Erosion Working Group Recommendations for Phase 1 Studies

Presented By

West Valley Erosion Working Group (EWG)

Quarterly Public Meeting

August 22, 2012

Introduction & Overview

Study 1 – Terrain Analysis

Study 2 – Age Dating and Paleoclimate

Study 3 – Recent Erosion and Deposition Processes

Study 4 – Model Refinement, Validation, and Improved Erosion Projections

Summary

Questions & Answers

Introduction & Overview

Presented By Dr. Robert H. Fakundiny

PROBLEM:

- Lack of consensus between the two agencies over long-term erosion projections

QUESTIONS:

- Future landscapes
- Future exposure to radionuclides

RECOMMENDED STUDIES:

- Fill data gaps
- Improve scientific defensibility
- Strengthen confidence in projections
- Synergy

PREFERRED MODEL:

- CHILD landscape evolution model

DISCUSSION OF EACH STUDY:

- Objectives
- Components
- Rationale

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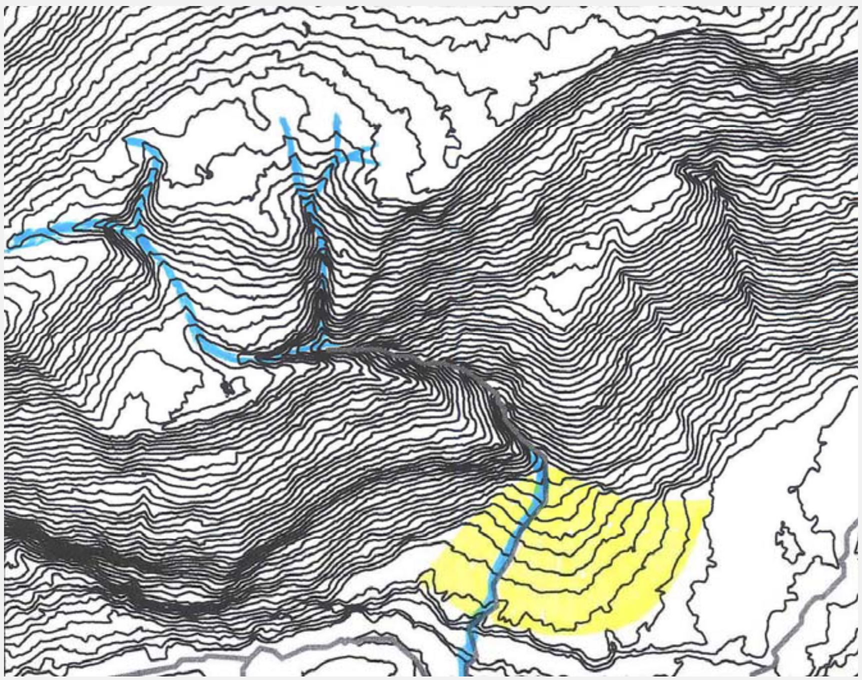
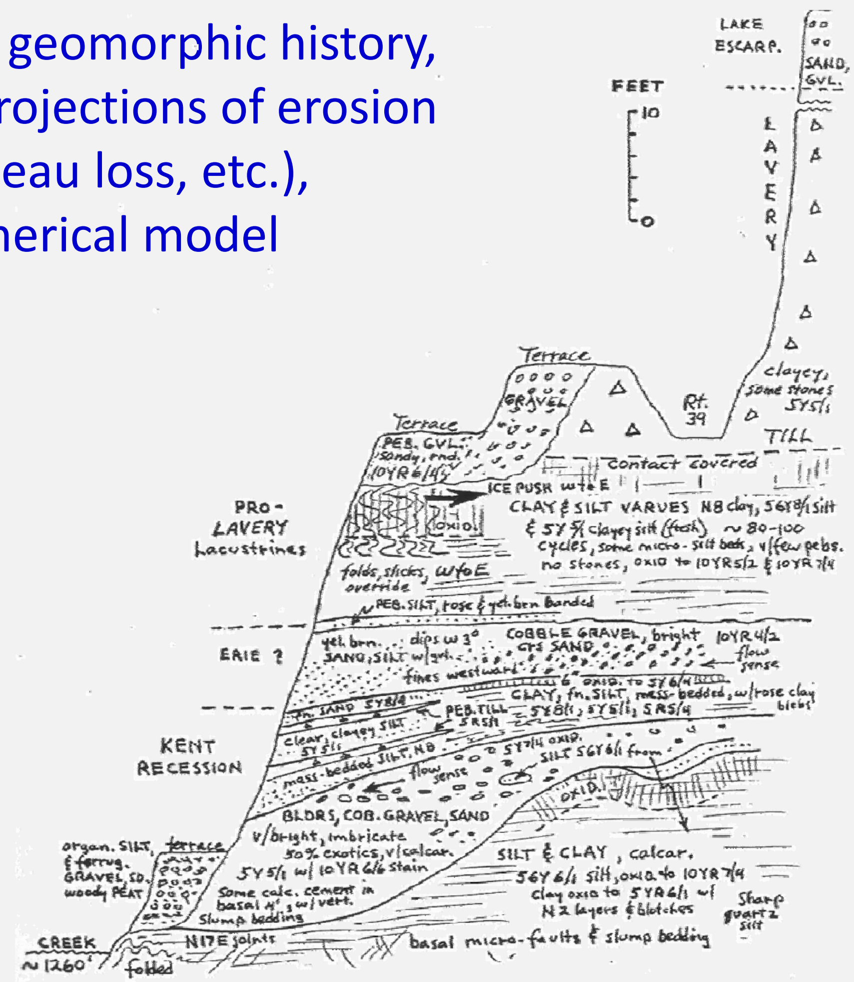
Study 1 – Terrain Analysis

Presented By Dr. Michael Wilson

Objectives: Build on previous work in order to:

1) enhance understanding of post-glacial geomorphic history,
2) enable more confident independent projections of erosion (fan development, gully initiation, plateau loss, etc.),
3) and provide enhanced context for numerical model calibration and sensitivity analyses.



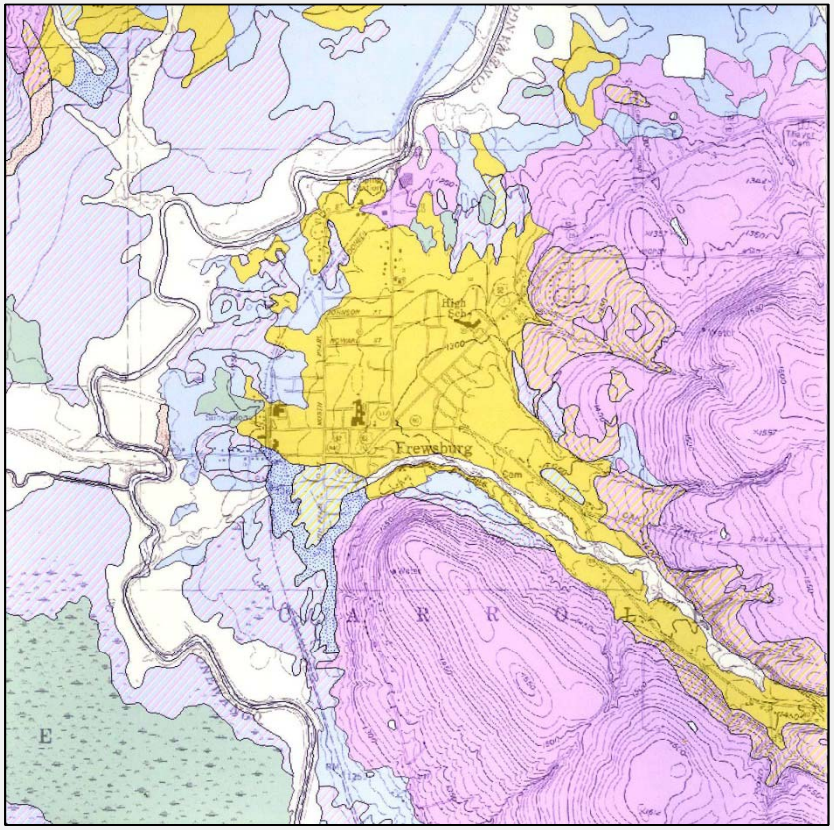


From LaFleur, 1980, figure 8.

