Dendrogeomorphology – A Means to Assess Past, Present, and Future Landslide Activity

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Dendrogeomorphology

Origin of the tongue-twister –

**Dendrochronology**, the science of dating changes in the environment through tree-ring analysis

**Geomorphology**, the science of landform configuration and change
Landslides in the Glaciated Northeast

The common elements for landslides in the glaciated parts of New York and elsewhere are:

Steep slopes

- Glacial lake (lacustrine)
- Clay and silt

Slope toe-cutting by high streamflow conditions

Destabilization of slopes by construction activities
Tully Valley Landslides
Old and New
Tully Valley Landslide - 1993
A. Plan view of Rainbow Creek Channels

B. Conceptual cross-section of Rainbow Creek Channels along section line A'-A''

C. Rainbow Creek today along section line B-B''

Current-day channel configuration:
(a) erosion of glacial sediments as channel regrades itself upstream of former waterfall,
(b) toe-failure of steep side slopes along the channel walls leading to current landslide situation.
Rainbow Creek at NYS-Route 11-A

Alluvial Fan build-up on the floor of the Tully Valley

2 five-foot squashed culverts filled with coarse-grained sediment from Rainbow landslide area.
Rattlesnake Gulf Landslide Areas

EXPLANATION
- Landslide area
- Creepmeter
- Stratigraphic test hole
- Ground water monitor well
- Tree measurement track
- Active rock slide
- Scarp
Rattlesnake Gulf Earth Slumps, and Mudflows

Note inclination of trees on the upslope.
Channel Aggradation
Dendrogeomorphology

Finally........
“Jayed” Trees generally indicate slope/tree movement
Tree cross-section exhibiting “eccentric” growth

Uphill side of tree

Downhill side of tree
Increment boring – a pencil-sized core from a tree

2 cores usually taken from each tree – one on the uphill and one on the downhill side of the tree

Annual ring-width difference ratio is then used to determine the year in which an ‘event response’ occurred, as shown by the eccentric growth.
Event response curve indicates years of ‘significant’ slope movement corresponding to eccentric ring response in a number of trees.

What caused the event response was the next part of the study –

Above normal precipitation in a single year?

Three- or five year moving average precipitation?

Dry periods followed by wet periods?
Results of the response-curve assessment:

Above normal annual or event based precipitation - Not significant

3-year and 5-year moving average precipitation - Sometimes significant

Dry years followed by above-normal precipitation - Often times significant

Is there something else? Yes, there always is.................
Linear Regression - Residual Values Analysis
Residual values from linear regression showed a periodic nature – a 30-year +/- increase in landslide activity followed by a similar period of declining landslide activity.

So......

Could it be a long-term response to slope failure propagating uphill followed by a period of general slope stability?

Could it be related to tree stand maturity and(or) timber harvesting?

Both cases are a possibility, possibly in tandem, but we do not have enough......
Bottom Line --

Assessment of slope stability involves understanding the geologic nature of the slope, characteristics, vegetation, climatic conditions and trends, and how the slope is influenced by natural and anthropogenic change.

Hydrogeomorphology is a useful tool to determine the stability and nature of steep slopes, and provides a “forensic” record of slope stability when no other historic record of stability is available.

The presence of ‘jayed’ trees, when viewed with the character of the slope (as outlined above) can be a simple, but good indicator of slope instability.
Pen, moves across chart (30 days per pen traverse)

Chart Drum
Rolls in response to movement of the tree and underlying soil 'island' in which tree is rooted.
Figure 3.—Cumulative creepmeter displacement and precipitation in relation to ground-water level within the Battlesnake Gulf landslide area from June 2006 through June 2008. (Location shown in fig. 2.)
Questions?