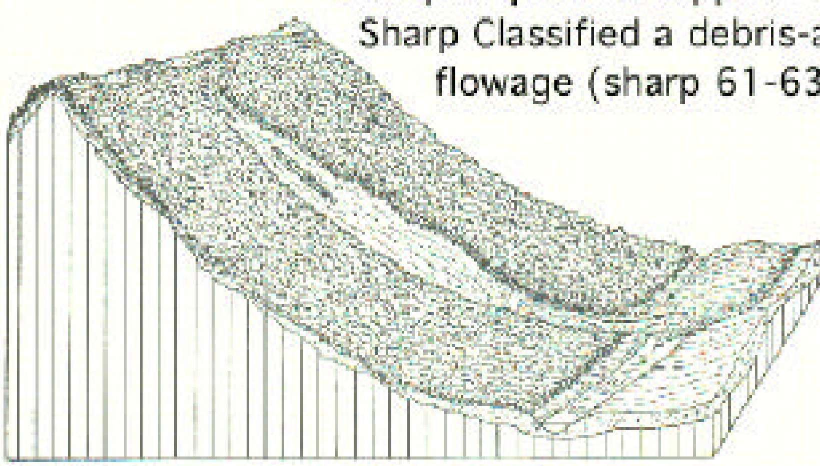


FIGURE 9. *A debris-avalanche.* The avalanche track is characteristically long and narrow, sometimes though not always exposing a slip surface on bedrock. After the initial slippage the saturated mass quickly loses shape and flows downward, commonly following a stream channel.