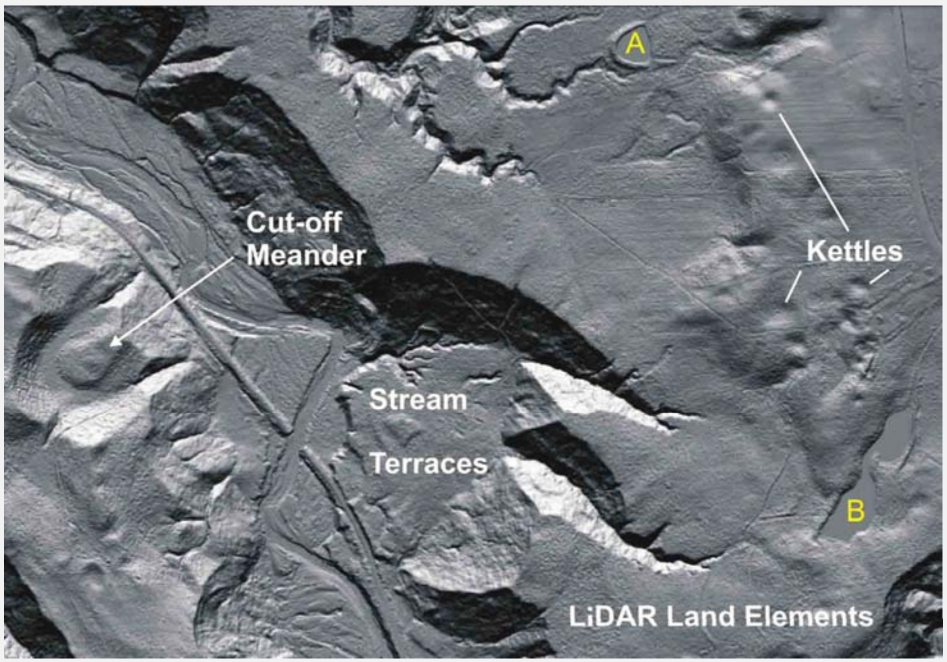
Study 1 – Terrain Analysis

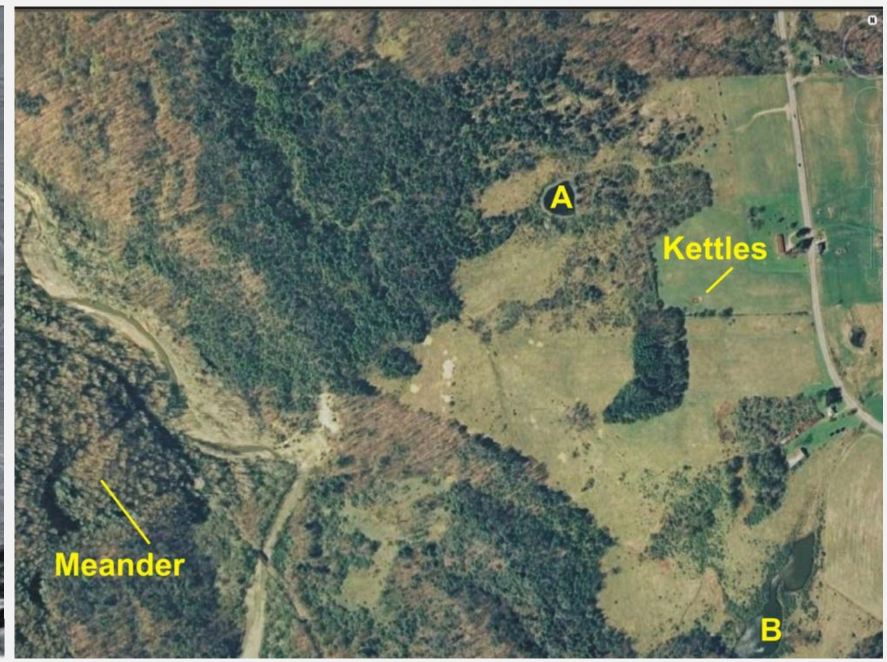
Components:

- Identify land elements of interest using Light Detection And Ranging (Lidar or LiDAR) hillshade or contour lines, and other mapping techniques such as USDA soil surveys.
- Compare local area with the wider region to identify useful similarities or differences, for example stream profiles.
- Perform field walk-overs, test drilling, and trenching as confirmation.
- Construct enhanced graphics of key areas, such as cross-sections, cut-away views, or animations.
- Identify targets for age dating.
- Use the data to refine the conceptual framework for geomorphic history of Buttermilk Creek and its base level.



Study 1 – Terrain Analysis





Buttermilk Creek abandoned meander scar (known as the "Race Track")
is shown on LiDAR and air photo images.

Study 1 – Terrain Analysis

Recent trenching by Lee Gordon south of the "Race Track" abandoned meander.

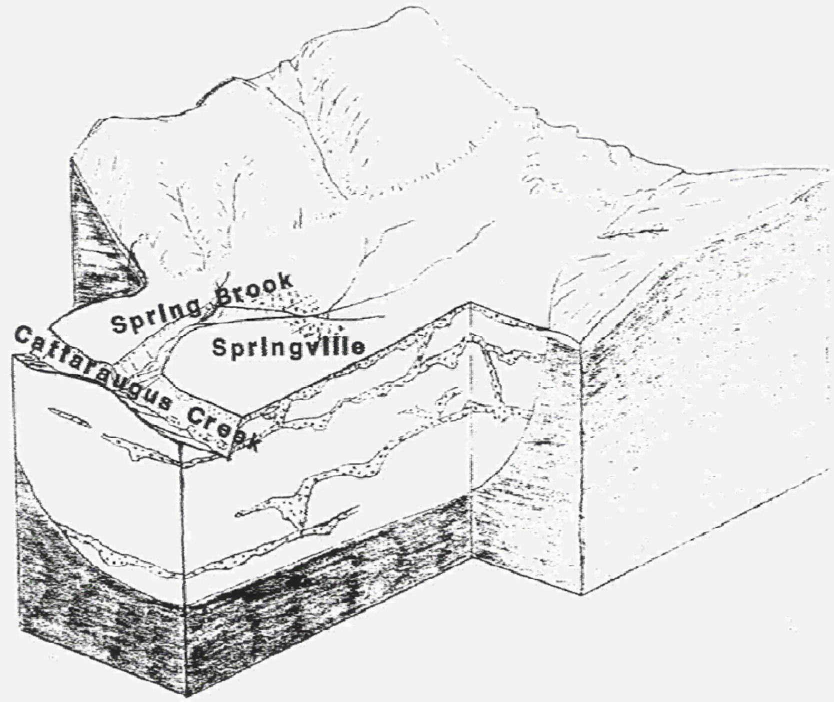
Rationale:

Enhancing the understanding of the history and rates of landscape processes will provide the following benefits:

- Enable better definition of critical parameters for use in constructing independent projections of future erosional and depositional effects.

- Enable better definition of model parameters for numerical simulations of potential future erosion of the site, and sensitivity analyses.

- Strengthen confidence in erosion prediction due to converging lines of evidence and enhanced characterization of uncertainty.



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Study 2 – Age Dating and Paleoclimate

Presented By Dr. Richard Young

OBJECTIVES:

Provide additional age and paleoclimate data at key locations to:

- better define and constrain past rates of stream downcutting and valley rim widening for the site, the Buttermilk Creek watershed, and potential companion drainages;
- provide a better understanding of post-glacial climate cycles and their effects on erosion processes; and facilitate sensitivity analysis of climate inputs in the predictive model.

Study 2 – Age Dating and Paleoclimate

***COMPONENTS*:**

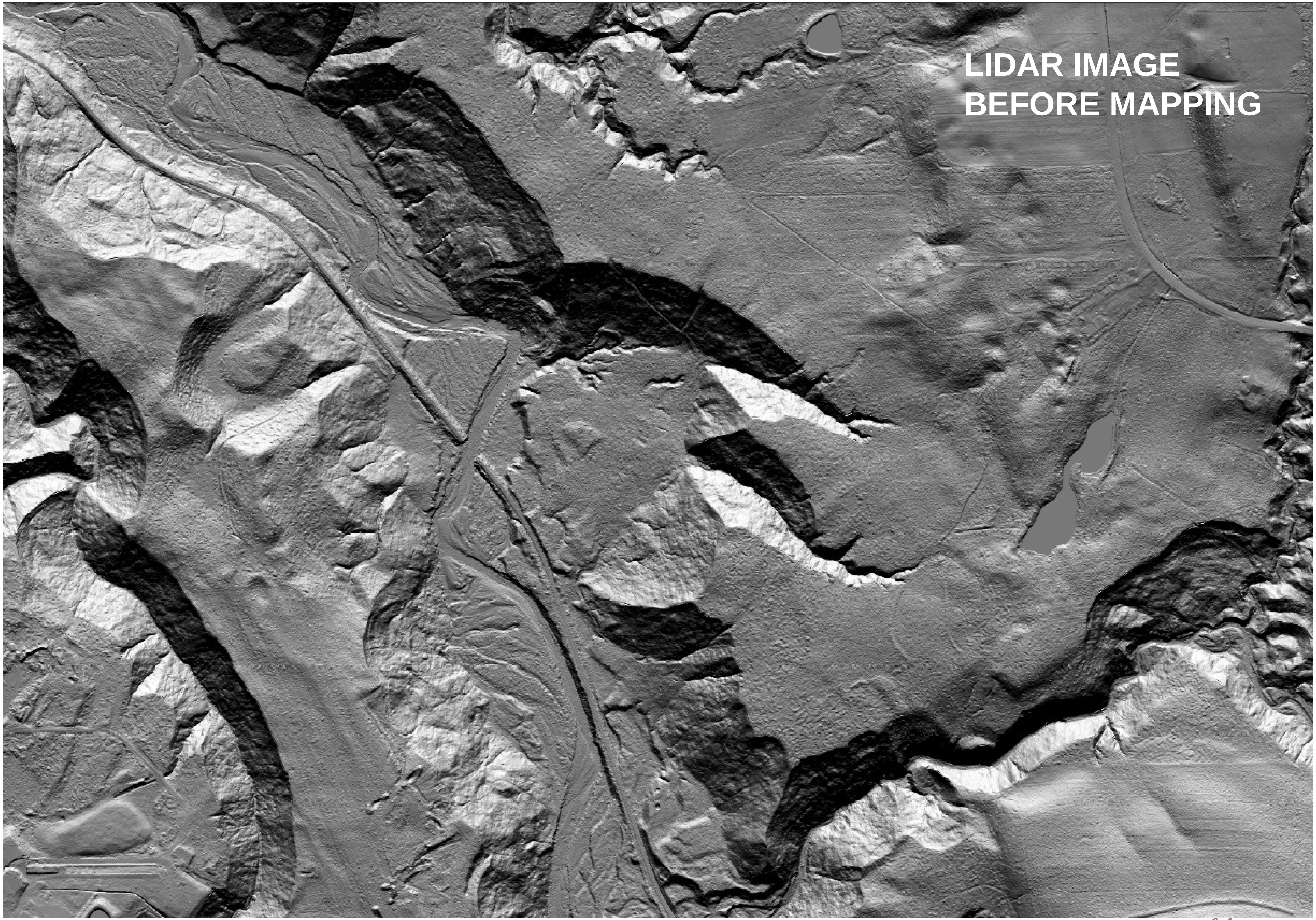
- Excavate and/or examine mapped key “land elements” such as terraces likely to contain reliable materials for dating methods.
- Excavate and/or core glacial kettles for “bog bottom” dating (end of glacial stadial).
- Examine relevant landslide toes exposed in channel walls or tributary gullies to search for buried debris (timing of slide activity).
- Core tree rings (determine times of tree deformation from landslide movements, and for local climate proxy [drought] linked to terracing).
- Collect samples for uranium-lead (U-Pb) dating of secondary carbonates.
- Date post-glacial erosional and depositional features.
- Analyze dating samples in laboratory.
- Evaluate age data for evidence of possible correlations with known Late Wisconsin glacial or postglacial climatic events.
- Optically Stimulated Luminescence date sampling (Some completed).

