Examining Slope Instability on a Small Bank Slope Along the Schoharie Creek in New York State

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Landscape Processes

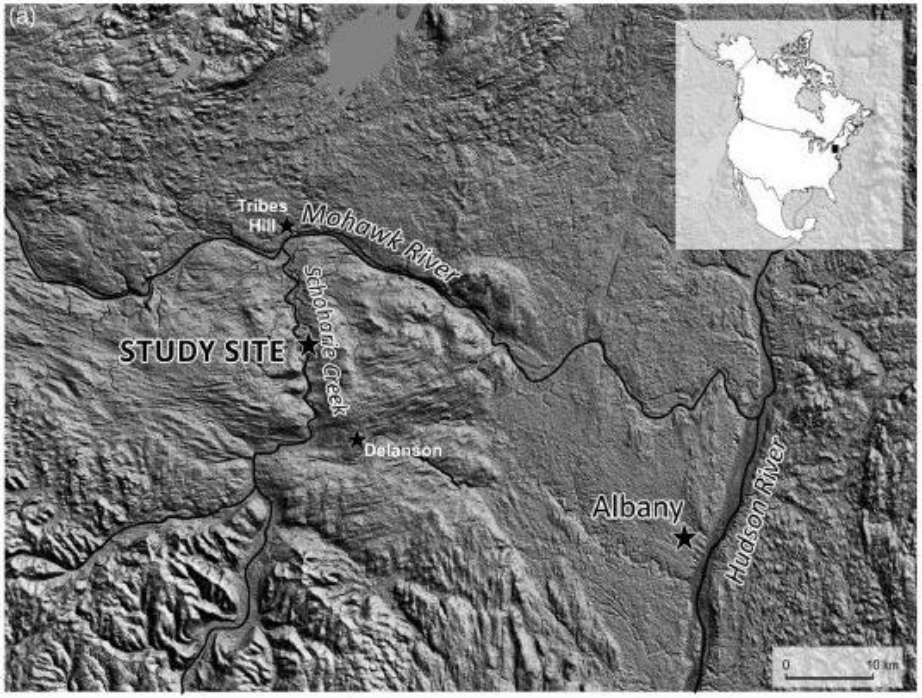
- The equilibrium that exists on a landscape is in constant flux where geomorphic processes have the potential to change the stability for any system
- The potential for an alternate steady-state on a landscape process can be caused by extreme events
- Understanding the feedbacks and interactions between the water budget and slope equilibrium is critical to characterize hazard risk and sediment yield contributions

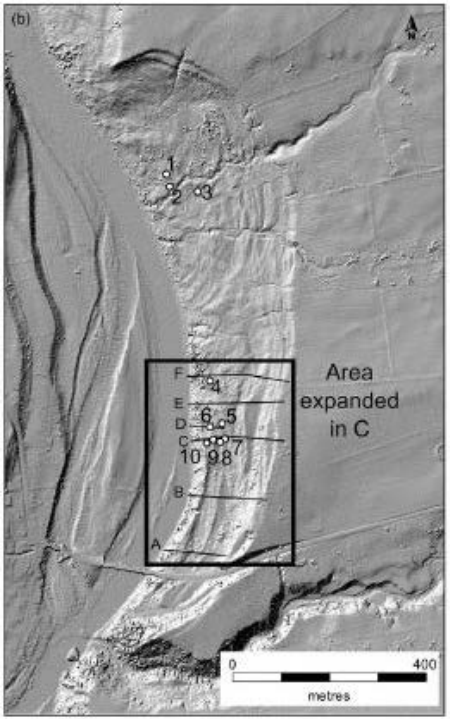
Research Aim

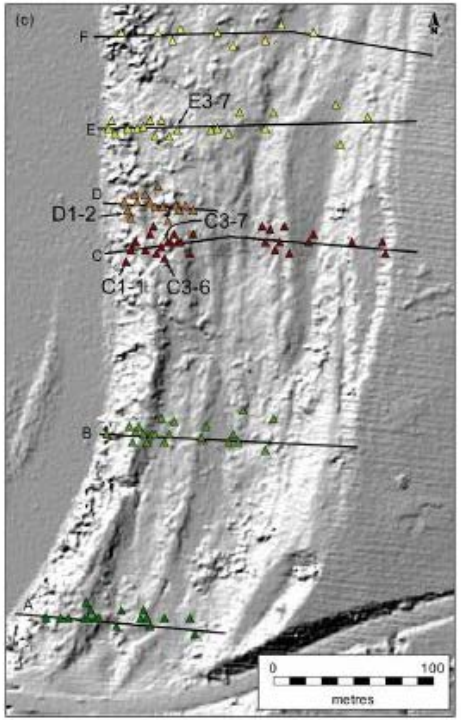
- *Our work aims to explore the potential mechanisms that control slope instability between large events using a dendrogeomorphological approach*