Fig 2

Avalanche pass topographic map created in 1997

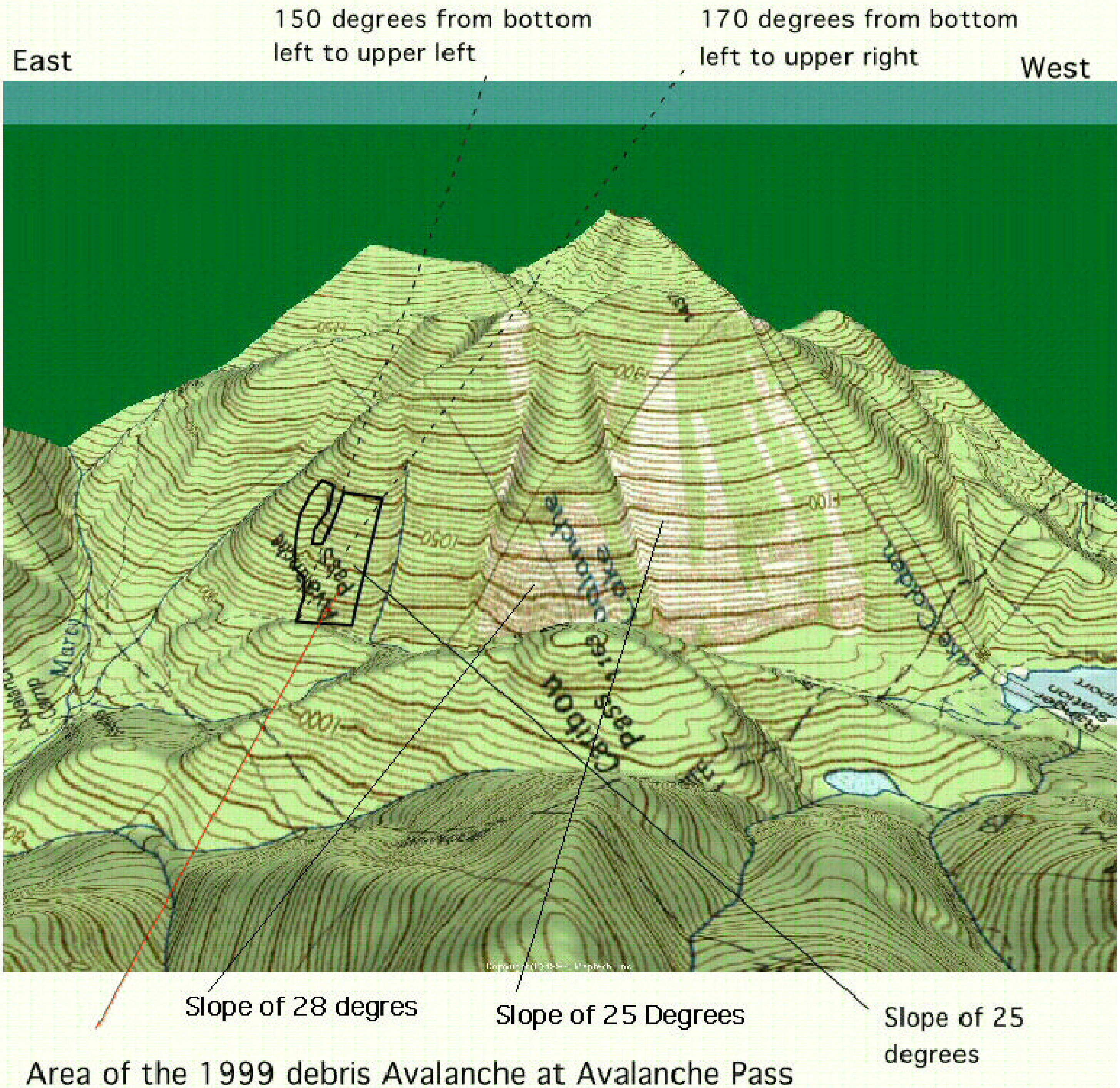


Fig 3 Pre-slide 3-D Topographic Image