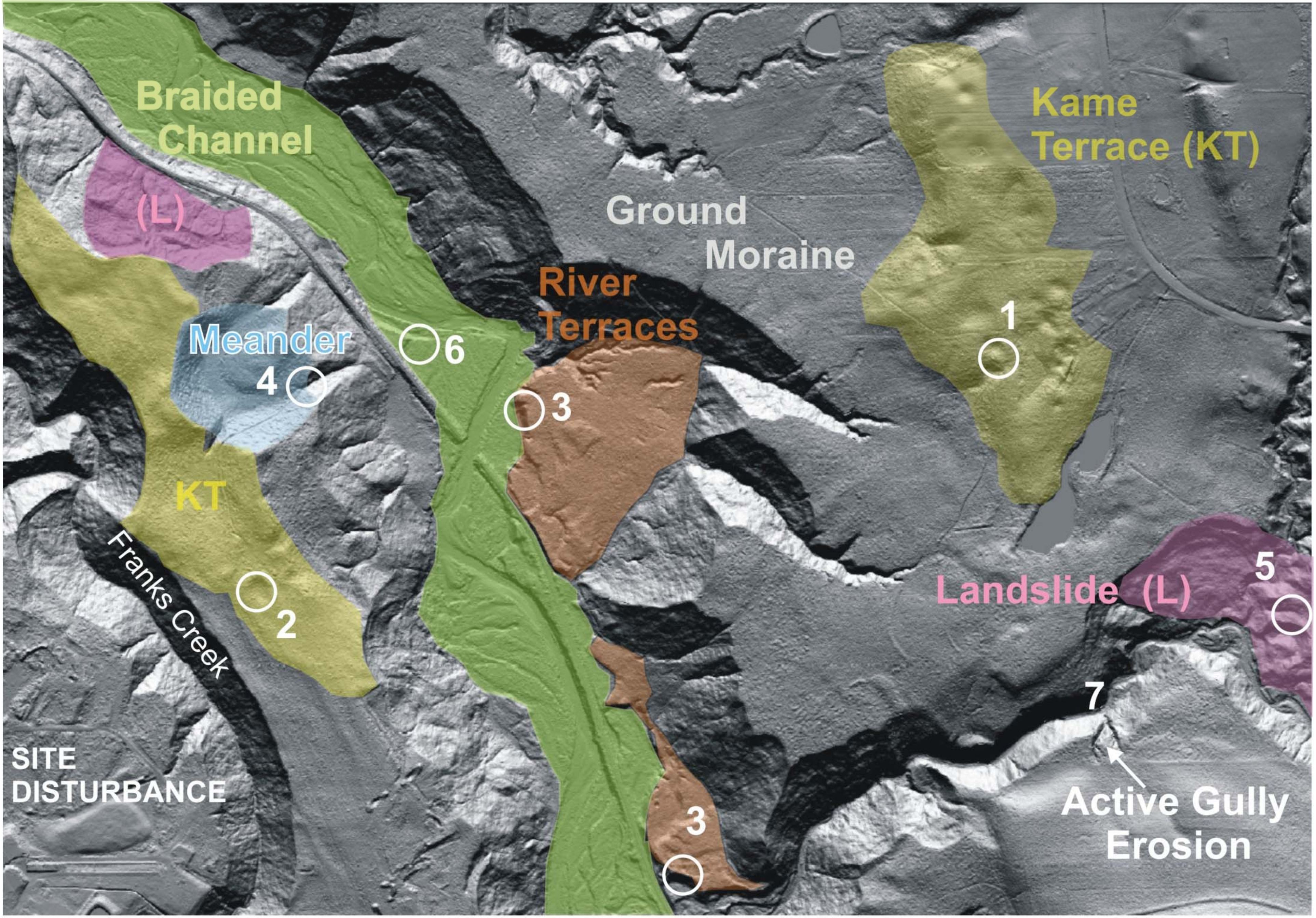
Study 2 – Age Dating and Paleoclimate

Examples:

Relate local ^{14}C data to broader global or regional climatic excursions

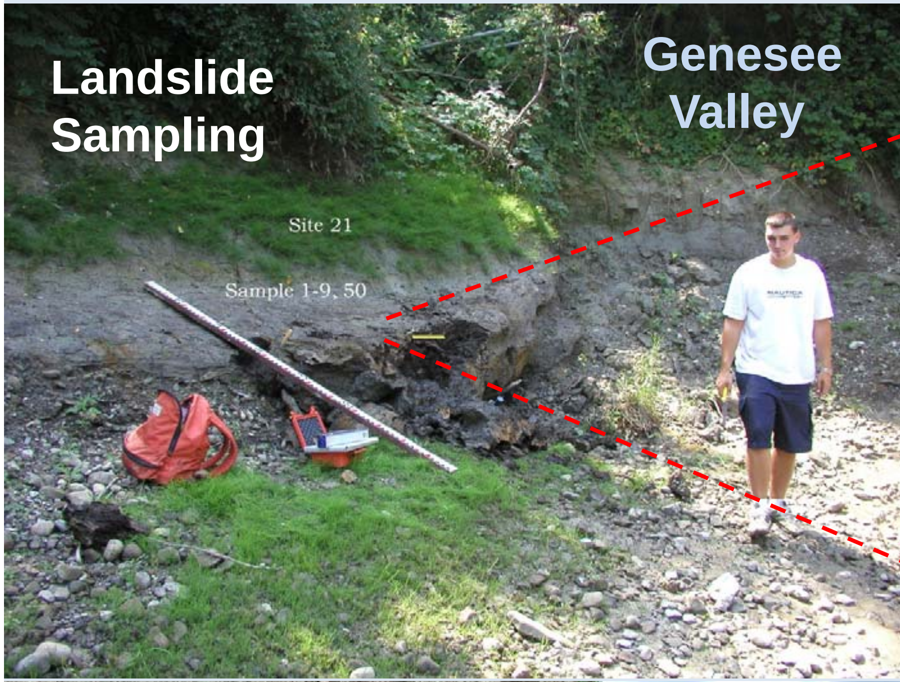
- Demonstrate that global climatic events may be recorded in local sediments
- Attempt to define sedimentary intervals and events that record variable erosion rates
- Demonstrate when West Valley region was first ice free (strengthen existing glacial chronology)

