Discovering Landforms Using LiDAR

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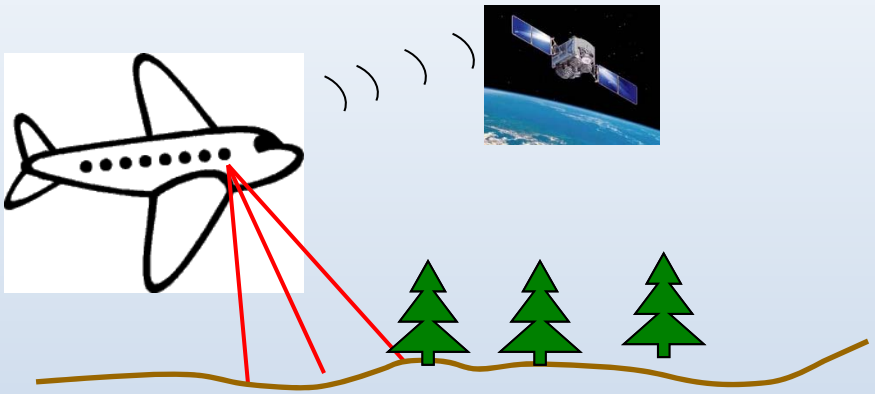
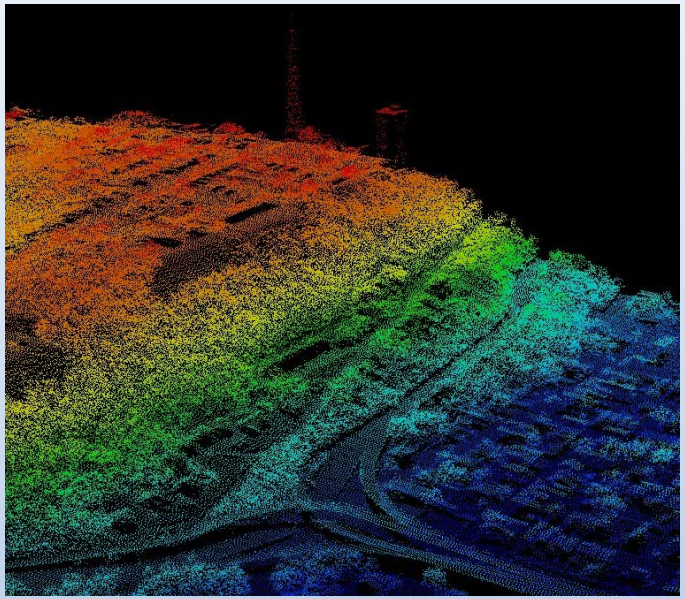
2014 Kentucky Geological Survey Annual Meeting

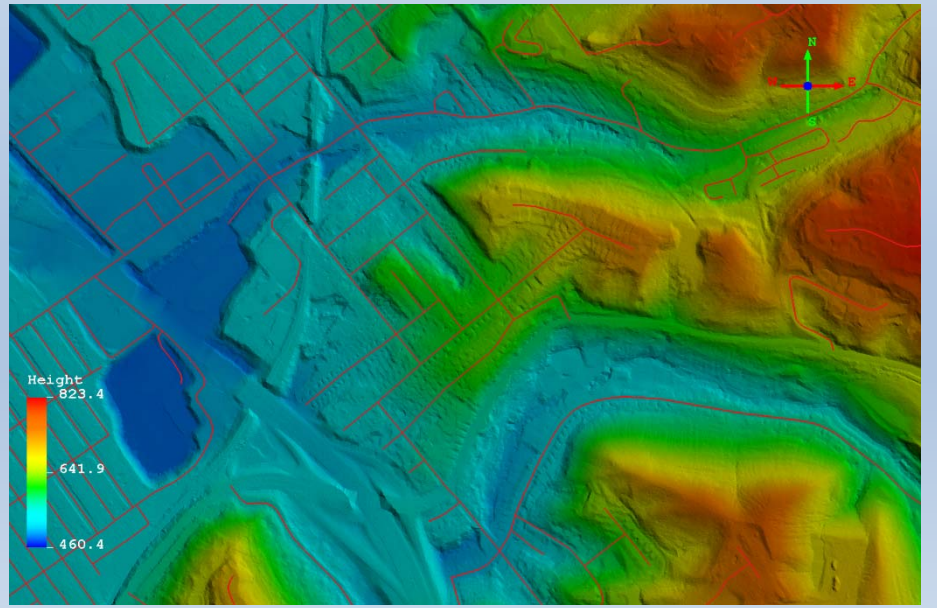
UNIVERSITY OF KENTUCKY
Kentucky Geological Survey