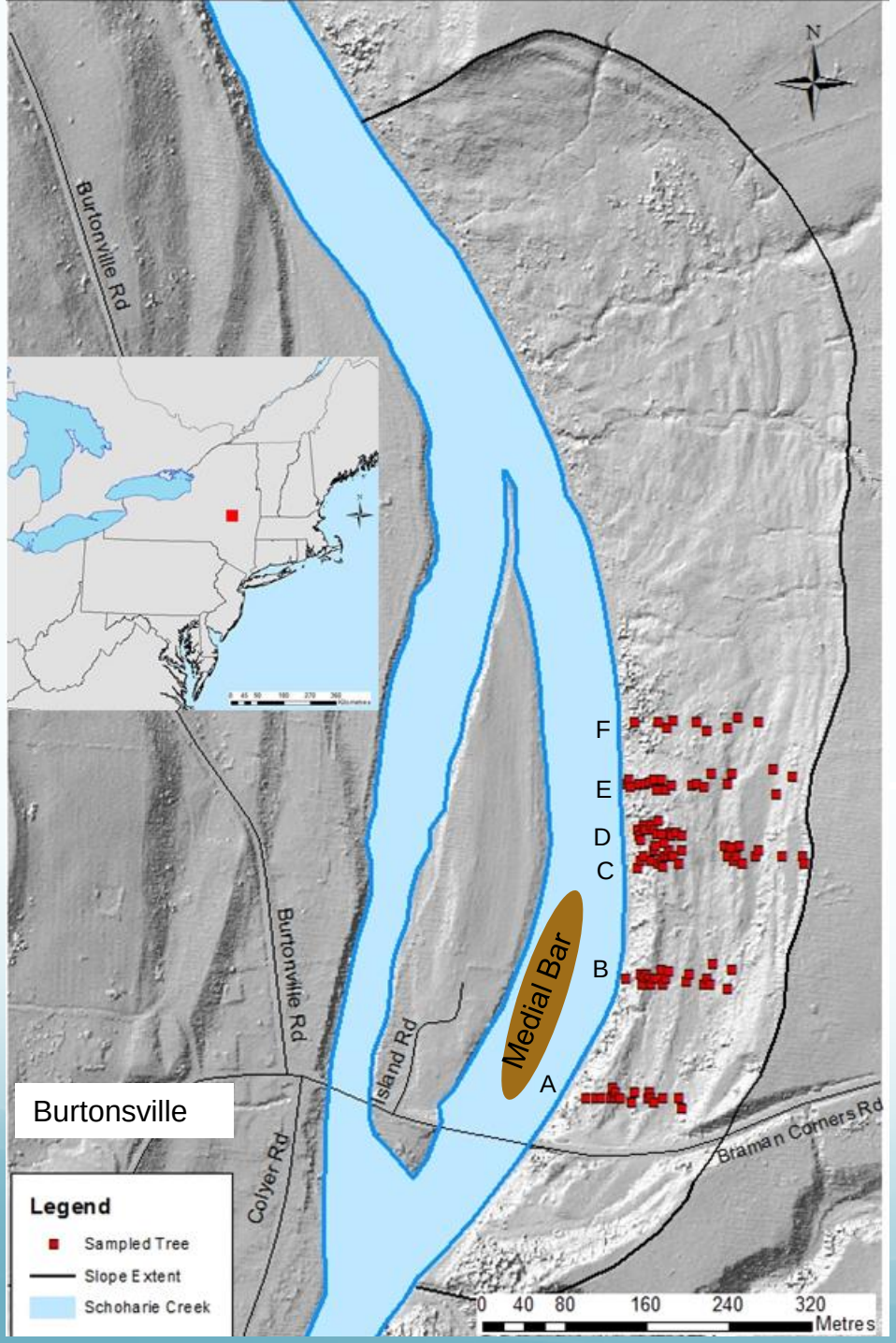
  - Examine tree ring eccentric growth (related to magnitude) and reaction wood presence (related to frequency), thus using the tree records as tilt-sensors on the hillslope

- Hypothesize that climate variability impacts moisture levels which in turn control the rate of movement on the complex rotational block slide, thus increasing sediment yield into the nearby watercourse


(a)
Tribes Hill
Mohawk River
Schoharie Creek
STUDY SITE
Delanson
Albany
Hudson River
0
10 km


(b)
Area expanded in C
F
E
D
C
B
A
0
400
metres


(c)
F
E
D
C
B
A
E3-7
D1-2
C3-7
C1-1
C3-6
0
100
metres

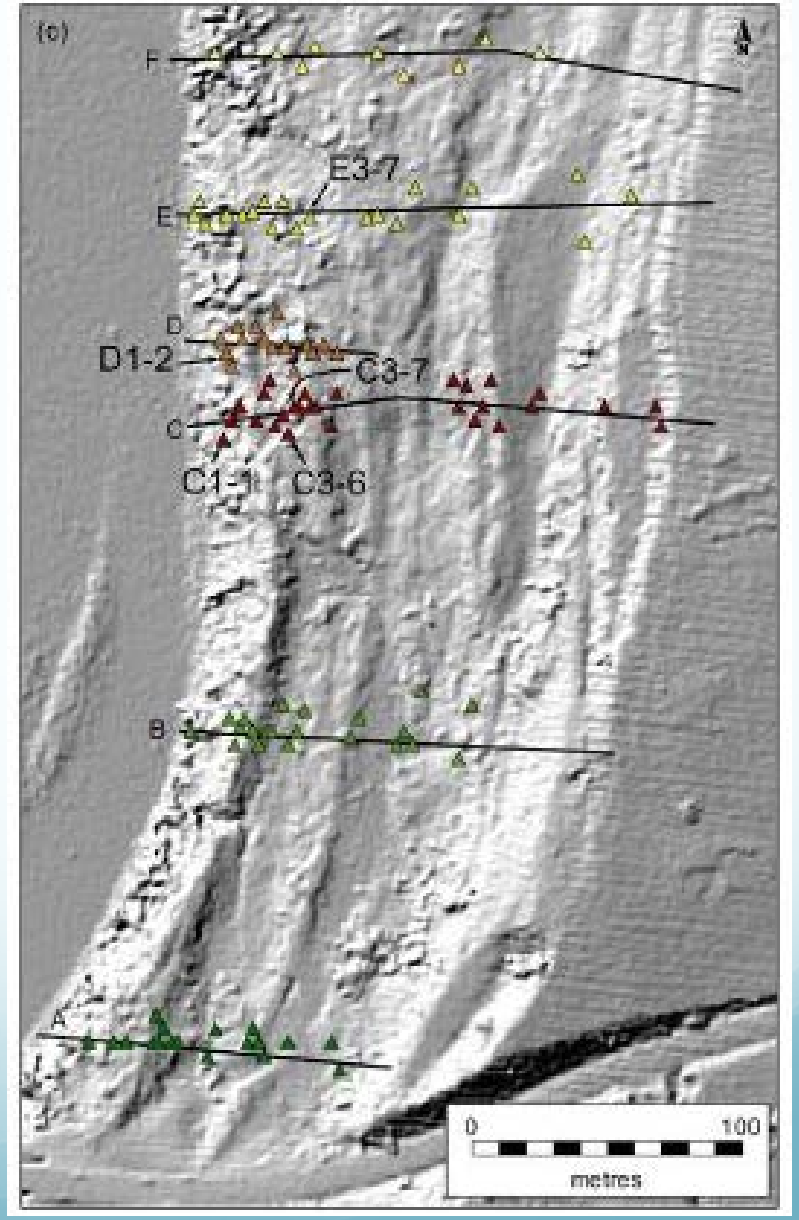

N
Burtonville Rd
F
E
D
C
B
A
Medial Bar
Burtonville Rd
Island Rd
Colyer Rd
Braman Corners Rd
Burtonsville
Legend
Sampled Tree
Slope Extent
Schoharie Creek
0 40 80 160 240 320
Metres

Sampling Strategy

- Trees were sampled within 10m from either the north or south of each transect line
  - 2-3 trees per slope unit, most sampled was 8
- Fix to sample the largest trees possible