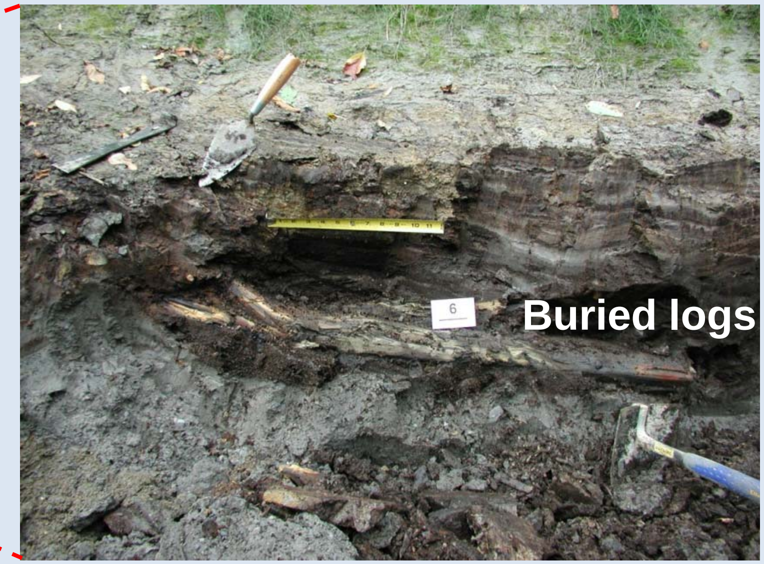

LIDAR IMAGE
BEFORE MAPPING

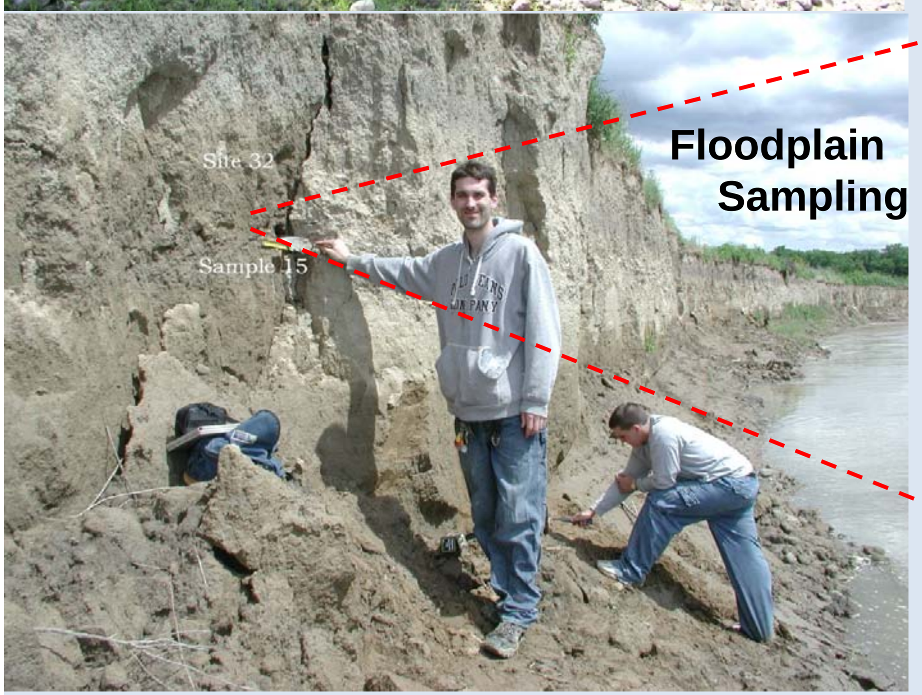


Example of Land Element Mapping (colors) with Dating Prioritization Numbers

LAND ELEMENT AGE SAMPLING





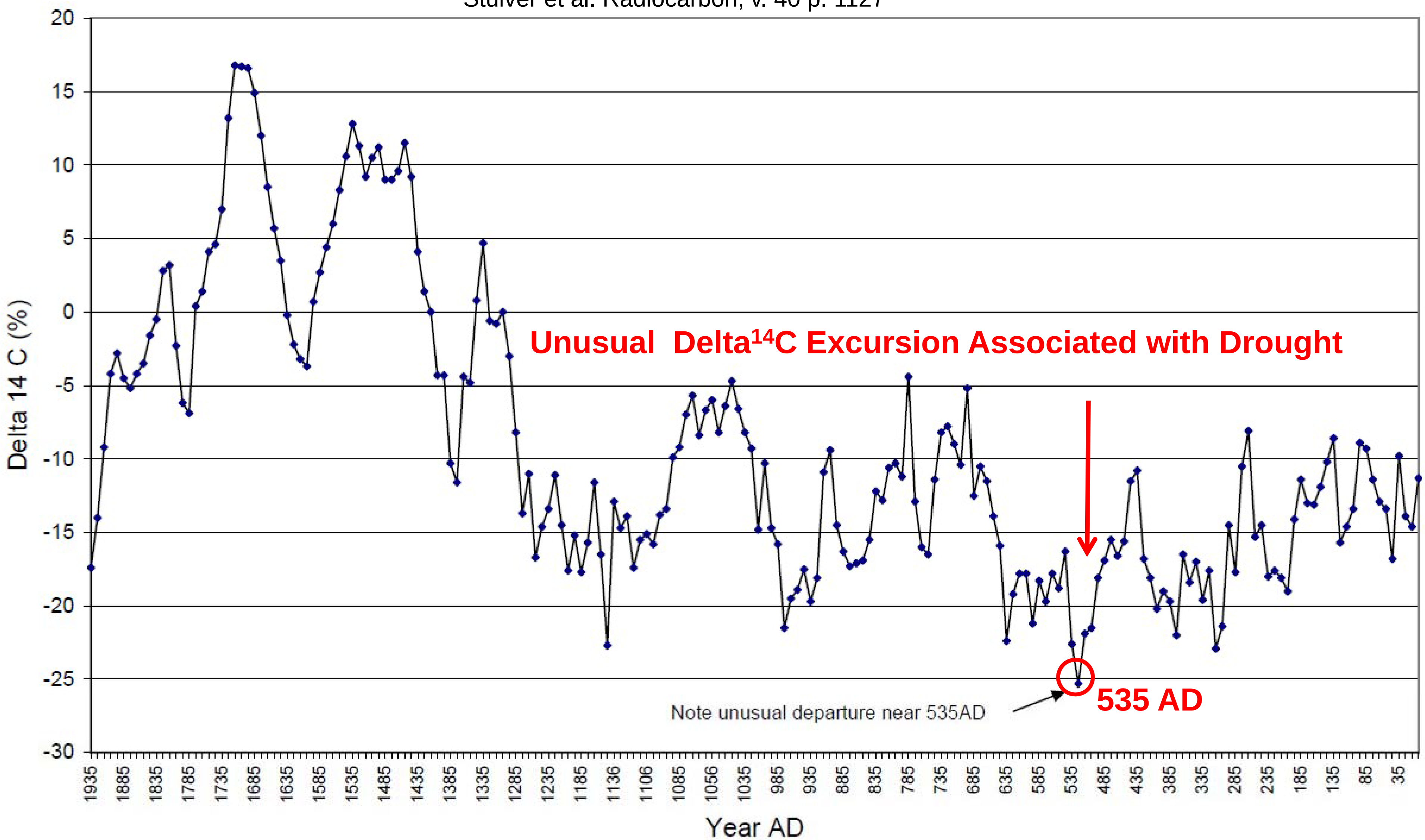


Global Climatic Event 535 AD (next slide)

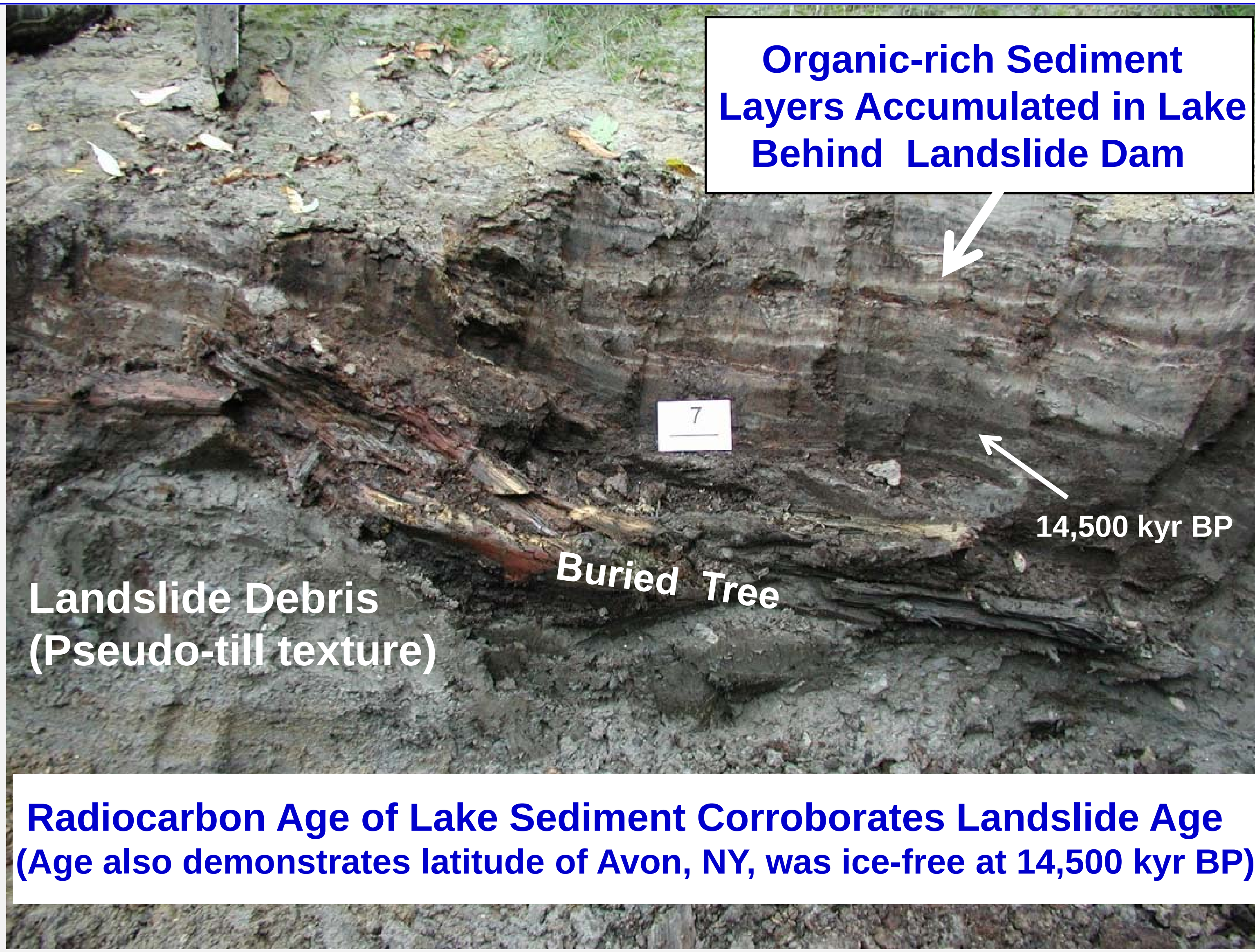
Example of Correlation of ^{14}C Data with Global Climatic Events

Delta ^{14}C Variation by Decade from 5 AD to 1935 AD

Stuiver et al. Radiocarbon, v. 40 p. 1127



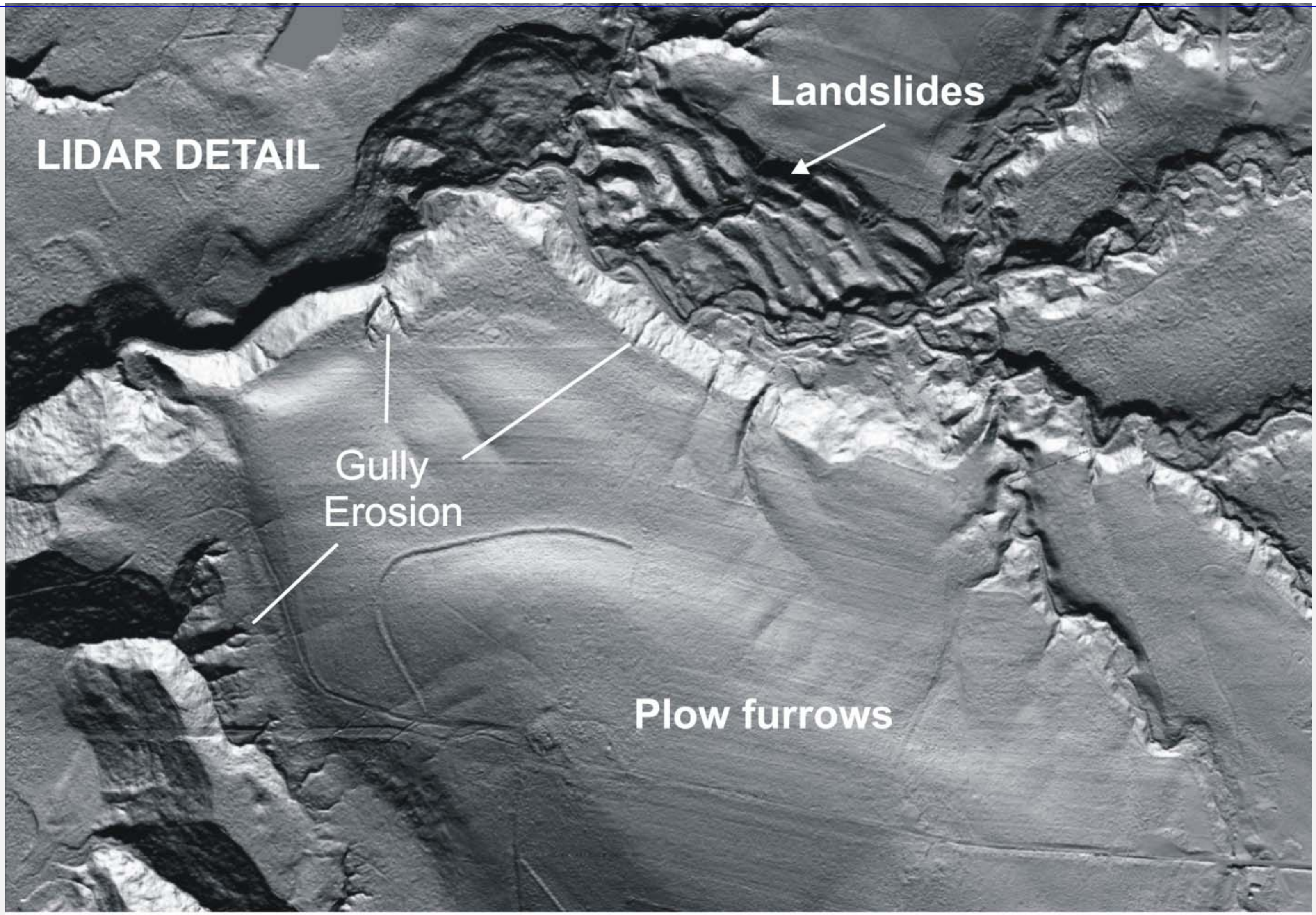
Example of Age-Dating Methods



Radiocarbon Age of Lake Sediment Corroborates Landslide Age
(Age also demonstrates latitude of Avon, NY, was ice-free at 14,500 kyr BP)