LiDAR – Light Detection and Ranging





- High resolution elevation data
- Laser pulses hitting the earth at random x, y, z points (**point cloud**)
- Multiple returns for one pulse allow filtering of non-ground hits, creating a **bare-earth model**
- 1.4 m H resolution and ability to create 2 ft. contours is typical

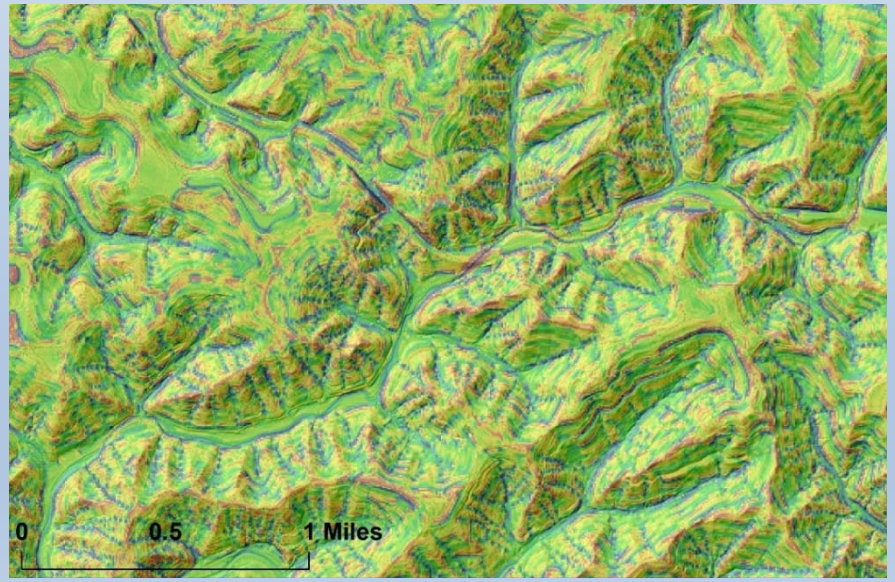


LiDAR and landforms

- Resolution: Typically, with 1 m spacing, expect to see something 10m wide on the ground. With 10m spacing, expect to see something 100m on the ground

- Bare-earth models, changes in illumination, time-lapse

- Geomorphic derivatives:
  - Elevation/contours
  - Slope
  - Curvature
  - Roughness
  - Wetness index