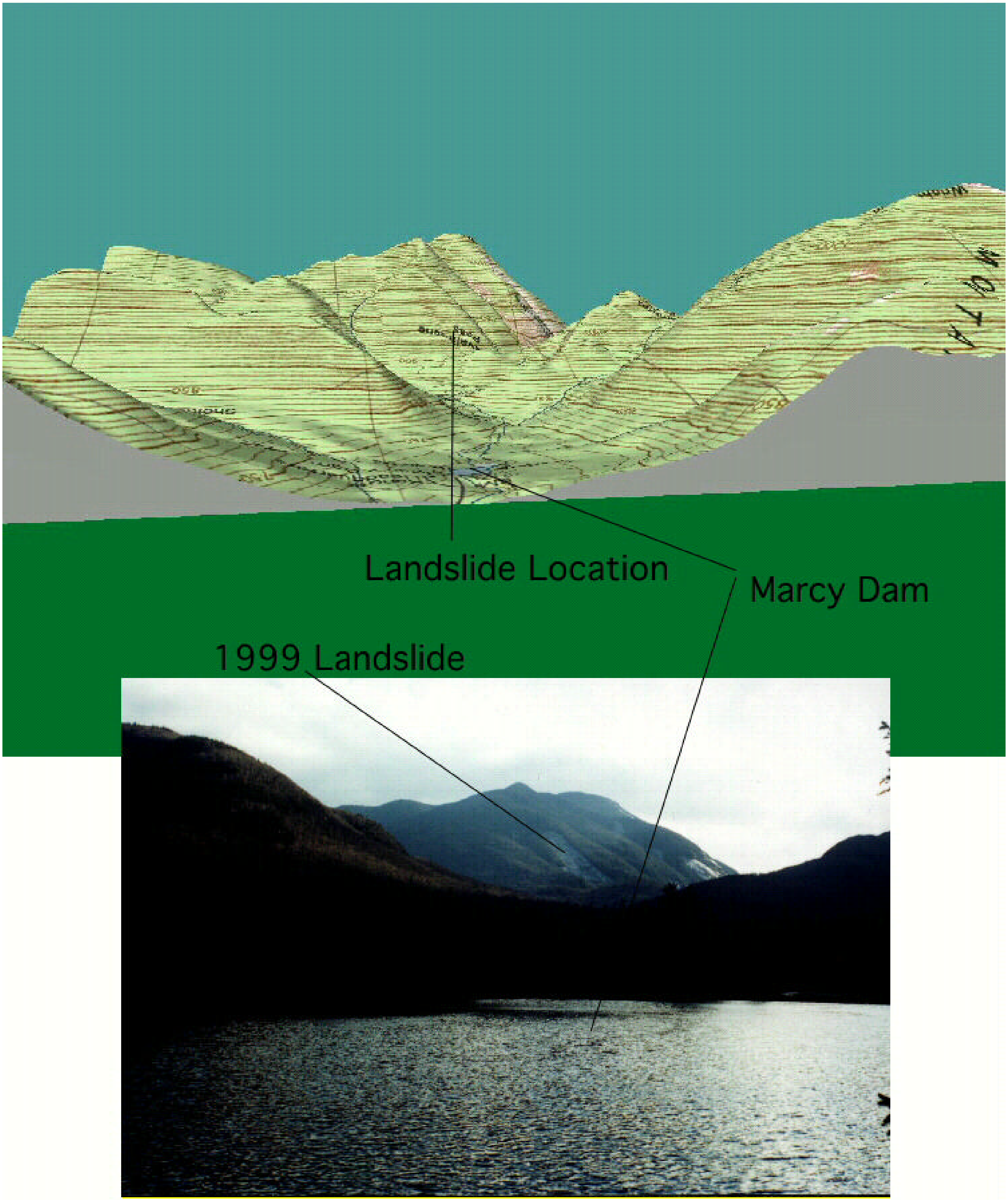
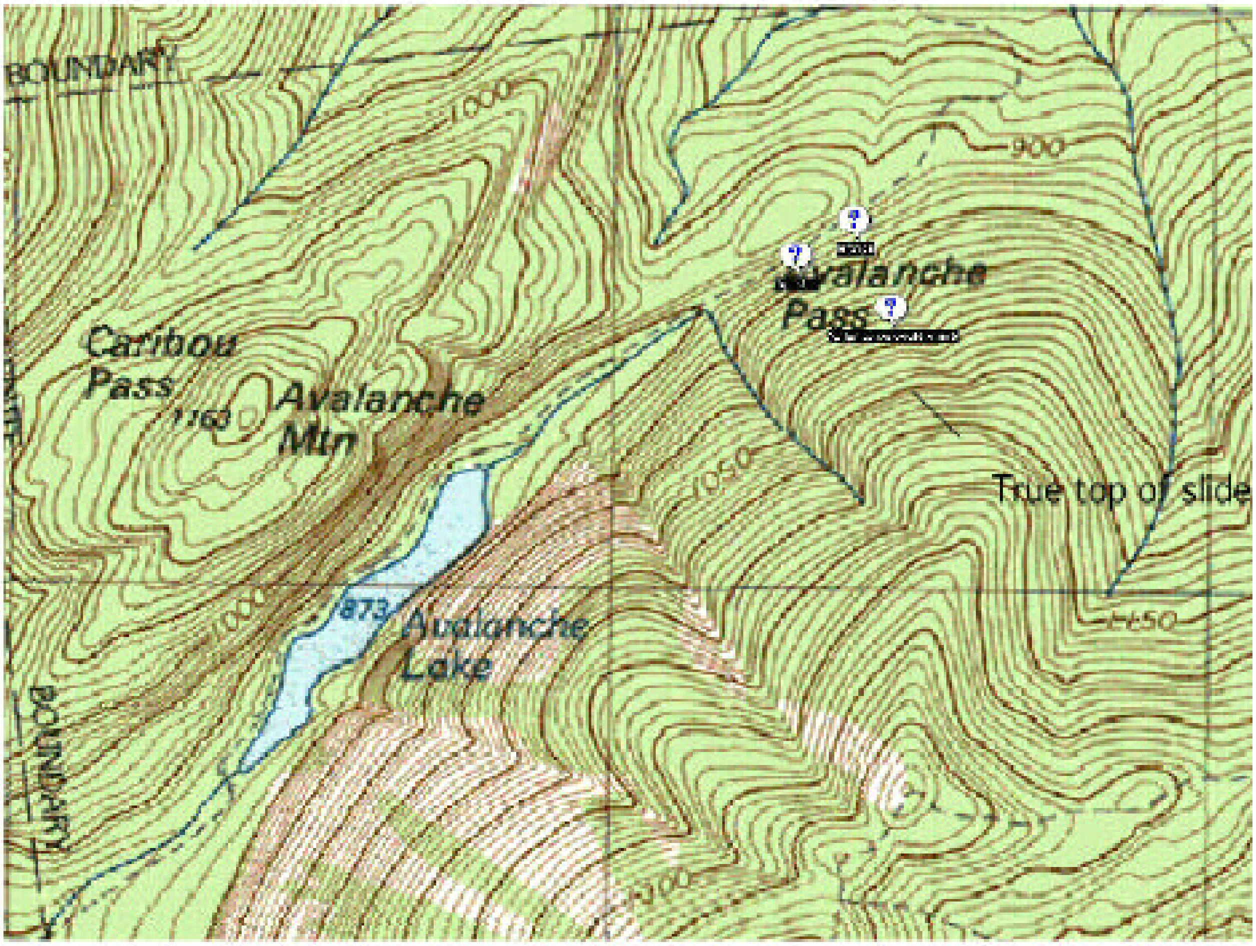