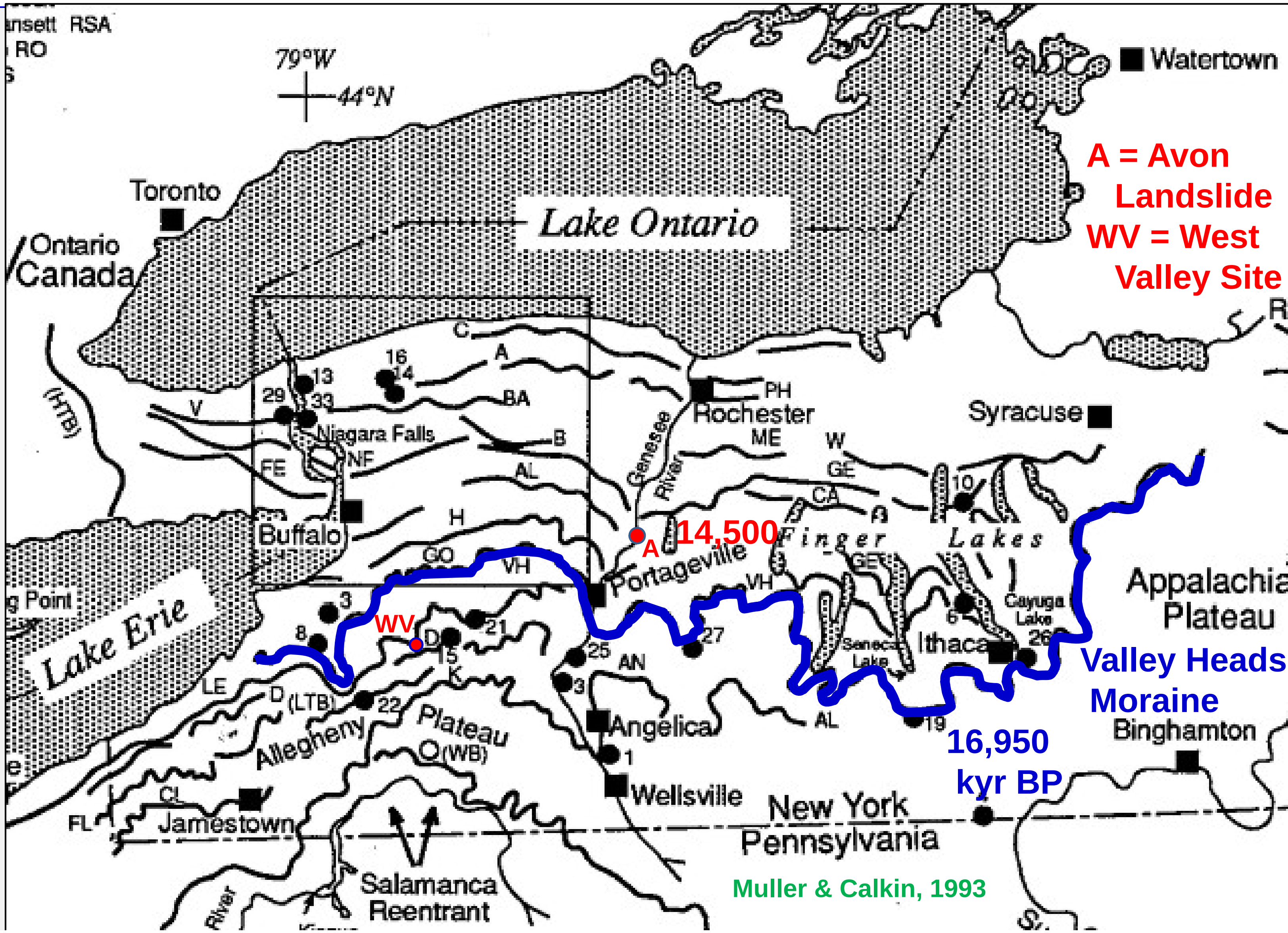
Landslide Activity – Genesee Valley

Landslide Activity Revealed by LIDAR

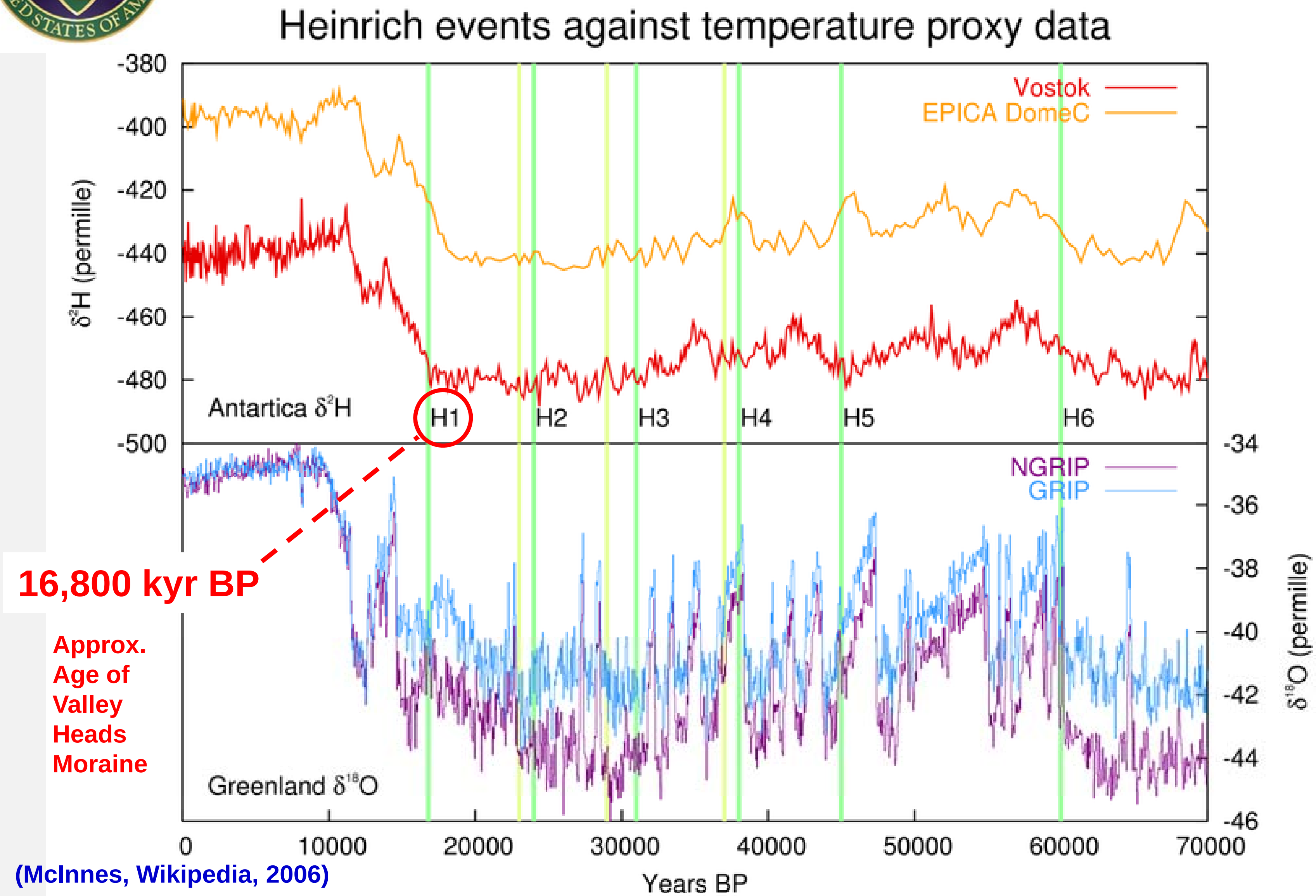


LIDAR Details Not Available Using Other Types of Imagery

Glacial Moraines and Ice Positions



Heinrich Ice Advances – Atlantic Ocean Cores



Approx. Age of Valley Heads Moraine

(McInnes, Wikipedia, 2006)

Study 2 – Age Dating and Paleoclimate

***RATIONALE*:**

- Age dating of geomorphic features provides the time lines of their formation, and together with spatial distribution of land elements, provides some of the required data for calibrating the landscape evolution model.
- By reducing uncertainty in key age dates, numerical model calibration could be improved thereby reducing uncertainty associated with erosion prediction.
- Paleoclimate data provide a meteorologic history that can be used for calibrating the landscape evolution model, and to bound ranges of climate inputs for sensitivity analyses. This in turn may help to quantify uncertainty and improve confidence in model predictions.

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Study 3 – Recent Erosion and Deposition Processes

Presented By Dr. Sean Bennett

Study Objectives:

- To quantify and characterize recent rates of erosion and deposition
- To understand more deeply how current processes compare to long-term evolution of the landscape
- To verify and validate erosion prediction technology