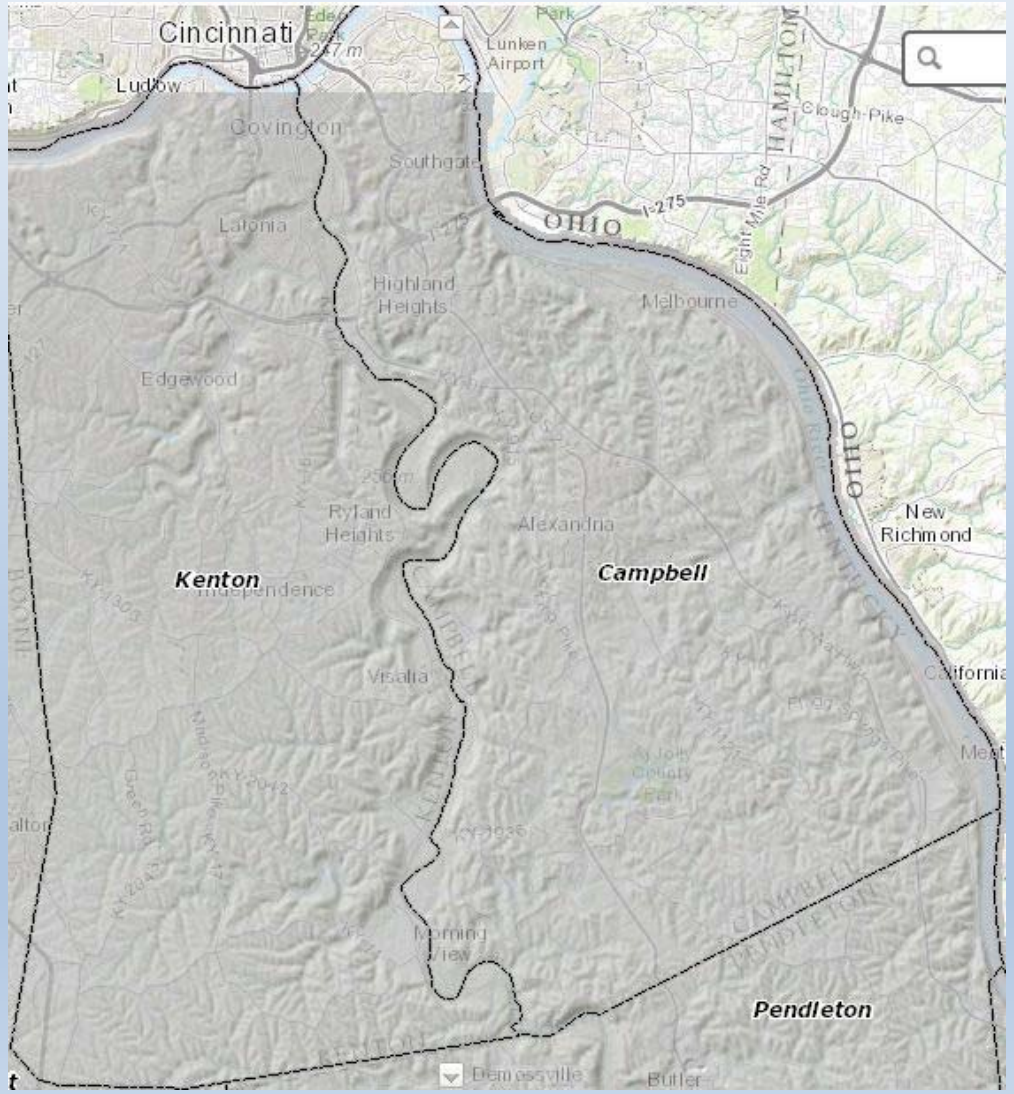
- What combinations are most useful to your task?