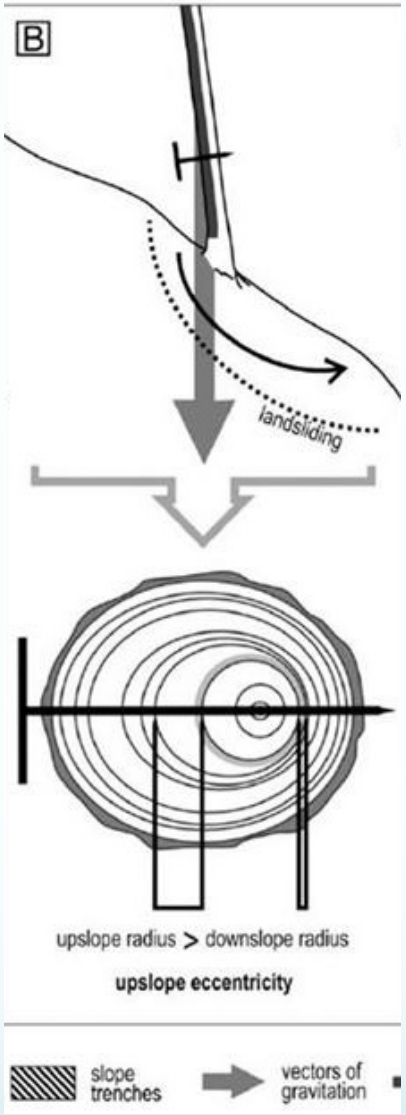
Oldest tree→ 1731 (Transect C)

Youngest tree → 1976 (Transect B)



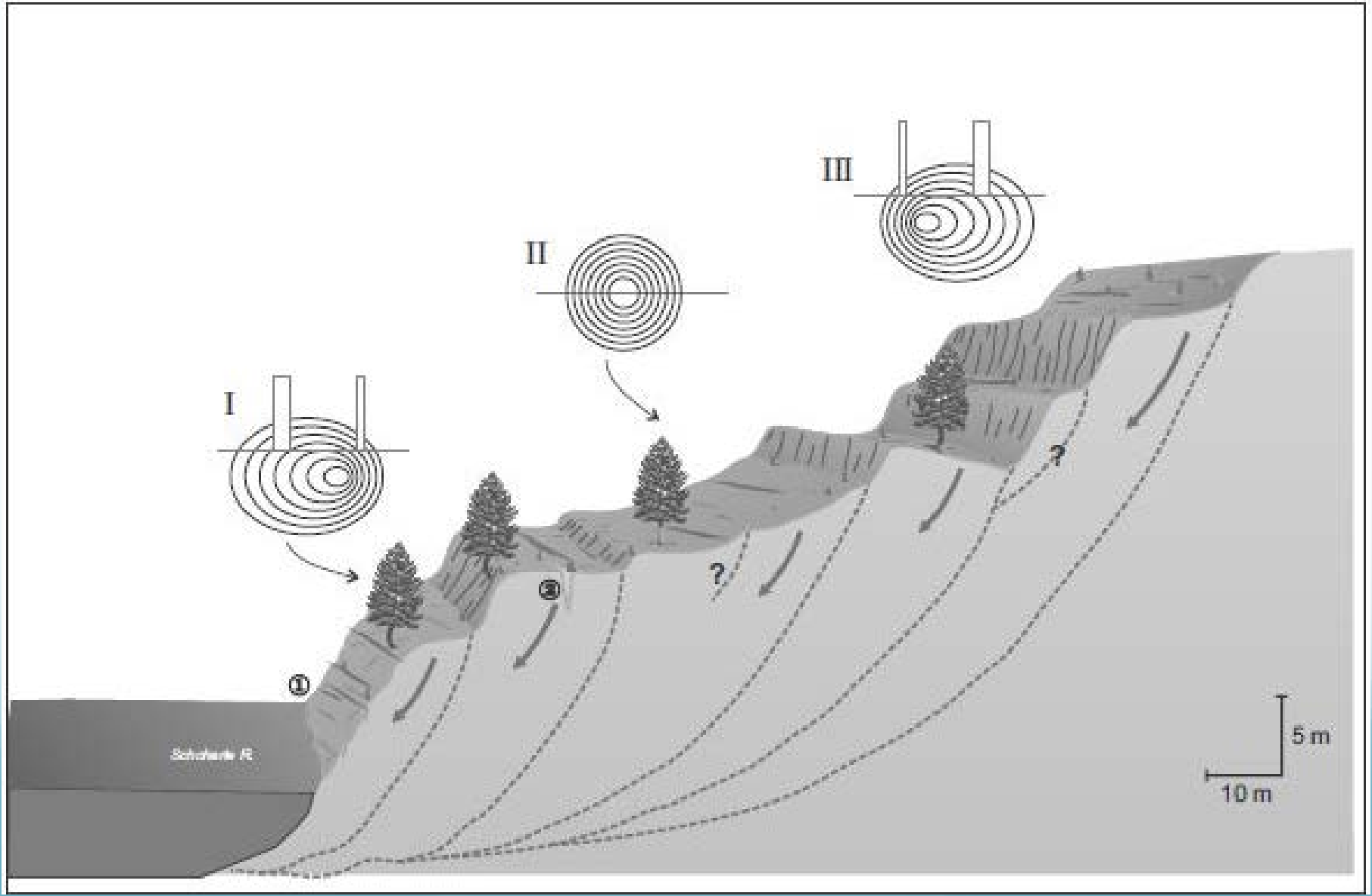
Tree Ring Growth Anomalies

- Two growth anomalies identified:
  - Growth eccentricity
  - Reaction wood
- Catalogued the absence/presence of reaction wood



(Wistuba *et al*., 2013; Figure 4)

Block Tilting Cross-Section



Instability Frequency and Response Indices

- The Compression wood (or reaction wood) response index (I_t) was used to infer ***frequency*** of instability events