Erdman Brook

Study 3 – Recent Erosion and Deposition Processes

Erdman Brook
Knickpoints: 0.4 m deep, 0.5 m wide, 3 m/yr

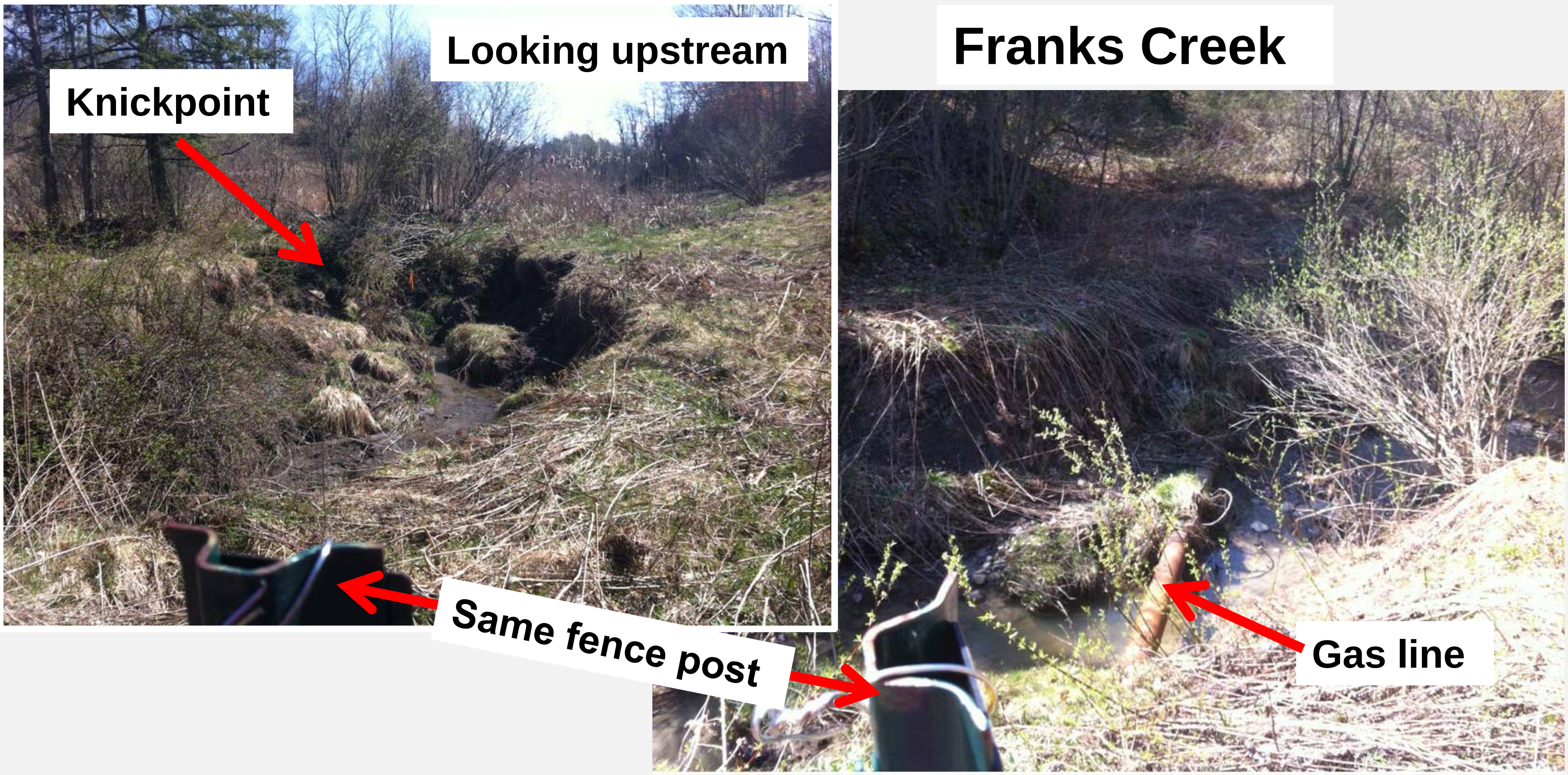
Franks Creek
Knickpoint: 1 m deep, 3 m wide, 8 m/yr

Gully, NE Slope

Slope Failure, Buttermilk Creek

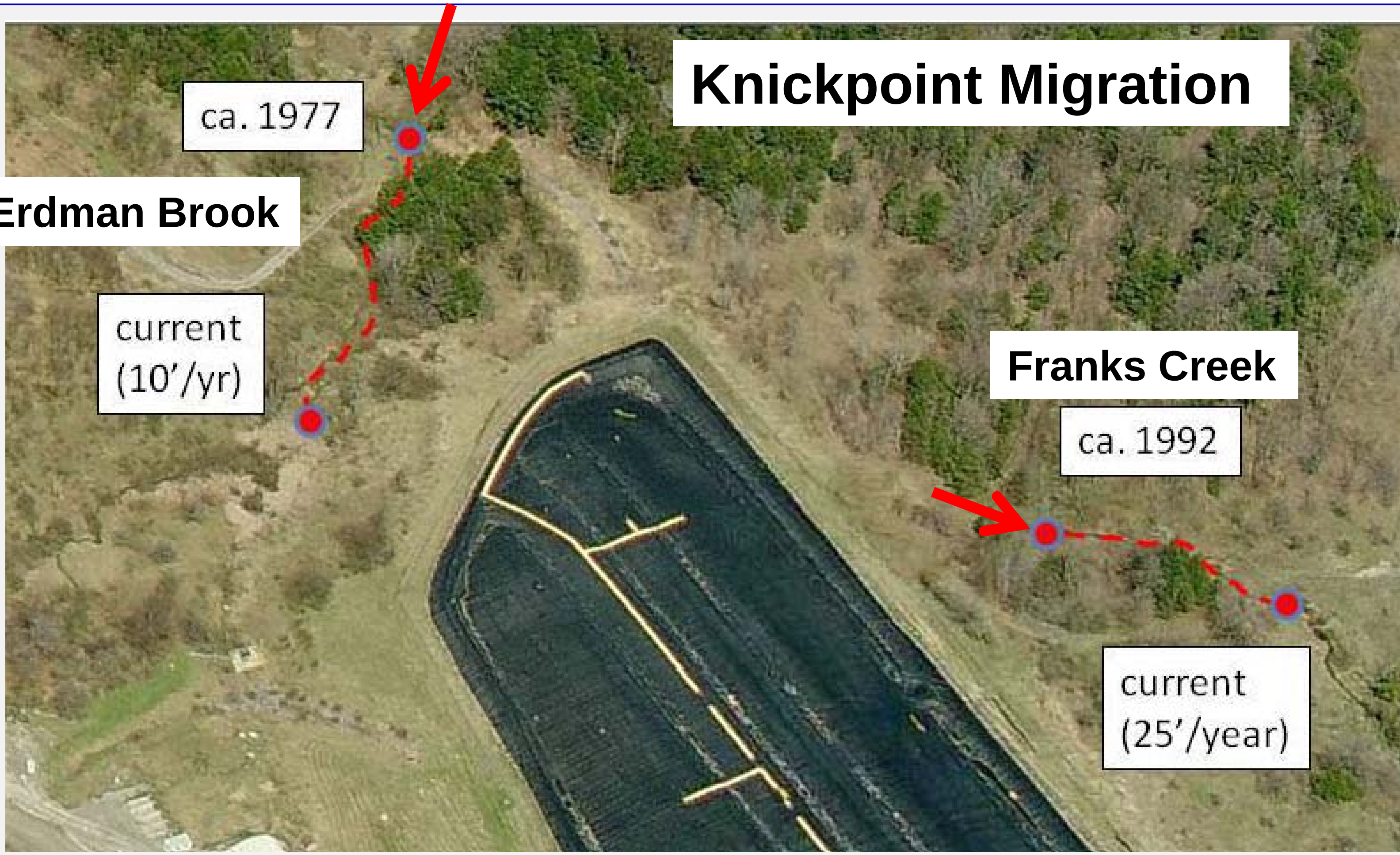
Surface processes are very active on-site, yet significant gaps exist regarding current rates, locations, and potential risks

Study 3 – Recent Erosion and Deposition Processes



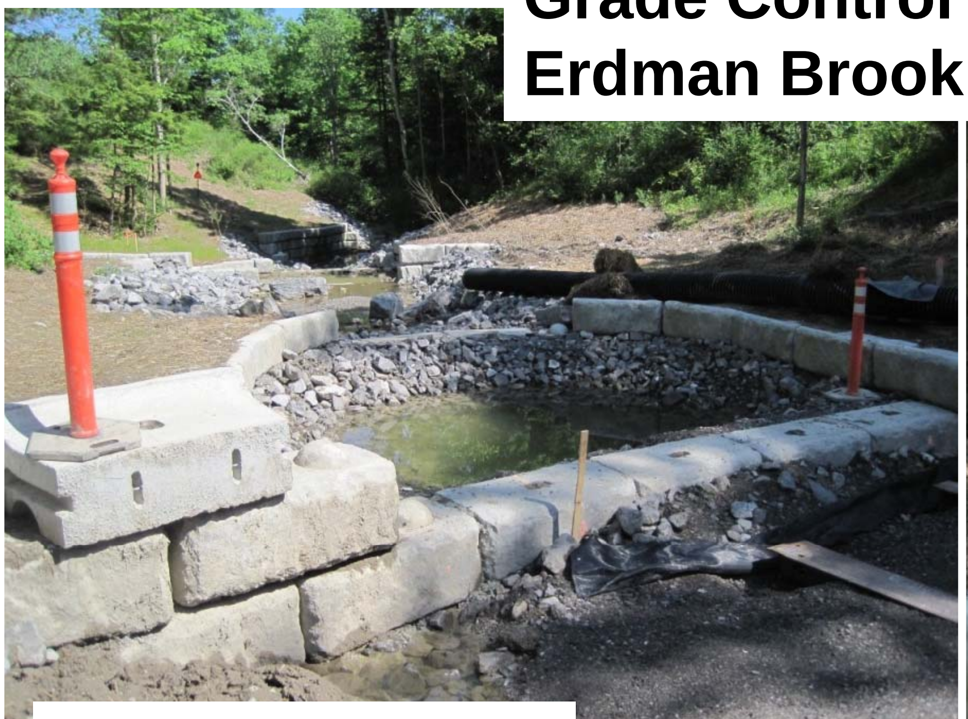
Active bed incision and channel widening due to knickpoint migration causes landscape degradation and destabilization

Study 3 – Recent Erosion and Deposition Processes



Active channel degradation along streams could initiate or accelerate gully erosion on side-slopes of the SDA

Grade Control Structures, Erdman Brook, May 2012



Looking downstream

Looking upstream

Recent channel erosion along Erdman Brook (shown) and Franks Creek (planned) has required active management

Study 3 – Recent Erosion and Deposition Processes

Foci of Proposed Study: *(building upon previous work)*

Hillslopes: Determine rates and mechanisms of mass-wasting, assess slope stability

Rills & Gullies: Map locations, determine erodibility and erosivity, monitor water flow and sediment transport

Streams: Define hydraulic and geomorphic stability, monitor flow and sediment transport, assess channel evolution.

Surfaces: Identify postglacial surfaces and forms as well as sites of sediment deposition

Rationale: *Study of current earth-surface processes could afford the following opportunities and benefits:*

- Provides an independent approach to assess past and future landscape trajectories
- Helps support or refute erosion prediction technology, as well as revise and refine the landscape evolution model
- Facilitates in reaching consensus amongst agencies regarding erosion processes

Energy. Innovation. Solutions.

