

MASS WASTING I ("LANDSLIDES") (20)

I Main Topics

A Emphases for Landslide Section of Course

B Case history 1: Nevados Huascarán, Peru, May 31, 1970

II Emphases for Landslide Section of Course

A Hazard recognition (see also the tables)

1 Magnitude of mass wasting problem in U.S.

a Est. annual cost in U.S. as of 1978: \$1 B (x 2 for 1991)

b Predicted losses in California (1970-2000): \$10 B

c Portuguese Bend (1956-1959): \$10 M (x 5 for 1991)

d Utah (1983*): \$250 million*

e S.F. Bay Area January 1982 storm: 18,000 landslides!

2 Human activity as a contributing factor

a Contra Costa County, California: 80%

b Allegheny County, Pennsylvania: 90%

3 Improved geotechnical practices can greatly reduce slide costs:

a New York State (1969-1976): 90% reduction

b Los Angeles 1968-1969 storm: 97% reduction vs. pre-1952

c State of CA (Beach Leighton): 95-99% reduction

4 Key empirical factors relevant to mass wasting processes

a Geologic Factors

i Geomorphology: Topography; processes of erosion & deposition and deformation that create topography

ii Composition: Rock types and weathering products

iii Structure: Distribution of flaws (e.g., bedding and fractures) and rock types; controls geometry of failure surface

iv Seismicity

v Geologic History (Time): Past is key to future

b Environmental Factors

i Climate and Hydrology: Rainfall, surface/ground water flow

ii Vegetation (Very sensitive to all factors above)

c Human Activity

i Deposition

ii Erosion

iii Alteration of environmental factors

B Hazard characterization (and classification)

C Slide mechanics: how do empirical factors contribute mechanically?

III Case history: Nevados Huascarán, Peru, May 31, 1970

On May 31, 1970 the most catastrophic known avalanche in history descended from Nevados Huascarán, the highest peak in the Peruvian Andes. The avalanche caused ~18,000 casualties, including 15,000 of 17,000 residents of the city of Yungay. The avalanche was triggered at 3:23 PM by a great earthquake ($M=7.7$) off the coast of Peru; the epicenter was 130 km west of Nevados Huascarán. The avalanche occurred at the end of the wet season, when snow cover was near a maximum and the snow had begun to melt. The avalanche originated from a partially overhanging cliff (average slope of $70-80^\circ$) at 5400-6500 m elevation, where the fractured granitic rock of the peak was covered by a 30-m-thick glacier. The avalanche had a volume of ~50-100 million cubic meters and traveled 16 km to Rio Santa with a vertical drop of 4 km. The avalanche shot over a 230m-high ridge on its descent, launching boulders as large as 60 metric tons as far as 4 km from the launch point. The average speed of the 1970 avalanche was 280 km/sec— peak speeds probably reached ~1000 km/hr. A previous avalanche from the same peak in 1962, with a volume of 13 million cubic meters, caused 4000 fatalities. That event prompted a prediction that an avalanche even larger than the 1962 could fall from the face and threaten Yungay. The hazard posed was thus recognized, partially characterized, and partially evaluated. Mapping after the 1970 event revealed deposits from a substantially larger pre-Columbian (pre 1492) avalanche that might have attained average speeds of 315-355 km/hr.

The 25 most catastrophic landslides of the 20th century

<http://www.canadacollege.net/galloway/haz.9.html>

Year	Country	Name and Type	Triggering process	Impact
1911	Tadzhik Republic	Usoy rock slide	Usoy earthquake M=7.4	54 killed
1919	Indonesia (Java)	Kalut lahra (volcanic mud flow)	Kelut volcano (eruption)	5,100 killed 104 villages destroyed
1920	Ningxia (China)	Haiyuan landslide	-	~100,000 killed
1921	Kazakh Republic	Alma-Ata debris flow	Snow melt	500 killed
1933	Sichuan (China)	Deixi landslide	Deixi earthquake M=7.5	6,800 killed; 2,500 drowned when dam failed
1939	Hyogo (Japan)	Mount Rokko slide/mud flow	Rain (typhoon)	505 dead, 130,000 homes destroyed
1949	Tadzhik Republic	Kahit rock slide	Khait earthquake M=7.5	12,000 to 20,000 killed; 33 villages destroyed
1953	Wakayama (Japan)	Arita River slide/debris/mud flow	Rain (typhoon)	460 dead, 4,722 homes destroyed
1953	Kyoto (Japan)	Minamiyamashiro slides/debris/mud flow	Rain (typhoon)	336 dead, 5,122 homes destroyed
1958	Shizuoka (Japan)	Kanogawa slide/debris/mud flow	Rain (typhoon)	1,094 dead; 19,754 homes destroyed
1962	Ancash (Peru)	Nevados Huascaran debris avalanche	-	4,000 to 5,000 killed most of Ranrahirca village destroyed
1963	Fruili-Venezia-Griulia (Italy)	Vaiont rock slide	Filling of Vaiont Reservoir	~2,000 killed; city of Longarone damaged ~ \$970 million (1994 U.S.dollars)
1964	Alaska (United States)	Alaska slides	1964 earthquake M=9.4	Estimated \$860 million in (1994 U.S. dollars)
1965	Yunnan (China)	Rock slide	-	444 dead; 4 villages
1966	Rio de Janeiro (Brazil)	Rio de Janeiro slides/avalanches/debris/mud flows	Heavy rain	~1,000 dead
1967	Serra das Araras (Brazil)	Serra das Araras slides/avalanches/debris/mud flows	Heavy rain	~1,700 dead
1970	Ancash (Peru)	Nevados Huascaran debris avalanche	Earthquake M=7.7	18,000 dead; town of Yungay destroyed and Ranrahirca partially destroyed

Year	Country	Name and Type	Triggering process	Impact
1974	Huancavelia (Peru)	Mayunmarca rock/slide/debris / avalanche	Rainfall	~450 killed; Mayunmarca village destroyed failure of 150-m-high landslide dam caused major flooding downstream
1980	Washington (United States)	Mount St. Helens rockslide/debris avalanche	Eruption of Mt. St. Helens	World's largest historic landslide 23-km-long debris avalanche with average velocity of 125 km/hr; surface remobilized into 95-km long debris flow
1983	Utah (United States)	Thistle debris slide	Snow melt and heavy rain	Total losses ~\$600 million in 1994 U.S. dollars
1983	Gansu (China)	Saleshan landslide	Loess landslide	237 dead; buried 4 villages
1985	Tolima (Columbia)	Nevado del Ruiz debris flows	Eruption of Nevado del Ruiz	>20,000 dead; four towns destroyed; ~100-km long debris flow
1986	Papu New Guinea	Bairaman rock slide/avalanche	Bairaman earthquake M=7.1	Village of Bairaman destroyed. Debris avalanche formed 210-m-high dam that impounded 50-million cubic meter lake; dam failed, causing 100-m-deep debris flow downstream
1987	Napo (Ecuador)	Reventador landslide	Reventador earthquake M=6.1 and M=6.9	~1,000 killed \$1.3 billion (in 1994 U.S. dollars)
1994	Cauca (Columbia)	Paez landslides	Paez earthquake M=6.4	271 dead; 1,700 missing; 32,000 displaced; villages destroyed

(Modified from Table 1, Schuster, R.L., 1996, in Landslide, Chacón, Irigaray and Fernández, eds. A.A. Balkema/Rotterdam

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