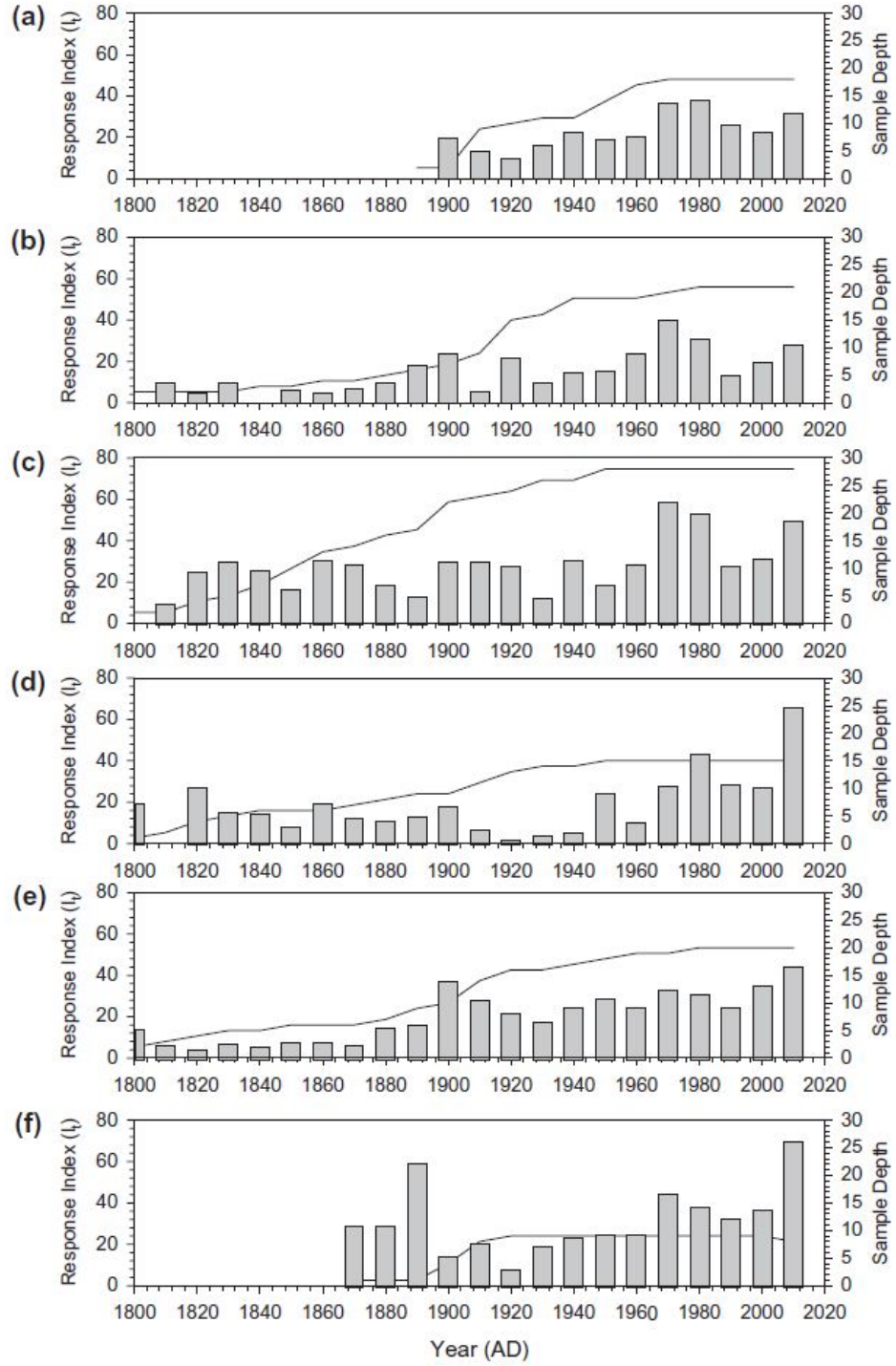
$$I_t = \frac{R_t}{A_t} \times 100\%$$

- Eccentric growth (E_t) was used to infer ***magnitude***

$$E_t = \left| (U_t - D_t) / (U_t + D_t) \right| \times 100\%$$

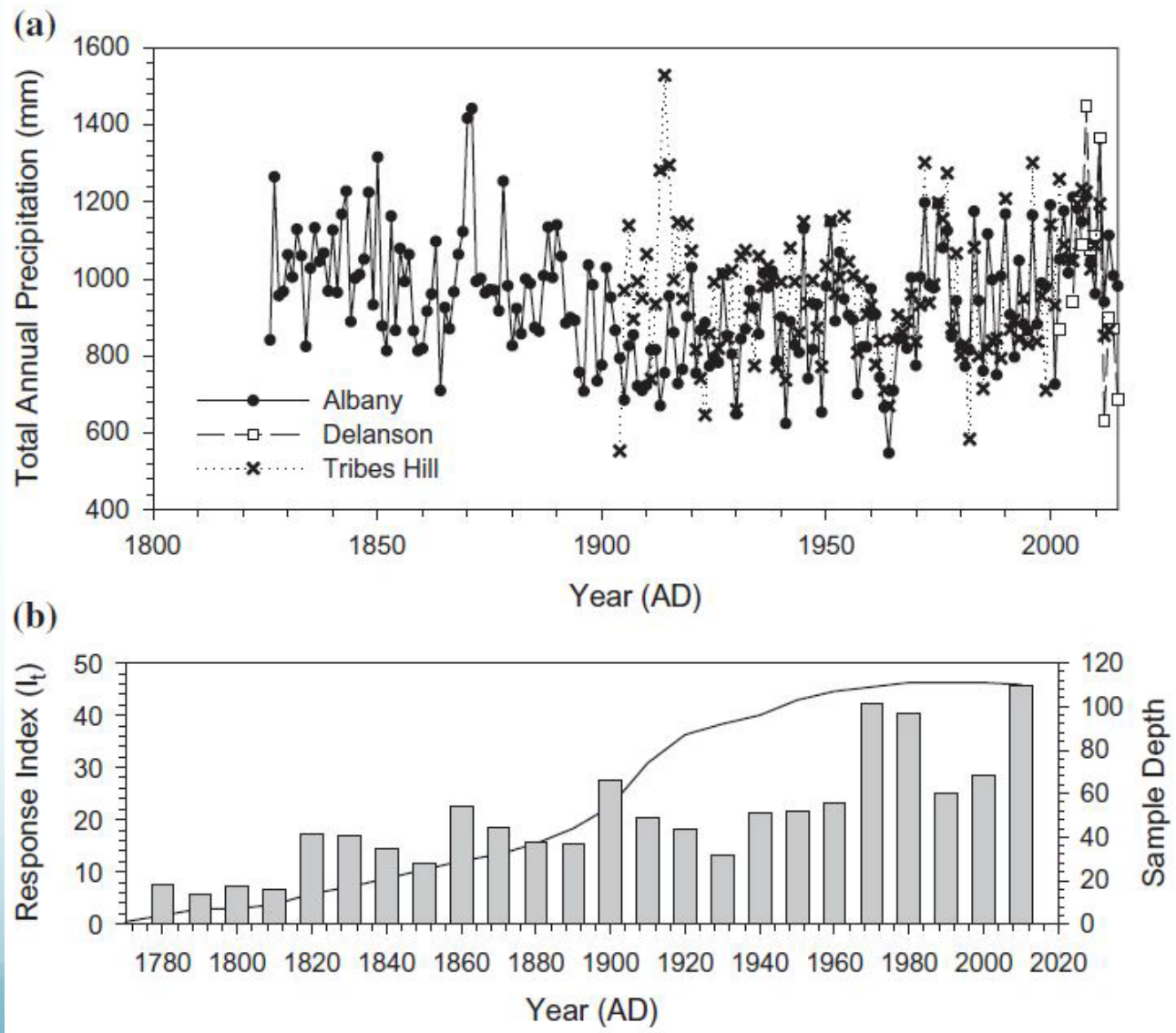
Assessing Frequency Patterns

- Frequency records indicate a greater occurrence in instability from 1969 to present