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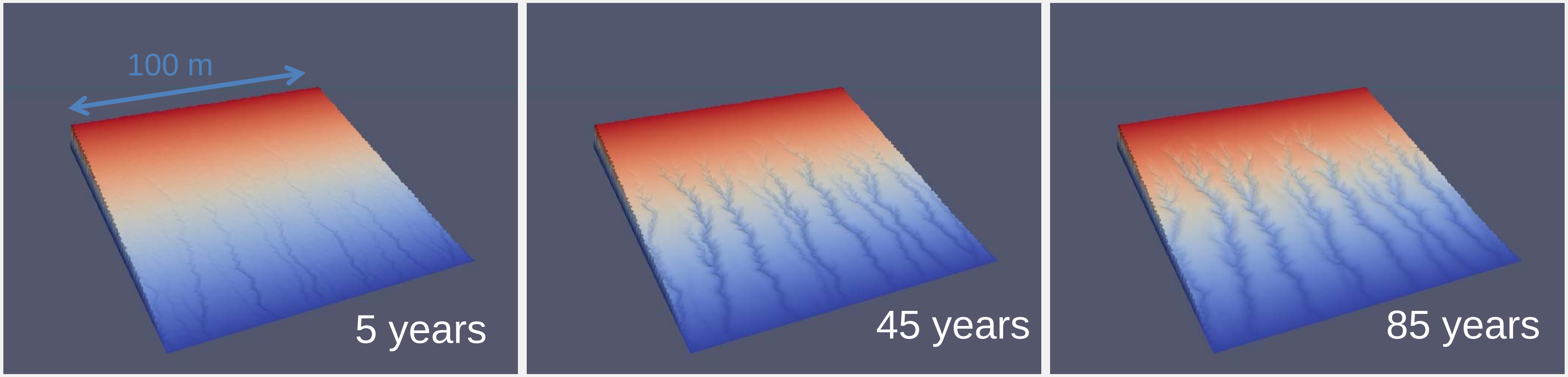
4. RELEVANT PAST PERFORMANCE

Questions & Answers

Overview of recommended approach:

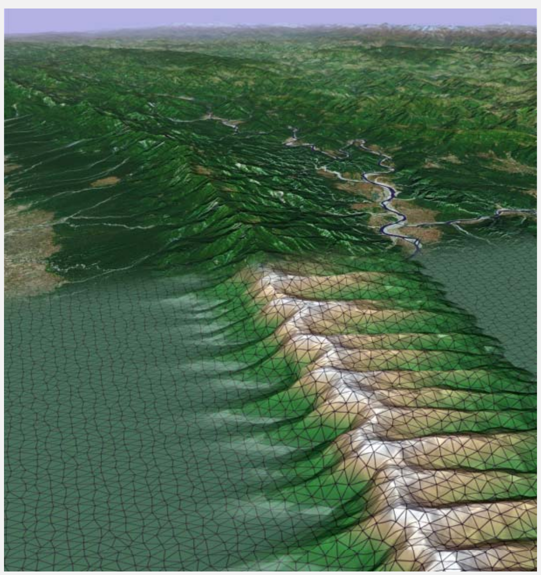
- Using new data from Studies 1-3, run a landscape evolution model to forecast erosion rates and patterns

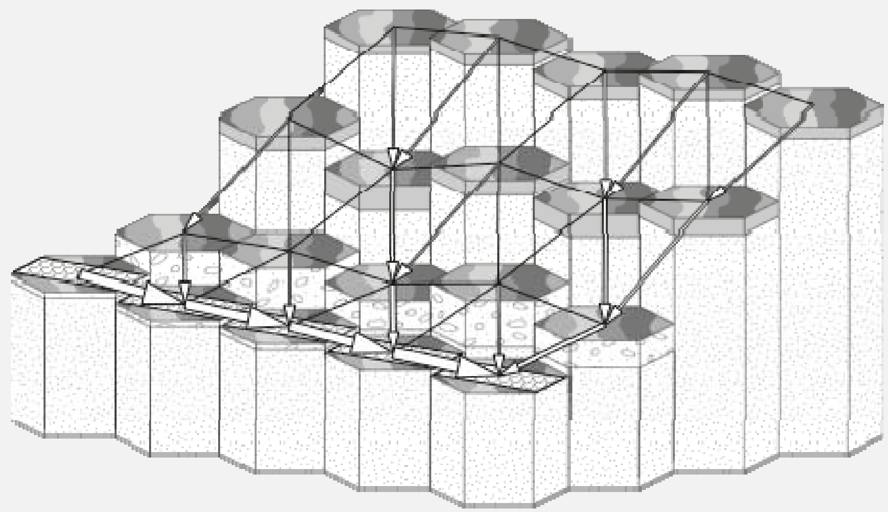


Example computer model simulation of growing gully networks

What is a landscape evolution model?

- Computes the erosional development of topography over time in response to erosional processes
- Represent scientific community’s current understanding



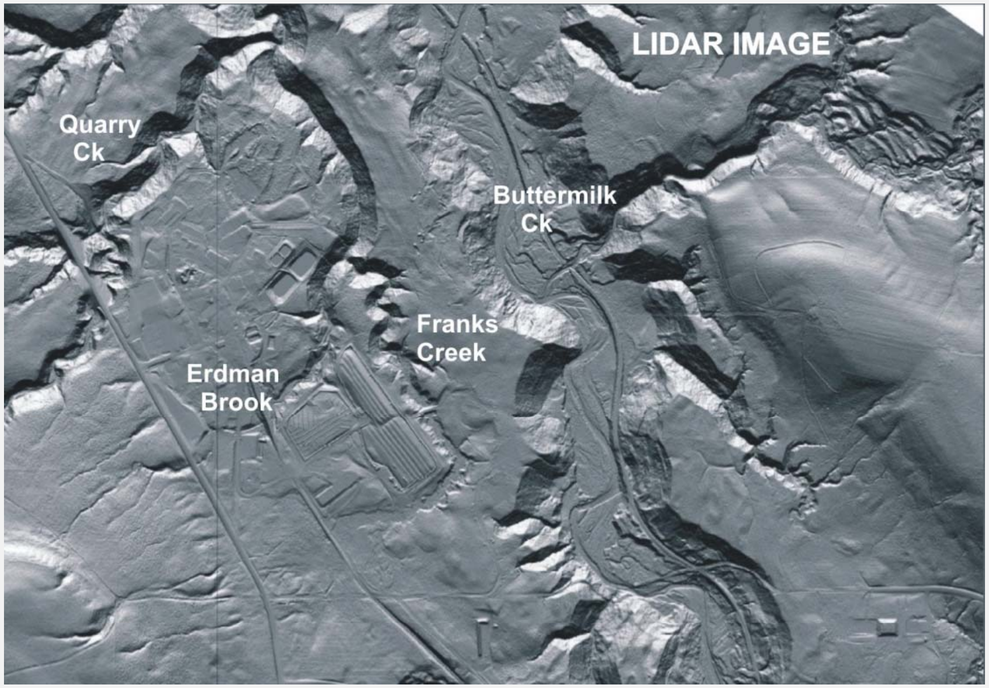


- Recommended model is Channel-Hillslope Integrated Landscape Development (CHILD) model (adapted to site)

Where do input data come from?

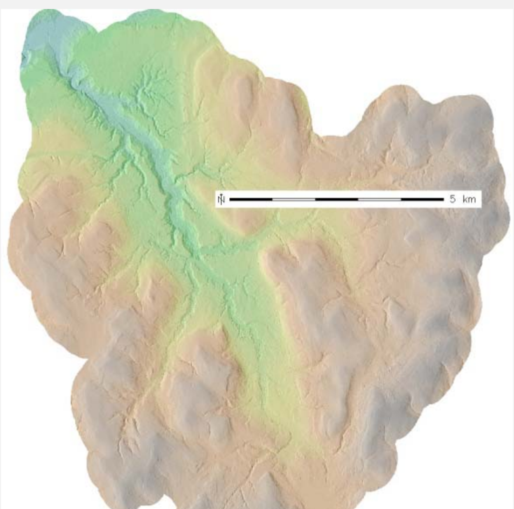
All computational models need input data to represent their starting conditions, outside inputs, and processes

- Lidar topography data
- Scientific literature
- Results from Studies 1-3
- Calibration to modern landscape

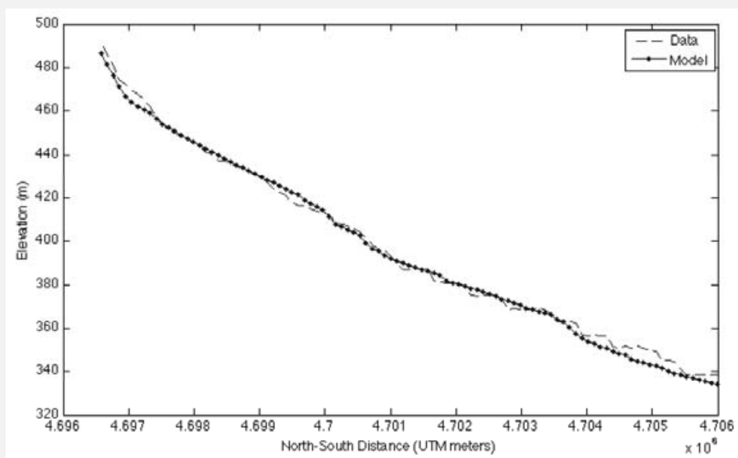


How can landscape erosion models be tested?

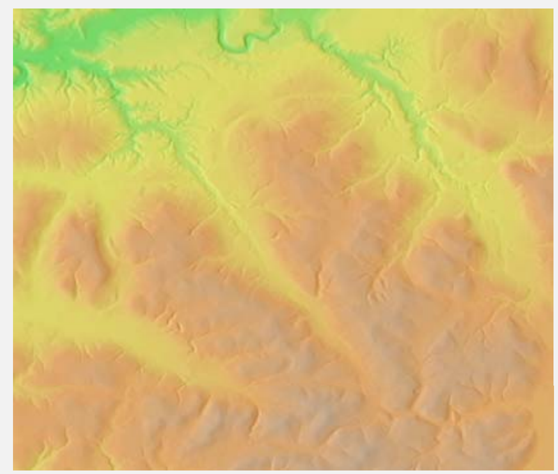
- Reproduce the modern landscape of Buttermilk Creek when run from the end of the last ice age to today
- Reproduce modern topography of a second watershed without re-calibration
- Predict erosion rates & patterns consistent with Studies 1-3



Buttermilk Creek basin



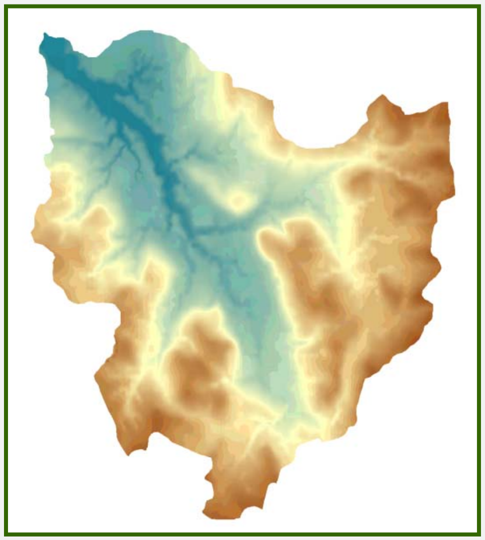
Longitudinal profile of Buttermilk Creek: real vs. modeled (from FEIS)



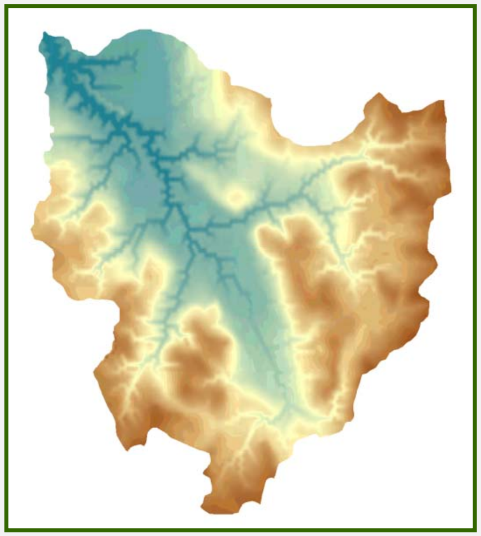
Connoisarauley Creek area

How can model uncertainty be assessed?