Example applications / KGS research

- Landslide mapping
- Earthquake hazards/fault identification
- Geologic mapping

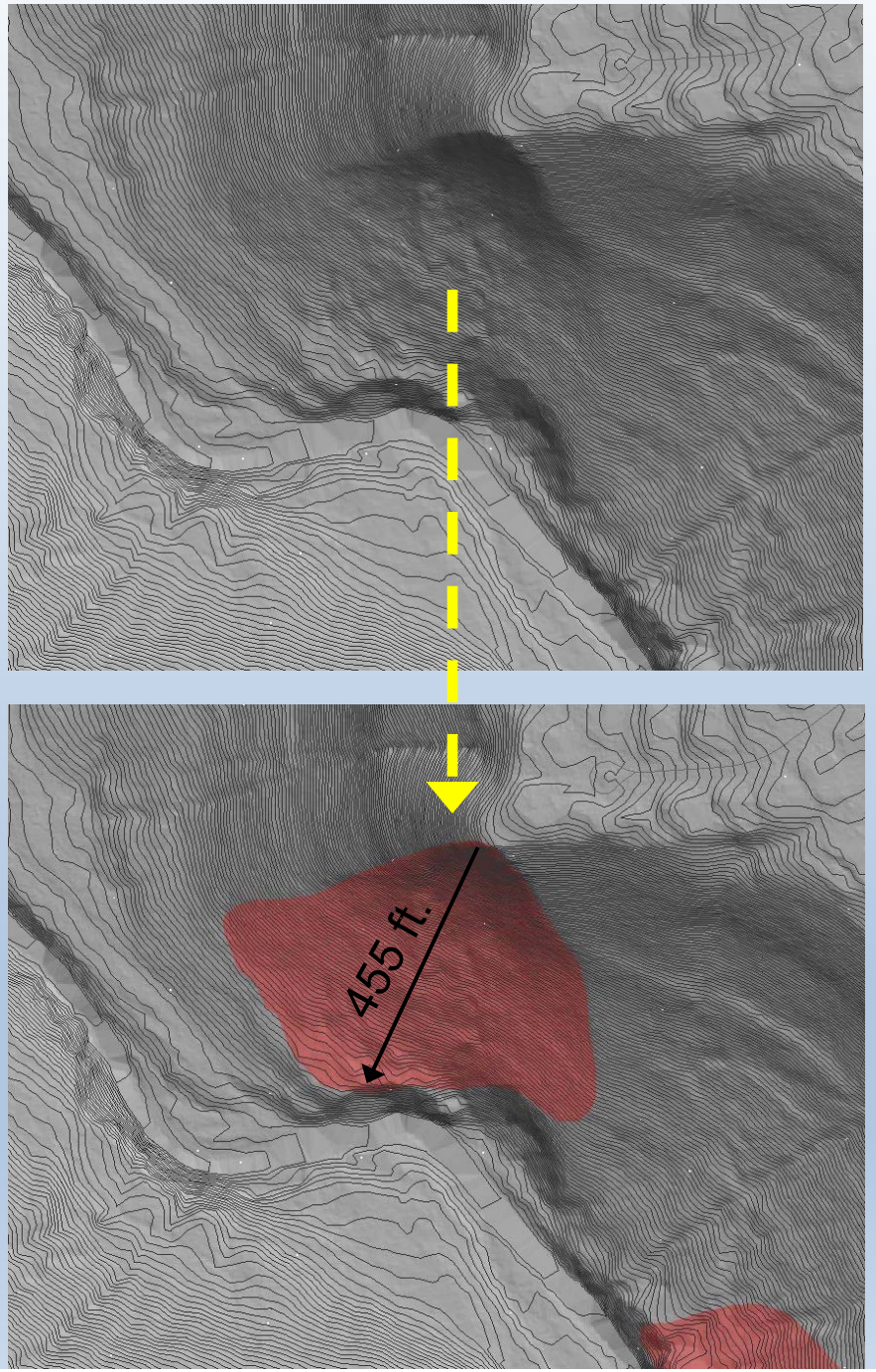
Landslide Mapping

Landslide mapping using LiDAR in Kenton and Campbell Counties

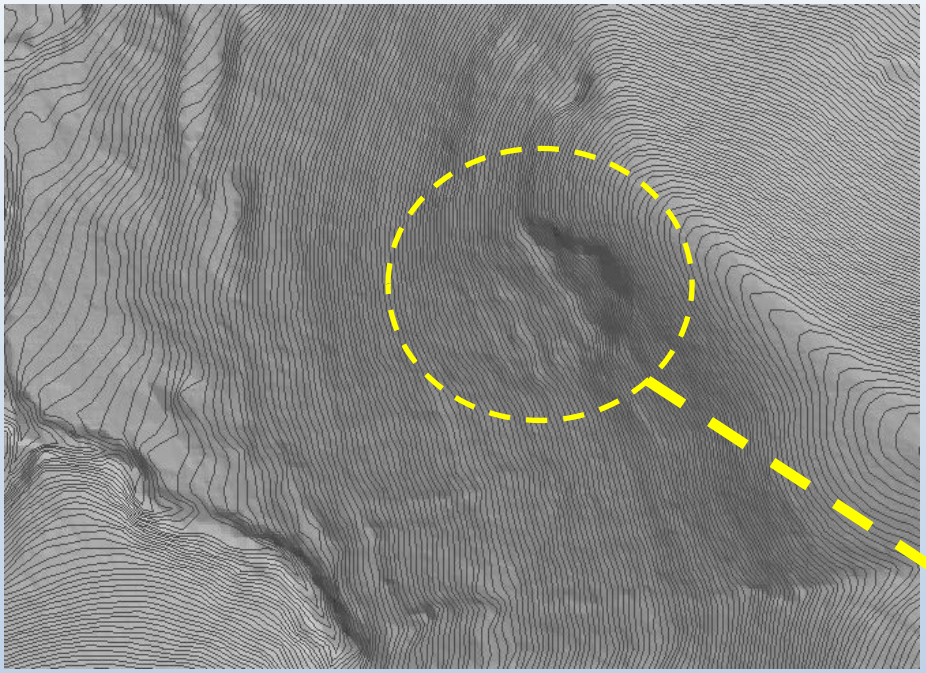


Landslide mapping

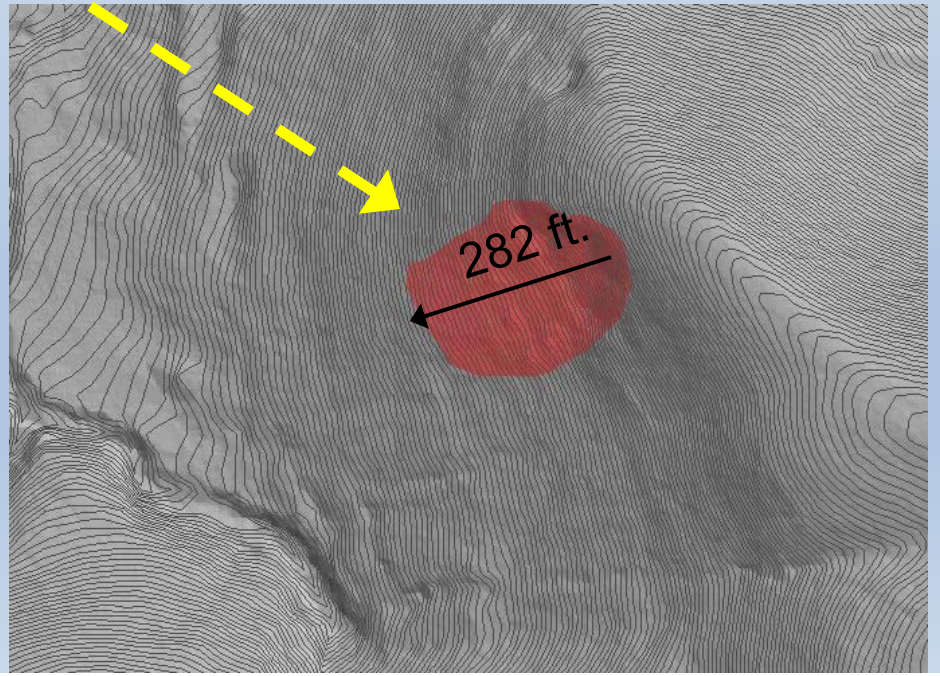
- Used Applied Imagery's Quick Terrain Modeler to create bare earth hillshade DEM's from LAS files
- Used ArcMap for visualization, spatial analysis, and digitization
- Systematic panning looking for
  - Hummocky surface
  - Steep scarp, flanks
  - Thick toe
  - Concavity
- **230 potential landslide extents digitized (polygons)**