Fig 4 Topograghic map of Avalanche Pass



The dimensions of the 1999 avalanche pass slide marked by gps coordinants
The rightside of the slide the left side and as high as we could climb and
take a reading

Fig 5

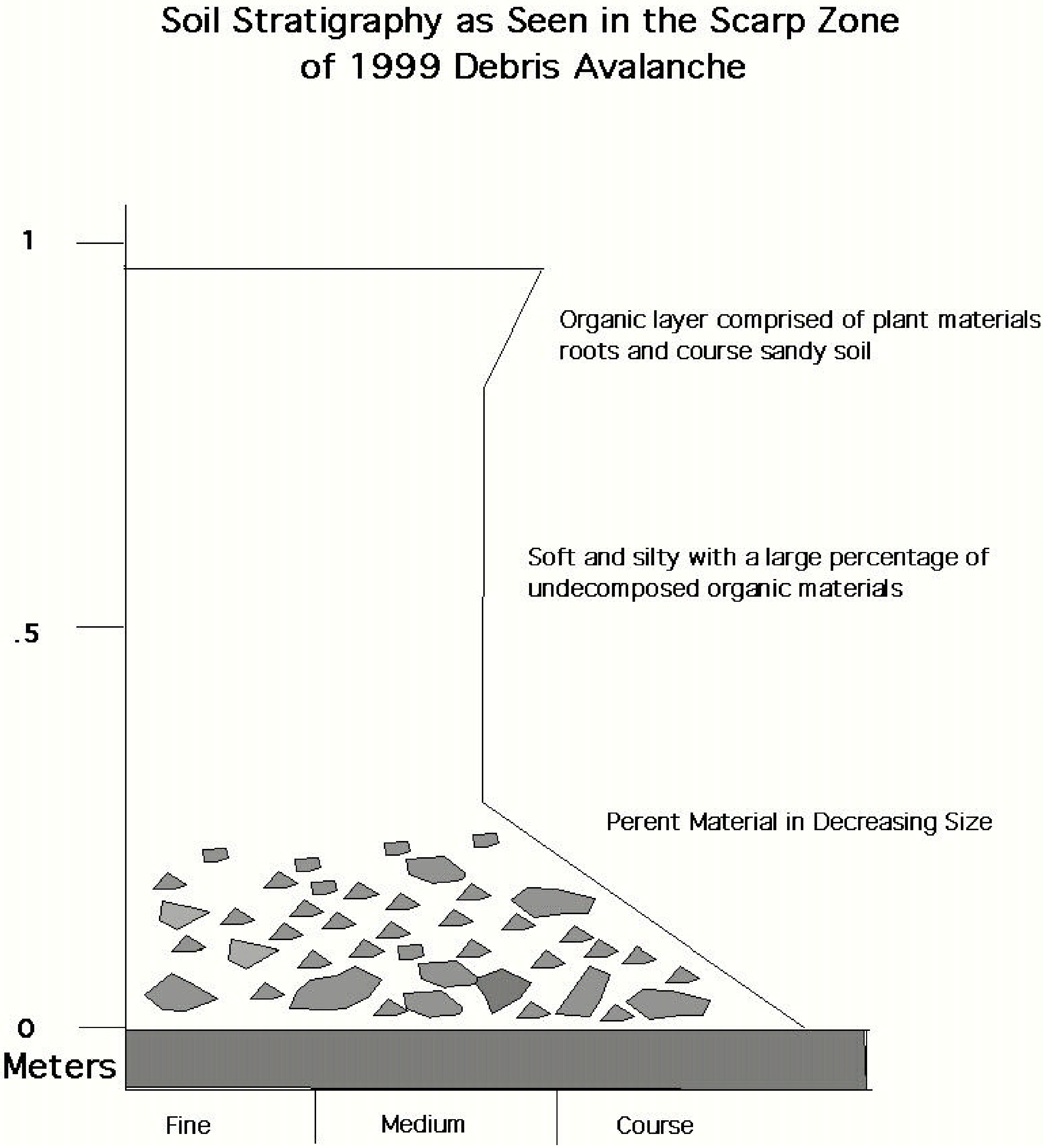

Soil Stratigraphy as Seen in the Scarp Zone
of 1999 Debris Avalanche
1
.5
0
Meters
Organic layer comprised of plant materials
roots and course sandy soil
Soft and silty with a large percentage of
undecomposed organic materials
Perent Material in Decreasing Size
Fine
Medium
Course

Table 1 The weather data from the Lake Placid weather station, the precipitation of 1999 is highlighted.

Year	September rain fall total	Max rain in a day Sept	Days > 1inch of precipitation	Yearly total	Max yearly rain fall event	Month of max yearly rainfall	Events >1”
2	4.91	1.2	2	43.16	2.25	Jun	10
1	4.22	2.24	1	39.94	3.41	Jun	6
0	3.71	0.95	1	45.7	2.52	Arp	4
99	8.98	4.25	3	38	4.26	Spt	6
98	3.76	1.31	1	50	3.73	Jun	9
97	2.72	0.44	0	38	1.82	Jun	7
96	1.98	0.73	0	45.59	3.52	Nov	9
95	3.5	1.03	1	34.87	1.68	Oct	5
94	3.62	0.79	0	39.96	1.46	Jun	7
93	4.58	1.1	1	38.13	1.23	Mar	6
92	3.38	0.95	0	36.12	1.7	Oct	4
91	6.57	2.41	3	38.62	2.41	Spt	7
90	2.65	0.97	0	38.4		Dec	8
89	6.99	3.38	2	42.23	2.68	Aug	6
88	1.71	0.53	0	29.63	1.75	Nov	3
87	3.11	1.12	1	34.86	1.28	Oct	3
86	3.9	0.87	0	42.79	1.71	Jul	8
85	6.34	2.68	3			Spt	
84	3.1	0.75	0	32.5	1.26	Jul	3
83	3.53	1.56	1	42.79	1.93	Dec	7
82	2.86	0.75	0	34.27	2.71	Jun	4
81	6.58	1.9	2	44.9	2.43	Feb	6
80	4.82	0.96	0	36.86	1.48	Jul	4
79	4.7	2.14	1	41.82	2.14	Sept	4
78	3.16	0.95	0	37.31	2.22	Jan	4
77	6.11	1.53	1	43.6	2.29	Oct	8
76	3.64	0.68	0	44.68	1.62	Jun	10
75	5.19	1.59	1	32.19	1.59	Sept	3
74	4.77	1.01	1			Jul	4
73							
72		0.46	0				
71	4.34	0.6	1	41.18	2.51	Jul	9
70	4.29	1.04	1	32.9	1.5	Jun	2
69	3.44	1.14	1	40.93	1.67	Aug	8
68	2.26	0.63	0	33.52	1.76	Apr	2
67	3.25	0.69	0	44.94	1.6	Nov	5
66	3.89	1.42	1	29.45	1.42	Sept	1