- Response to stress is synchronous both across the entire study site and within each transect during different periods



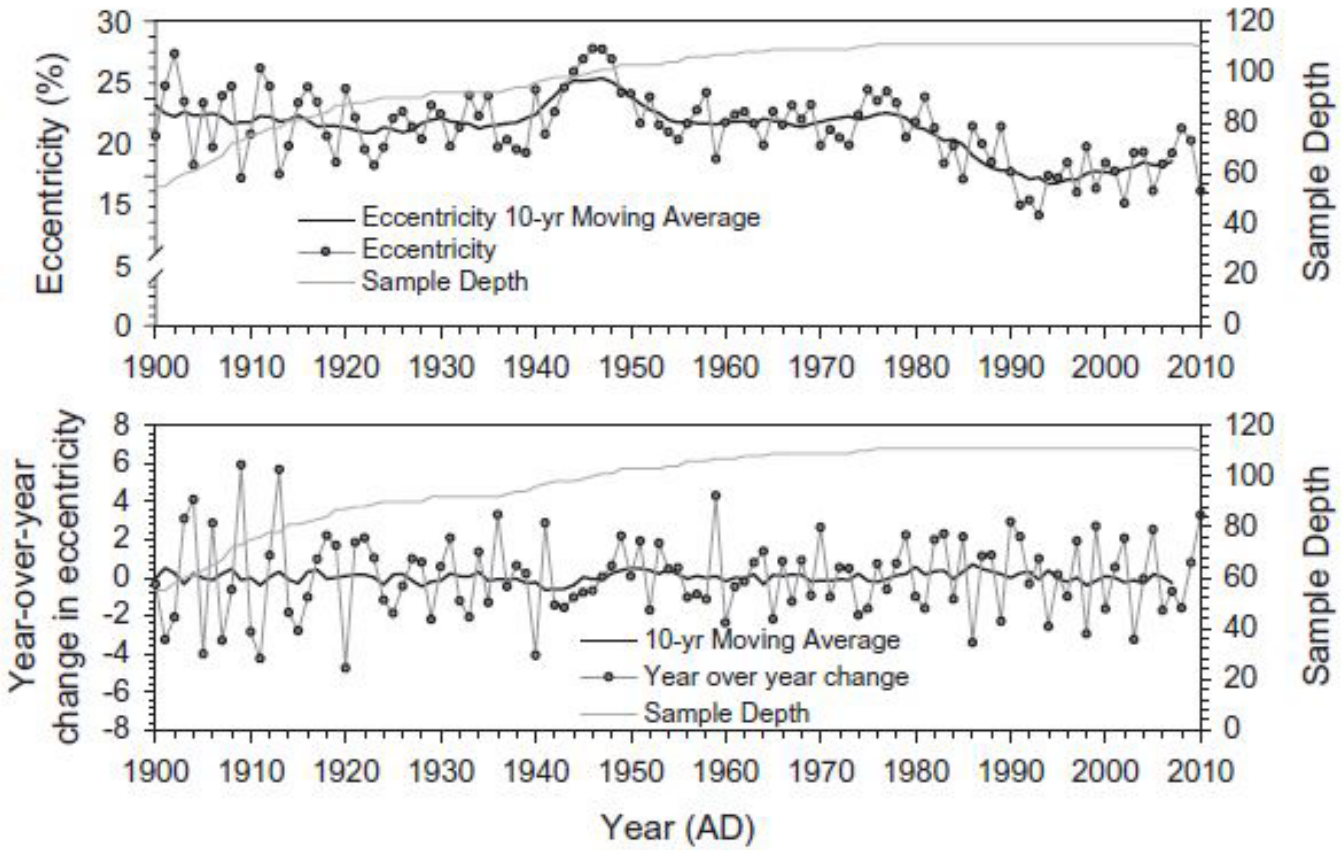
Linking Slope Instability with Precipitation

- Statistically significant positive trend (using a Mann-Kendall test) was found for the response index for 1960s to present.
- 1960s coincides with the end of a regional drought and the beginning of a significant wet period in the 1970s.