Landslide mapping



LiDAR derived hillshade DEM with contours

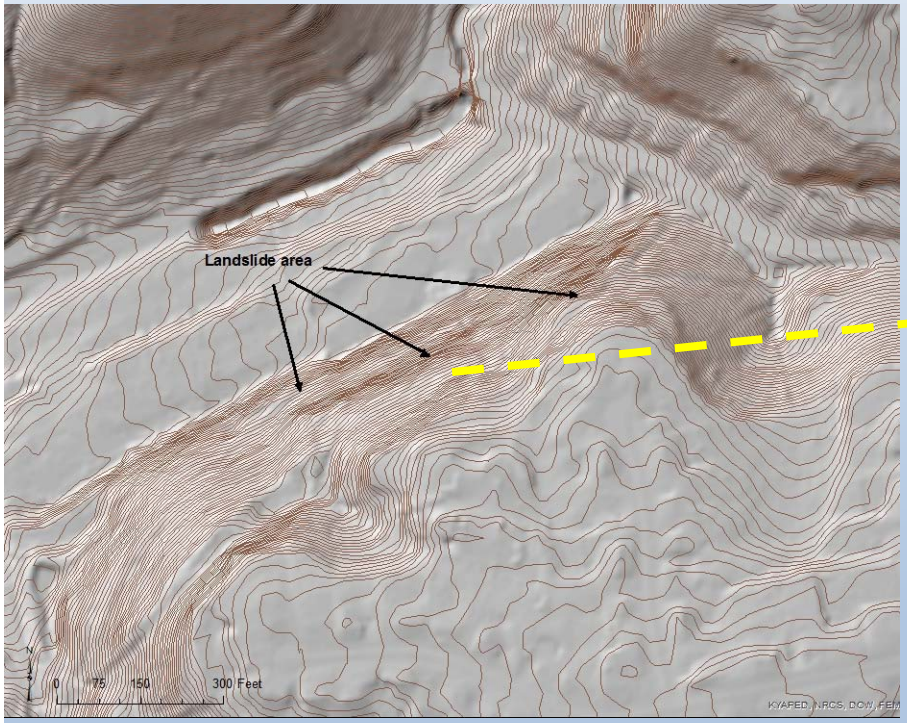


Mapped landslide

Why is landslide mapping important?

Preexisting slides are susceptible to subsequent failure!