65	4.55	1.03	1	30.91	1.72	Aug	3
64	1.49	0.34	0	29.73	1.35	May	4
63	1.18	0.3	0	33.9	2.48	Nov	5
62	4.72	1.8	1	35.45	1.8	Sept	4
61	2.53	0.91	0	34.71	2.97	jul	3
60	3.73	1.51	1	34.66	2.1	Jun	3
59	2.25	0.97	0	46.6	1.9	oct	6
58	5.26	0.99		43.78	2.1	feb	4
57	3.2	1.11	1	36.25	1.51	dec	3
56	2.9	0.66	0	33.3	1.45	May	3
55	2.7	1.07	1	43.14	1.78	Oct	7
54	6.89	1.67	2	54.85	1.8	Mar	6
53	2.71	0.96	0	36.56	2.2	Aug	5
52	2.75	0.8	0	35.51	2.8	Dec	4
51	2.86	0.82	0	31.98	1.56	Jul	2
50	4.78	0.99	0			Nov	6
49	3.27	0.38	0	33.32		Aug	3
48	1.45	0.7	0	37.02	1.7	Nov	6
47	2.32	0.7	37	42.41	2.2	Jun	3
46	3.8	1.25		40.04			
45	7.93	2.6		46.85	3.1	Jul	
44	4.62	1.36		37.28	2.1	Jul	
43	2.33	1.14		38.8	1.47	Jun	
42	5.58	1.63		36.9	1.77	Jun	
41	1.71	0.6		29.24	1.2	Jun	
40	4.28	1.8		41.52	2.05	Jun	
39	2.92	0.82		34.26	1.4	Nov	
38	8.06	2.95		42.83	2.95	Sept	
37	2.76	1.55		37.8		Sept	
36	4.68	1.65		42.61	1.65	Sept	
35	4.14	1.54		38.68	1.54	Sept	
34	3.41	0.97		31.68	1.15	Jun	
33	3.23	0.76		37.68	1.08	Aug	
32	1.27	0.34			2.45	Oct	
31	5.34	0.28		32.36	1.6	Jan	
			37	2532.45	126.47		
			37/ 53	2532.45/66	126/62		
			0.698113208	38.370455	2.032258065		
			Average of .7 days >1”precipt	Avg 38.37			