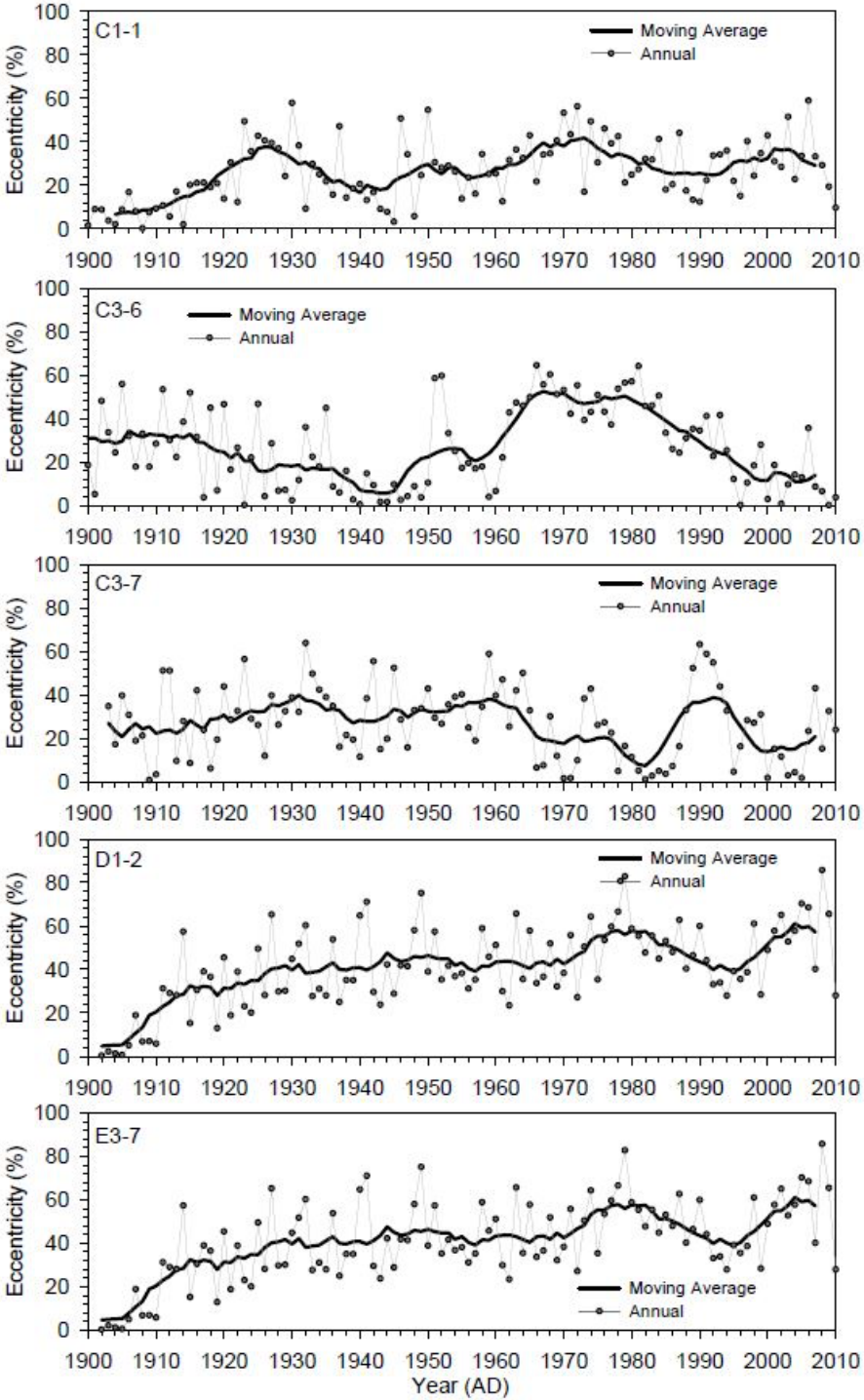
Assessing Patterns in Magnitude

- Average eccentric growth over the entire site does not correlate with temporal trends observed in response index



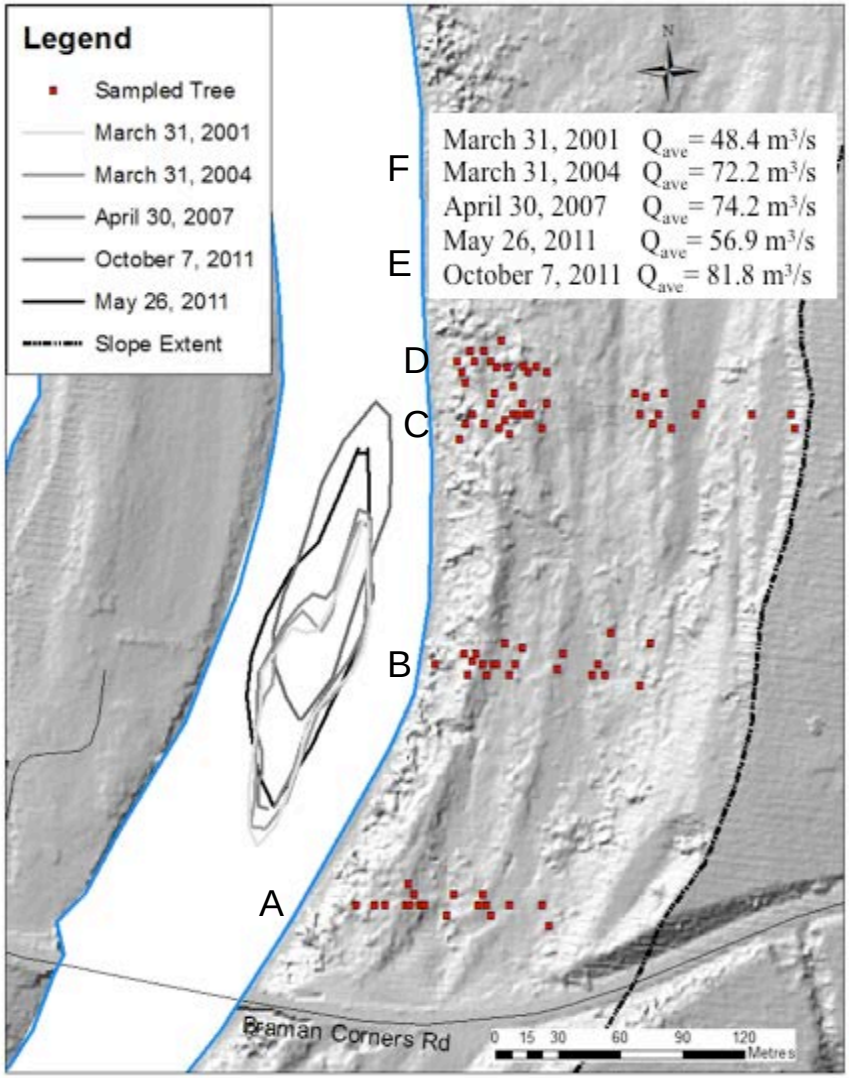
Assessing Patterns in Magnitude

- Localized instability was evident in the distribution of highly variable eccentricity records for individual trees