- Calibration and validation: what is the range of reasonable input values?
- Sensitivity analysis: how much does uncertainty in each parameter influence the forecast?



Buttermilk Creek

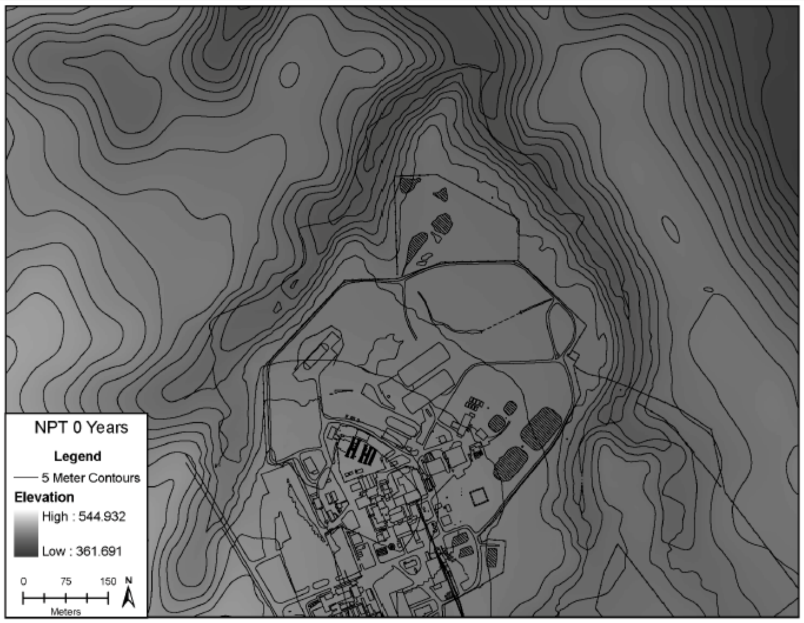


Best-Fit Model
(calibrated)

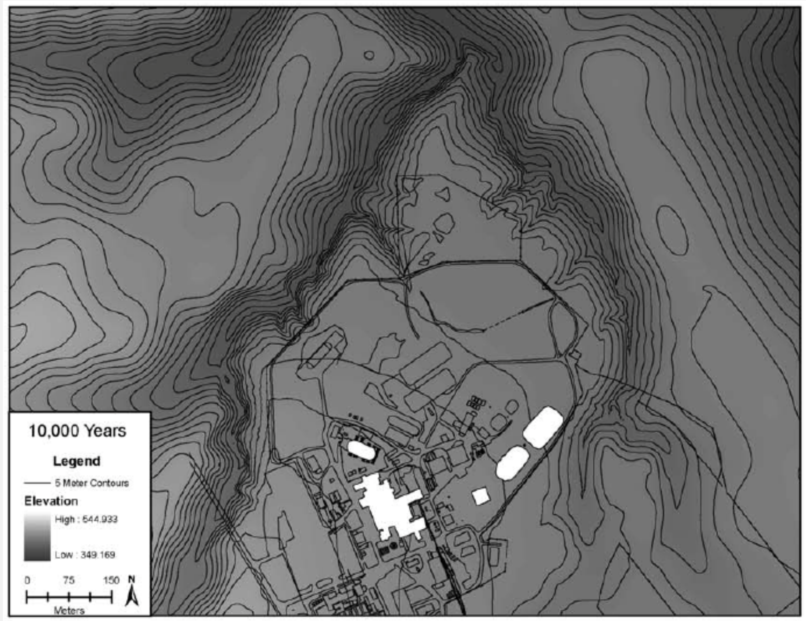
Poor-Fit Model
(unrealistically high erosion)

How would potential future erosion be calculated?

- Run model forward from present-day using best estimates for input data and parameter values
- Estimate uncertainty in projections by performing calculations with different sets of plausible inputs



North Plateau, Present day

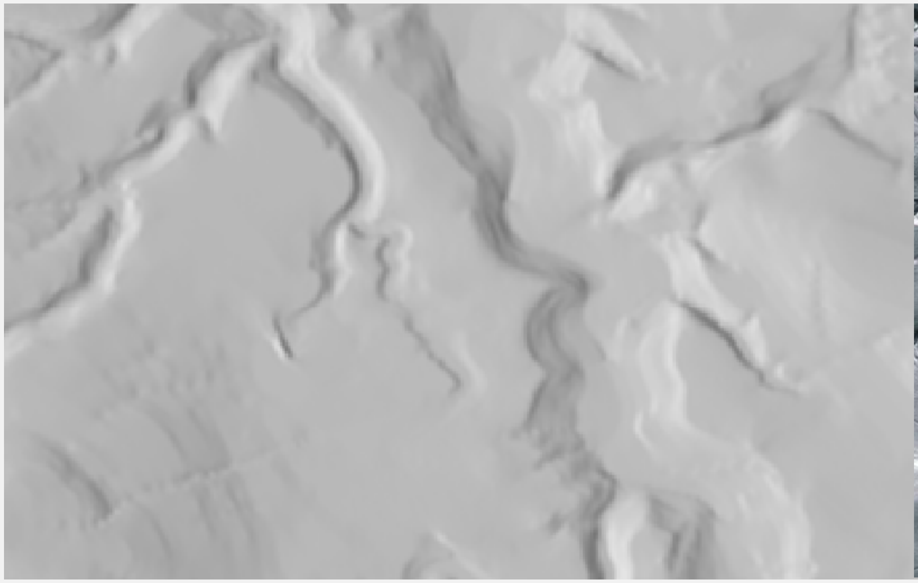


Future Erosion Scenario “NP2”

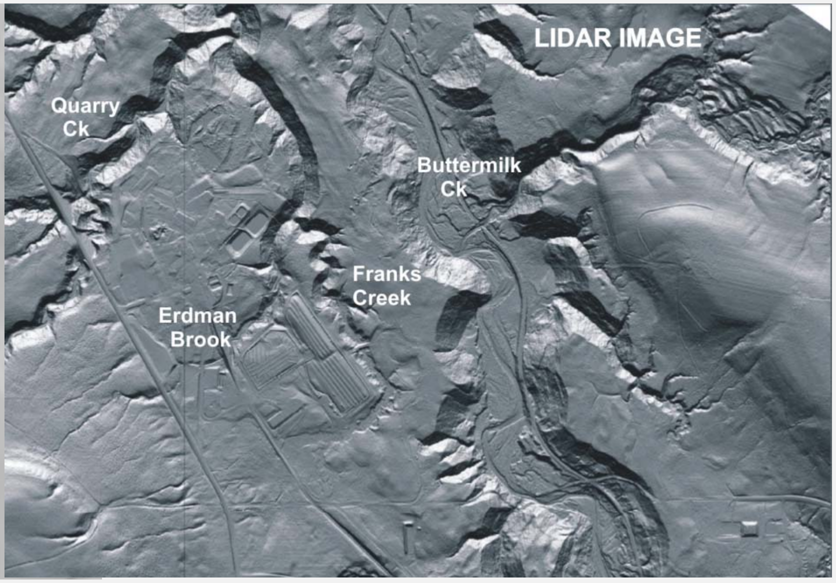
Study 4 – Model Refinement, Validation, and Improved Erosion Projections

Summary:

- Refining erosion model testing, calibration, and projection could reduce and better quantify uncertainty by taking advantage of new data from lidar and Studies 1-3



10-meter resolution digital elevation model



Lidar digital elevation model

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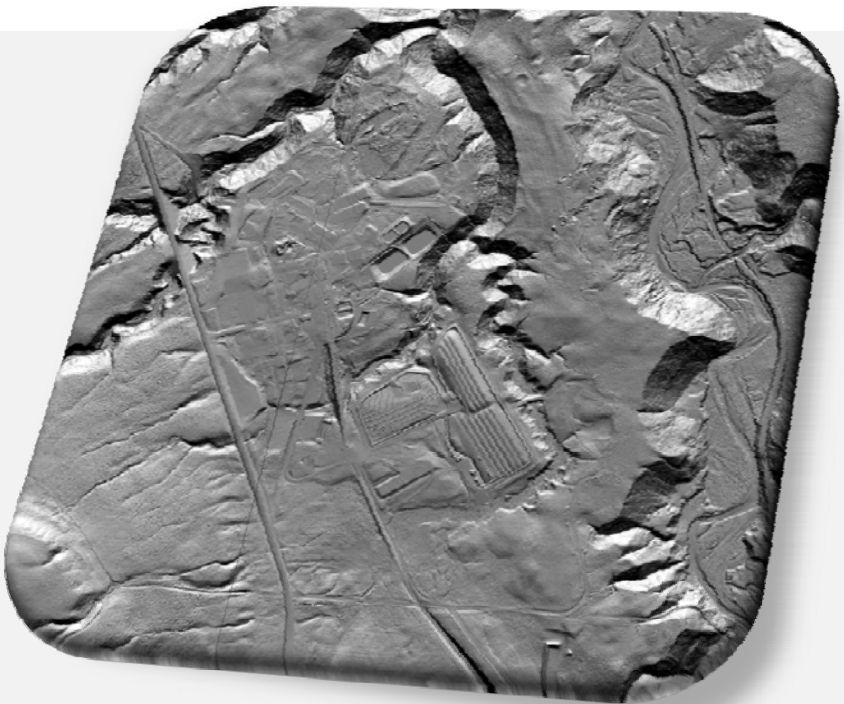
“In summary, the EWG recommends these studies because together they may improve the scientific defensibility of the assessment of long-term erosion effects based on converging lines of evidence that may reduce uncertainty, strengthen confidence in the results, and facilitate agency consensus.”



We Welcome Your Questions . . .