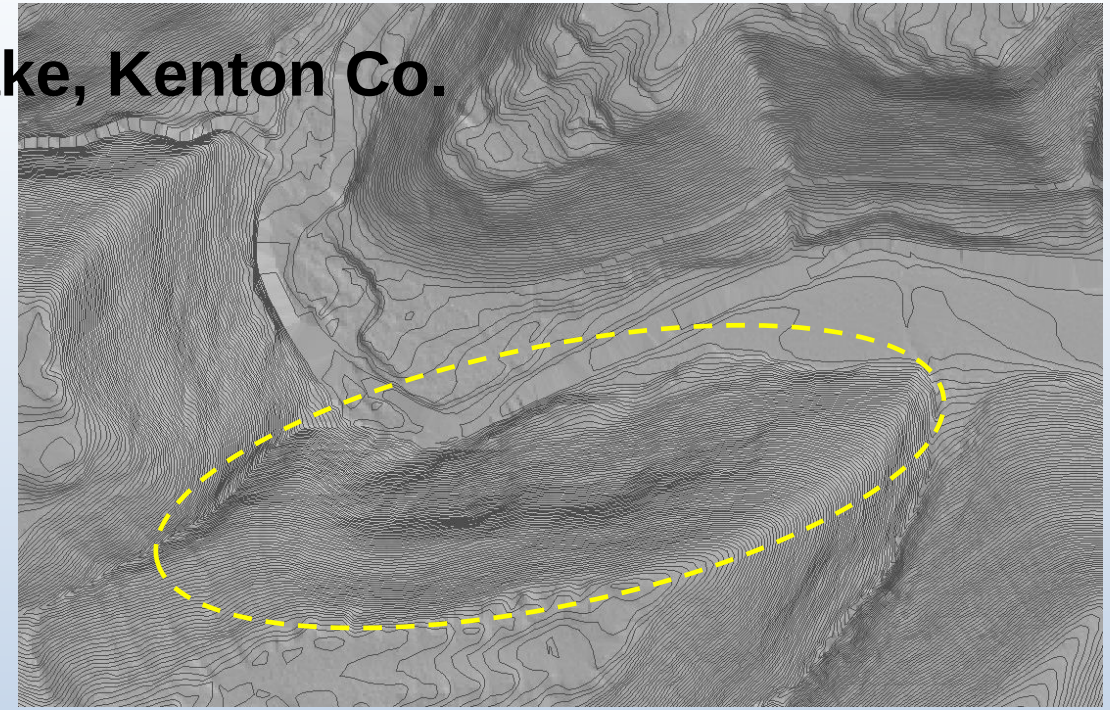
Bellevue, KY., Campbell Co

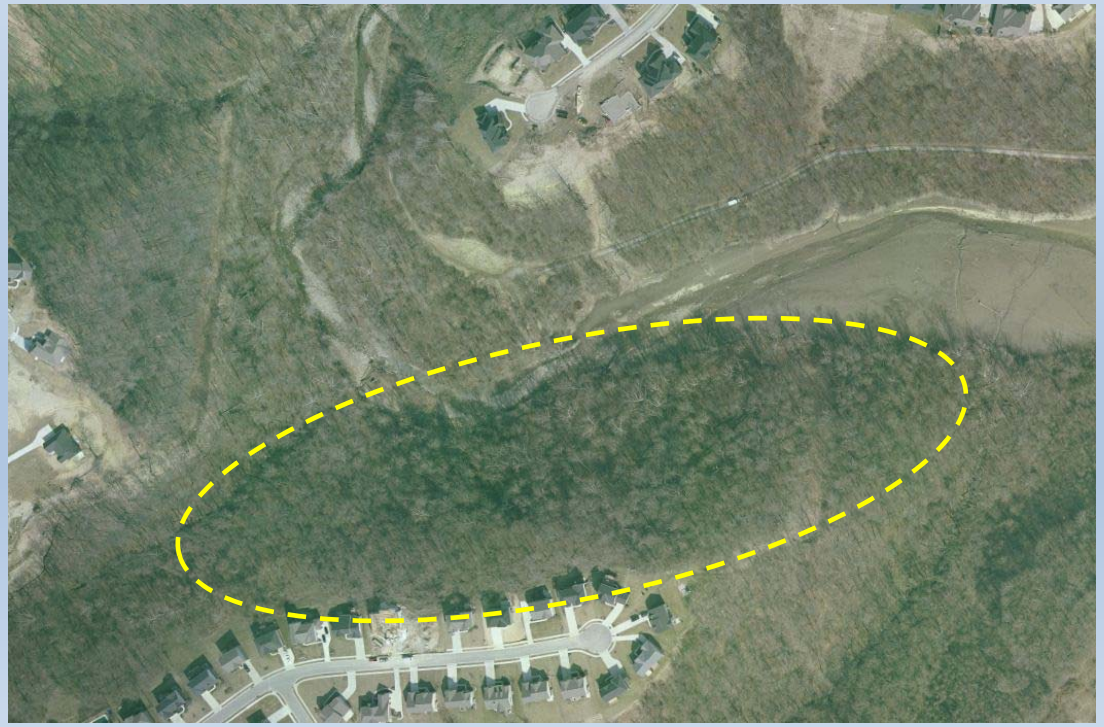


December 2011

Bellevue, KY. Campbell Co.
Mudslide/debris flow

Doe Run Lake, Kenton Co.