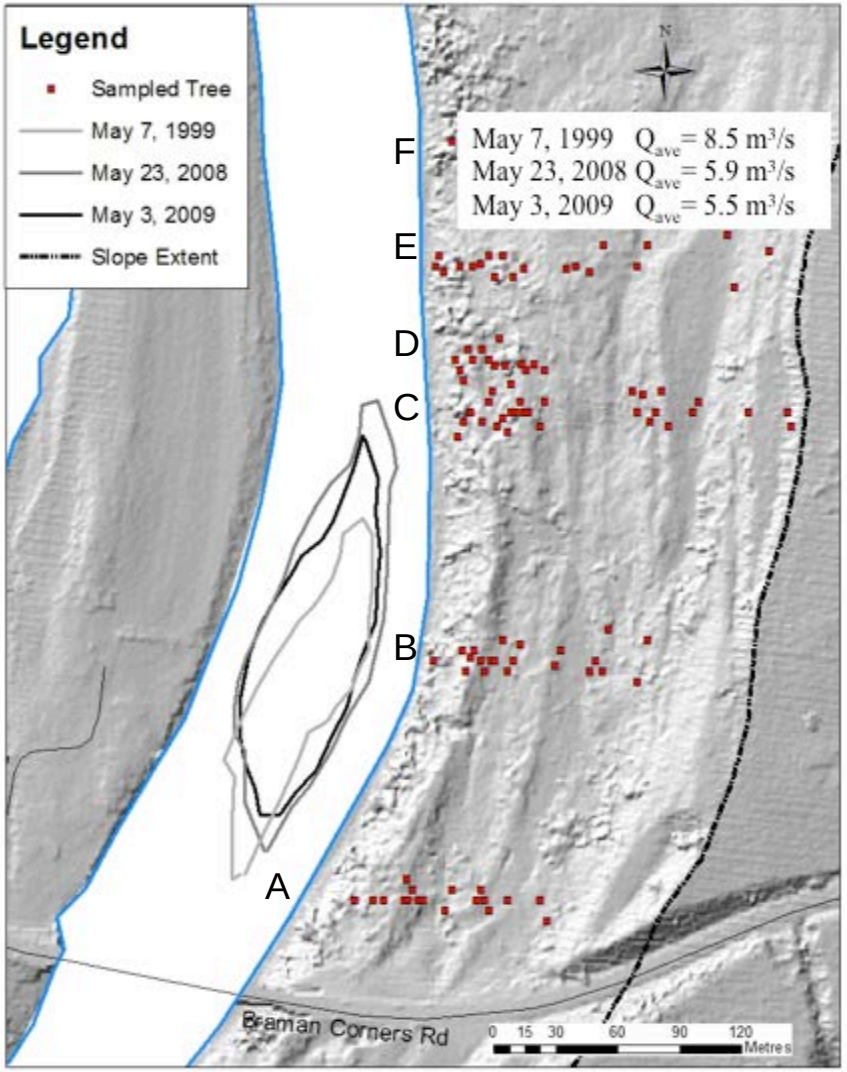


Medial Bar Mapping

High Flow Conditions

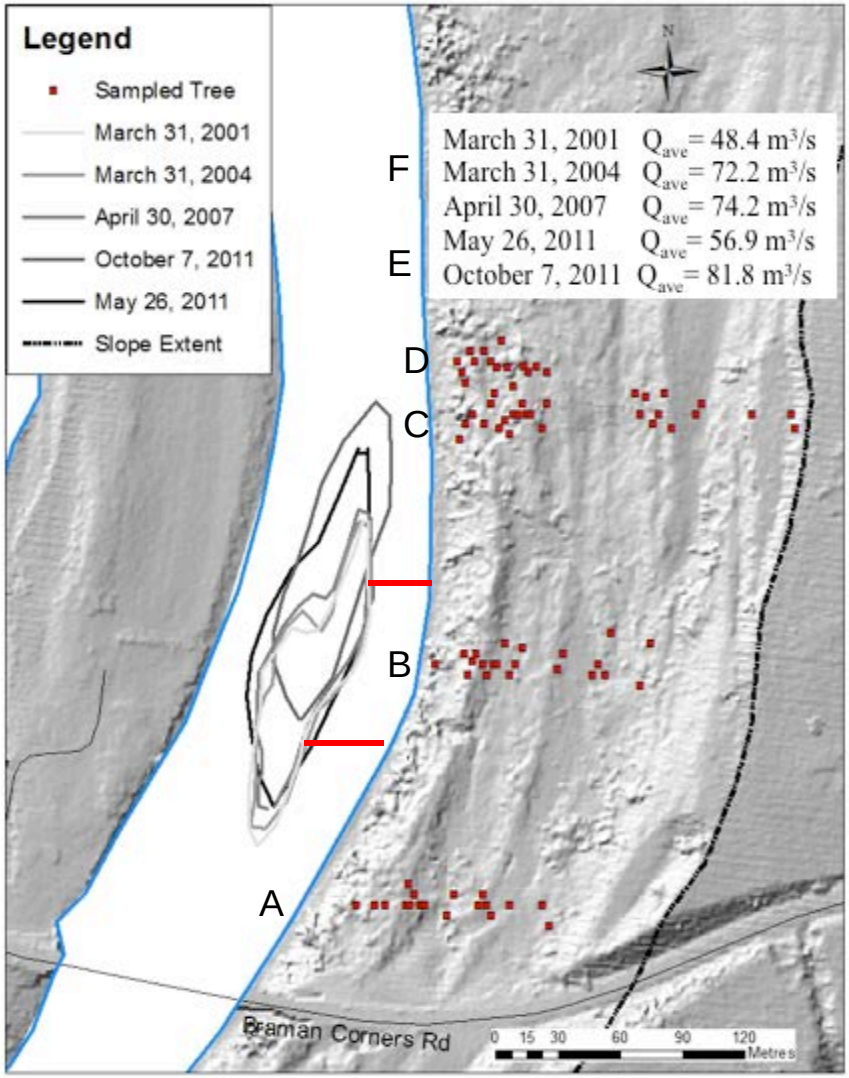


Low Flow Conditions

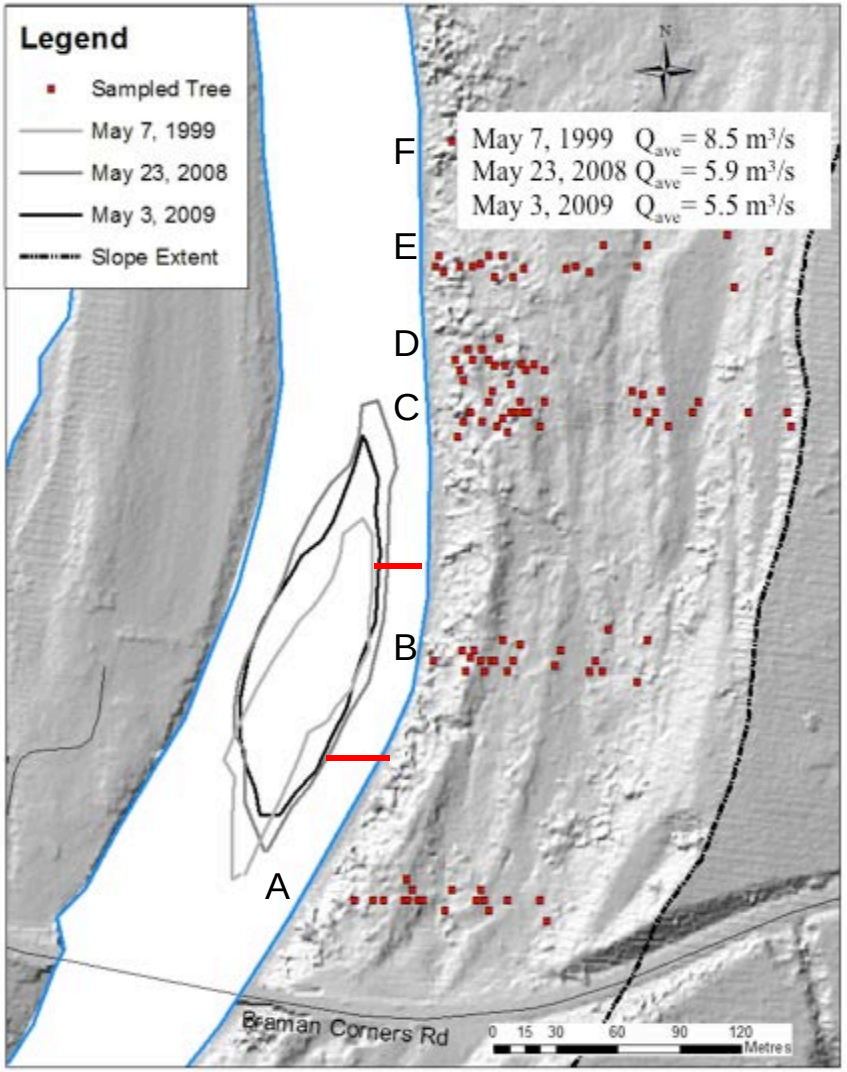


Medial Bar Mapping

High Flow Conditions



Low Flow Conditions



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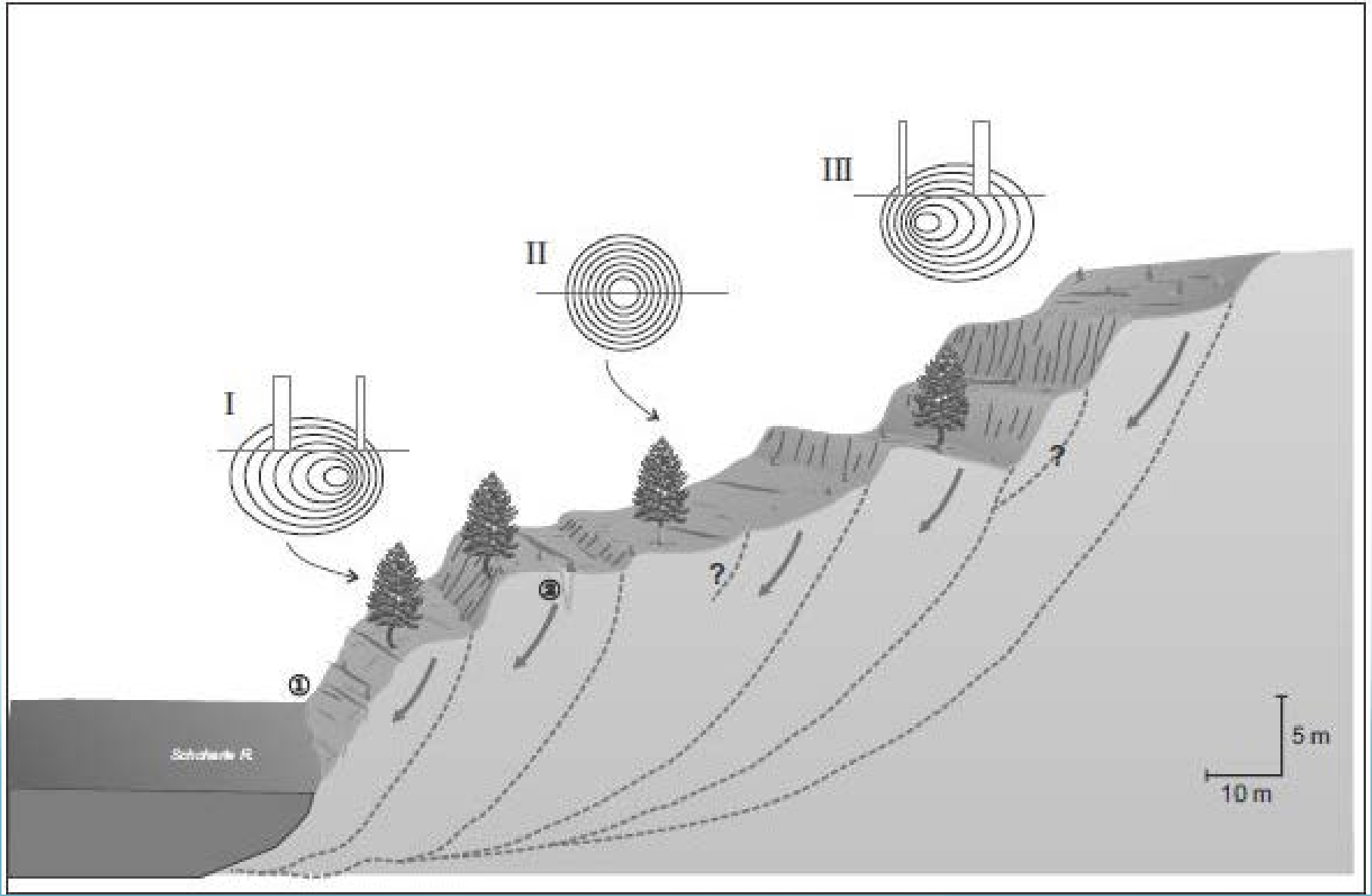

Summary

- The large rotational failure is shifting in response to changes in shear strength and stress across the slope, coinciding with a regional shift in moisture conditions
- Variability in instability suggests that there are multiple slip boundaries across the site
- The synchronous reaction response suggests the mechanisms driving slope instability are site wide; however the timing is variable
- The asynchronous magnitude of the response indicates some areas are more susceptible to instability, especially those near the creek edge where ground cracking was observed

Thank You