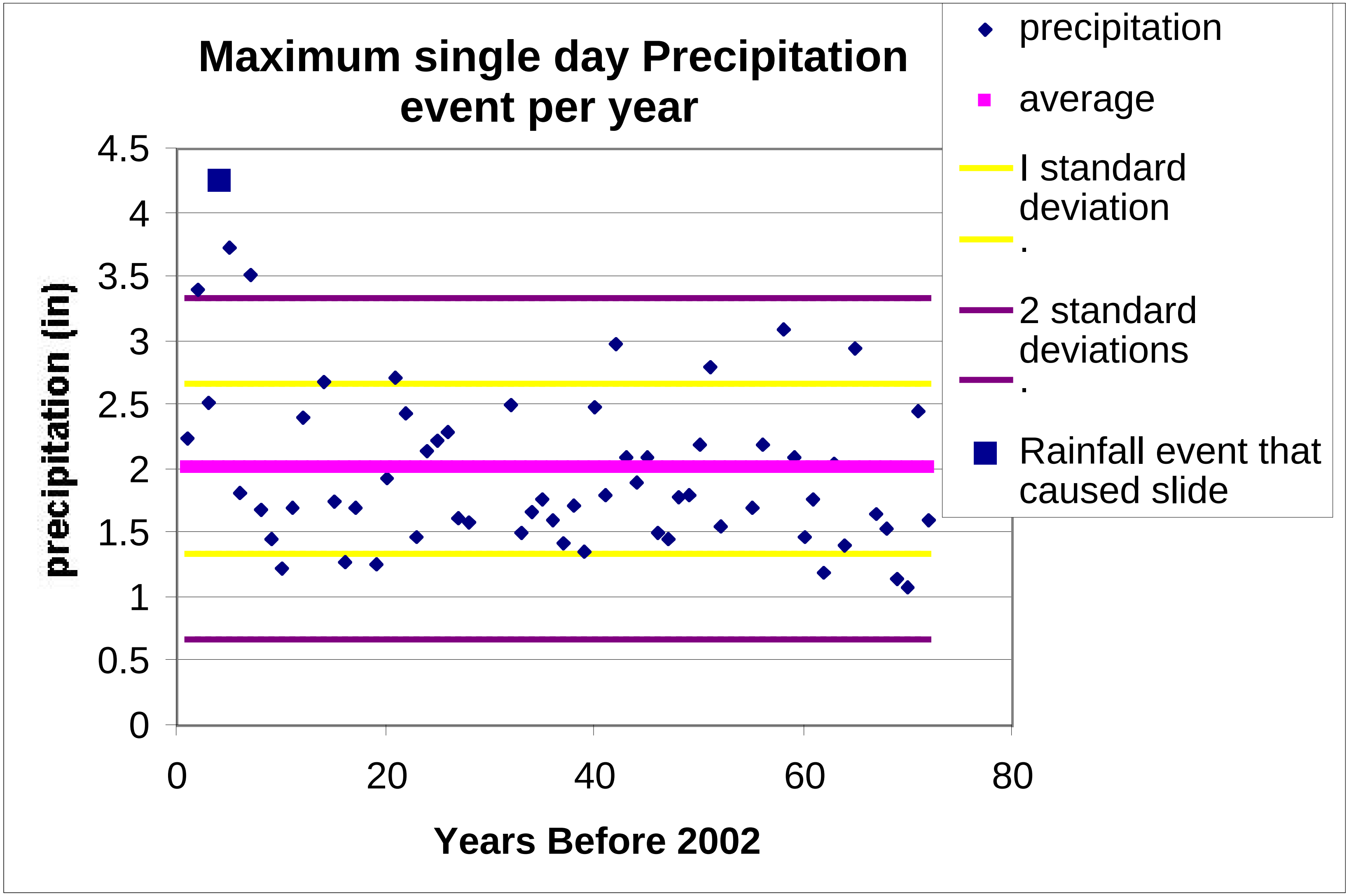
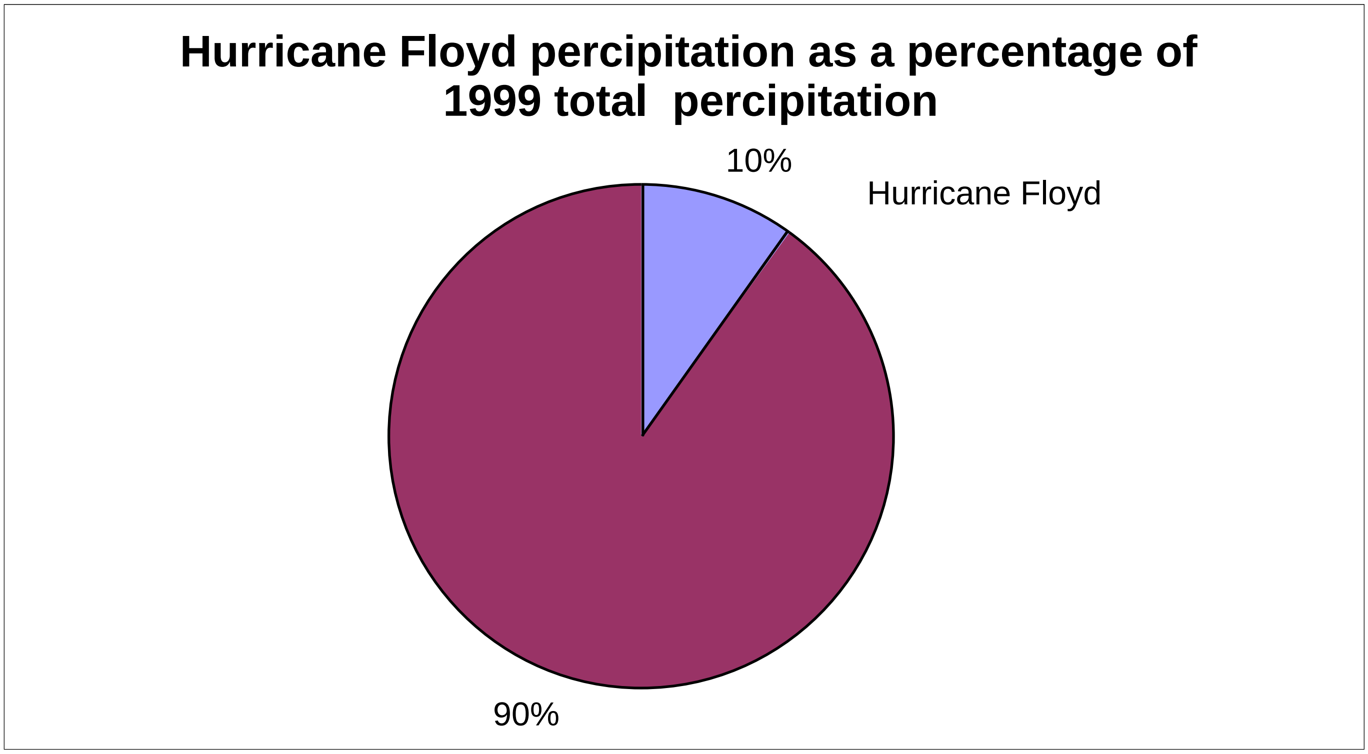


Table 2: The yearly maximum rainfall events occuring in a single day. In 1999 the max rainfall for a single day was 4.26 just before the slide.

