

# Rockfall records, BC Hwy 99 Vancouver-Squamish

(Guttenberg-Richter method)

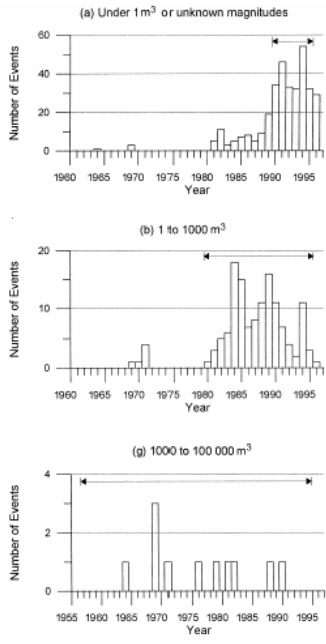
$$f_i = \frac{1}{T_i}$$

Incremental frequency

$$F_i = \sum_{i=1}^j f_i$$

Cumulative frequency

(Hungre et al., 1998)



## Range of magnitudes



30 m<sup>3</sup>

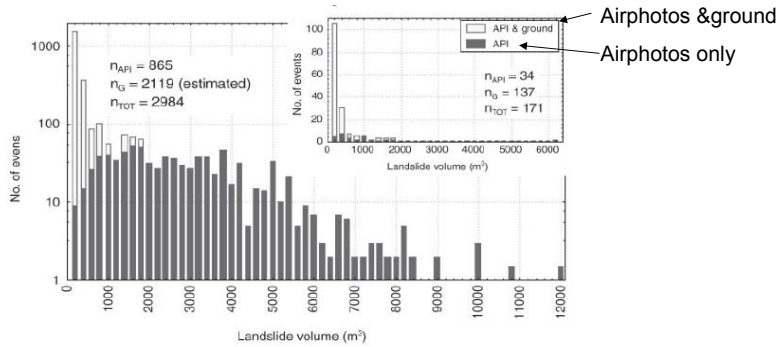


60 000 m<sup>3</sup>

## Alternative: Histogram approach

Example: frequency of debris avalanches in a region north of Vancouver (Brardinini and Church, 2003).

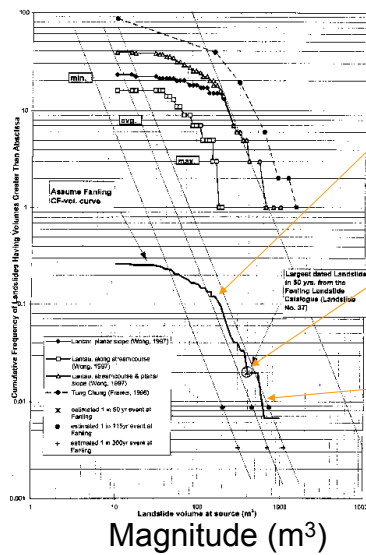
Histogram depends on bin size, arithmetic vs. logarithmic binning



## Censoring: CFM curves for debris avalanches

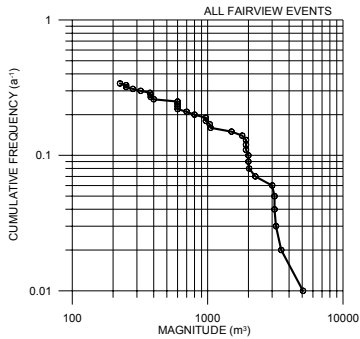
Lantau Island, Hong Kong, Wong et al., 1998

Cumulative frequency  
(scales to the size of the area)



**“Rollover” may be controlled by the size of the slope**

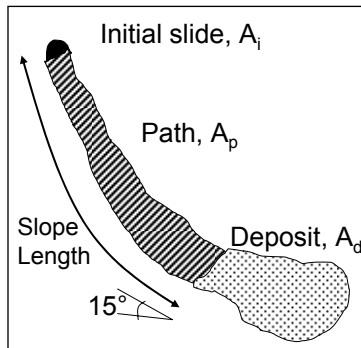
Container port, Prince Rupert, NW B.C.



**Independence:**

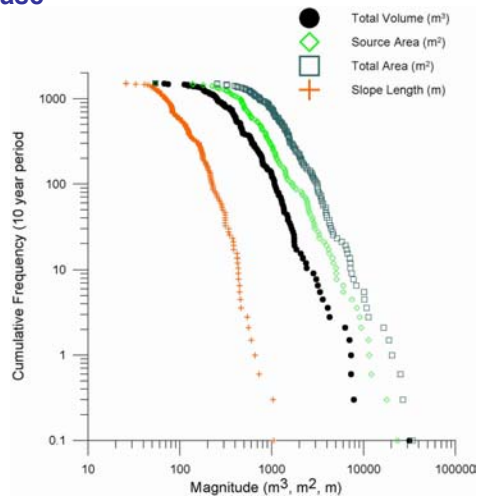
CFM curves for debris avalanches,  
Queen Charlotte Islands Database  
(data from Wise, 1996)

**Conclusion: M is not an independent quantity**



Source Area =  $A_i + A_p$

Total Area =  $A_i + A_p + A_d$





Stationarity

### Vargas state, Venezuela



←  
December 1999

February 1951  
→

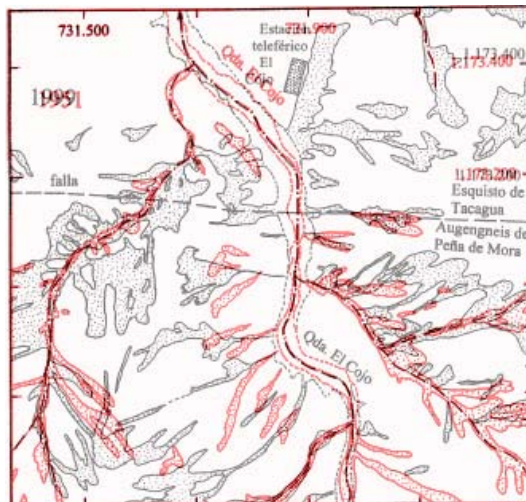


### Vargas state, Venezuela

Quebrada  
El Cojo:

1951

1999



Base topográfica: DCN, 1984  
Fotografías aéreas: DCN, Feb. 1951 y DIGECAFA, Dic. 1999

200 m



**“Depletion theory”:** Landslides are less likely to occur (or impossible), where they have occurred previously (Sarno)



Homogeneity (clustering)

**Cluster extent controlled by:**

**1) Pre-conditioning factors 2) Rainfall distribution (New Zealand)**



- Topography
- Geology
- Land use

Summary:

**Frequency-Magnitude relationships are useful, but user must consider the basic assumptions of statistics:**

- **Censoring**
- **Independence**
- **Stationarity**
- **Homogeneity**