Table 3: Hurricane Floyd's rainfall as a percentage of the 1999 yearly total



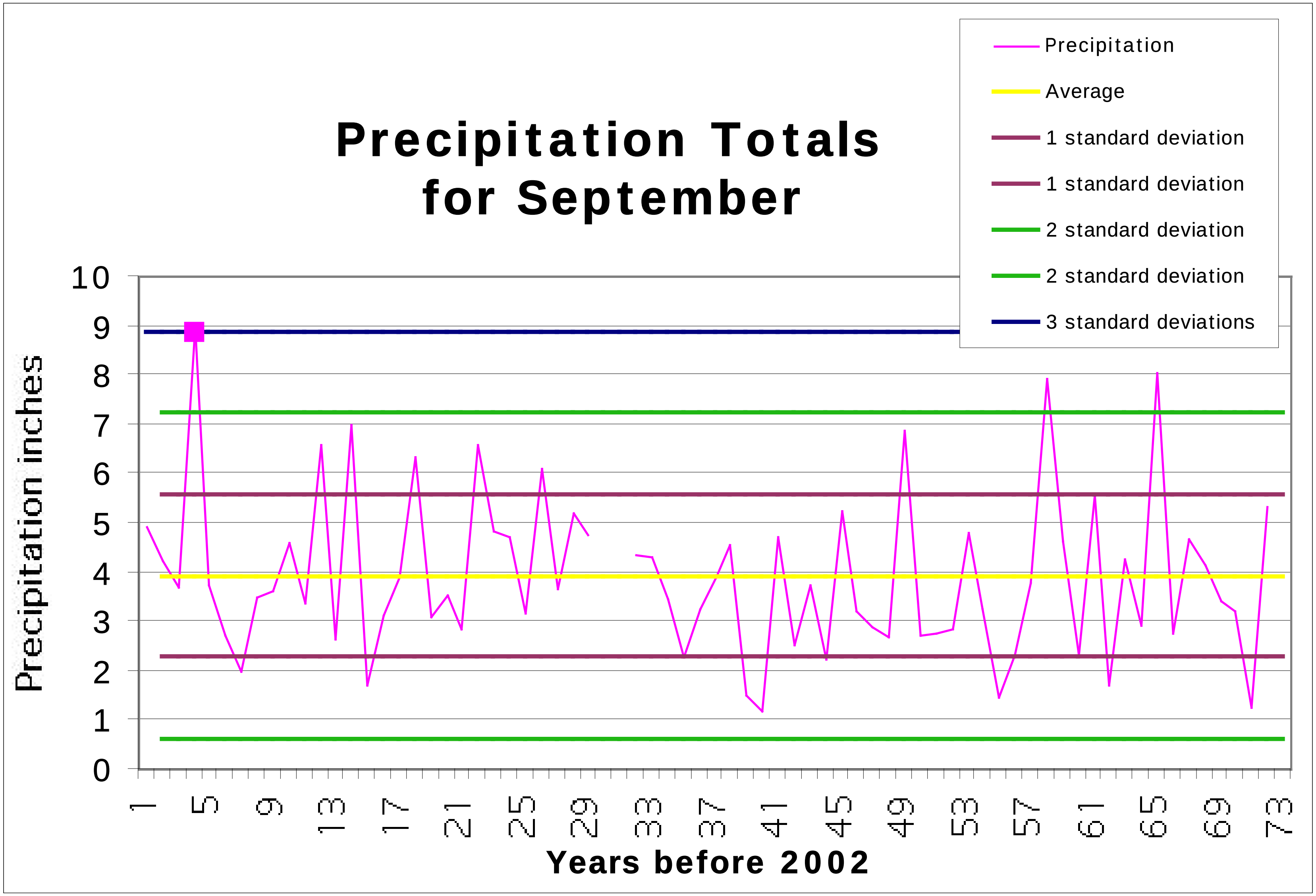


Table 4: Historic precipitation totals for September the rainfall event that caused the slide is indicated with a marker.