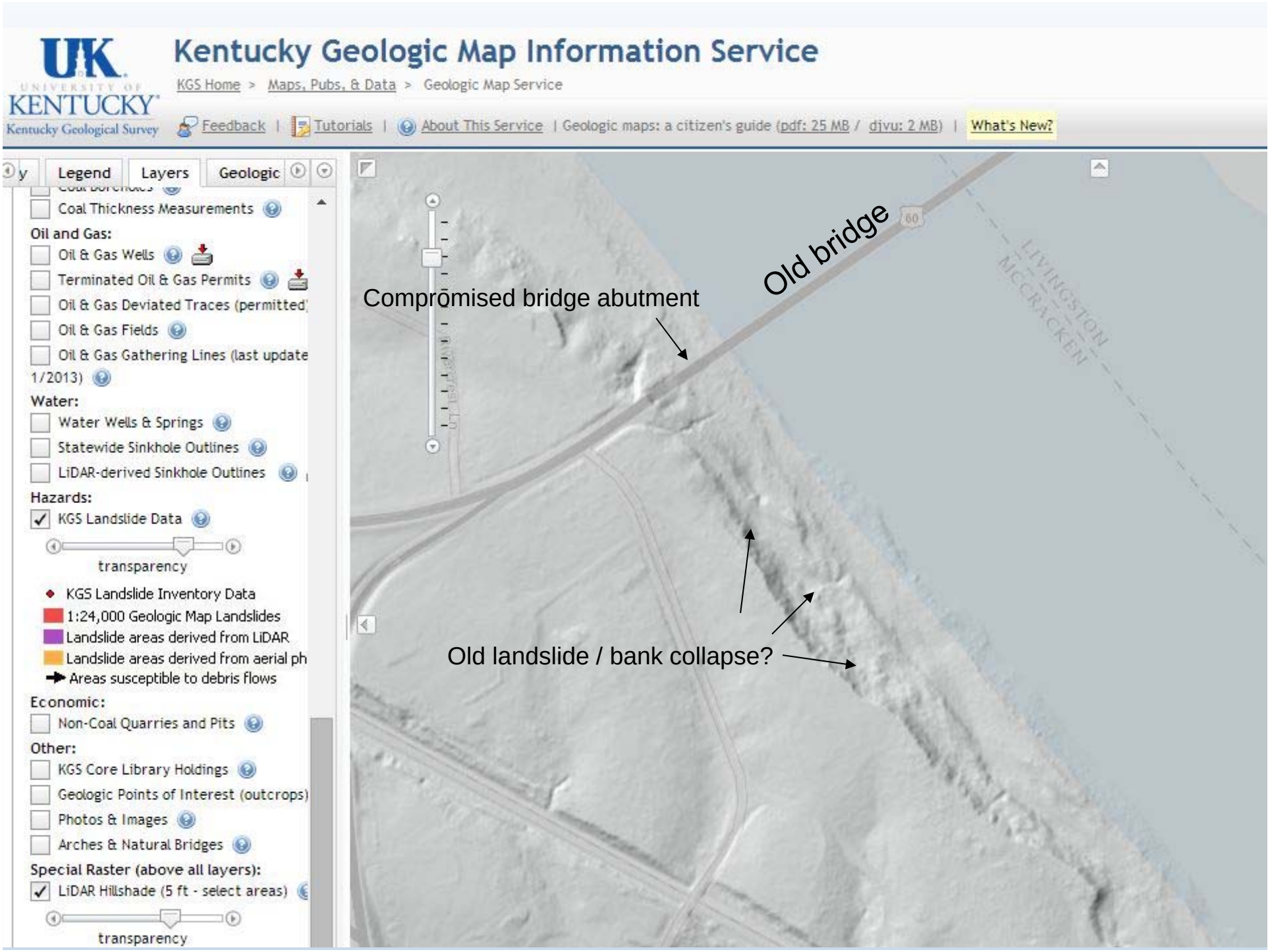


Doe Run Lake, Kenton Co.

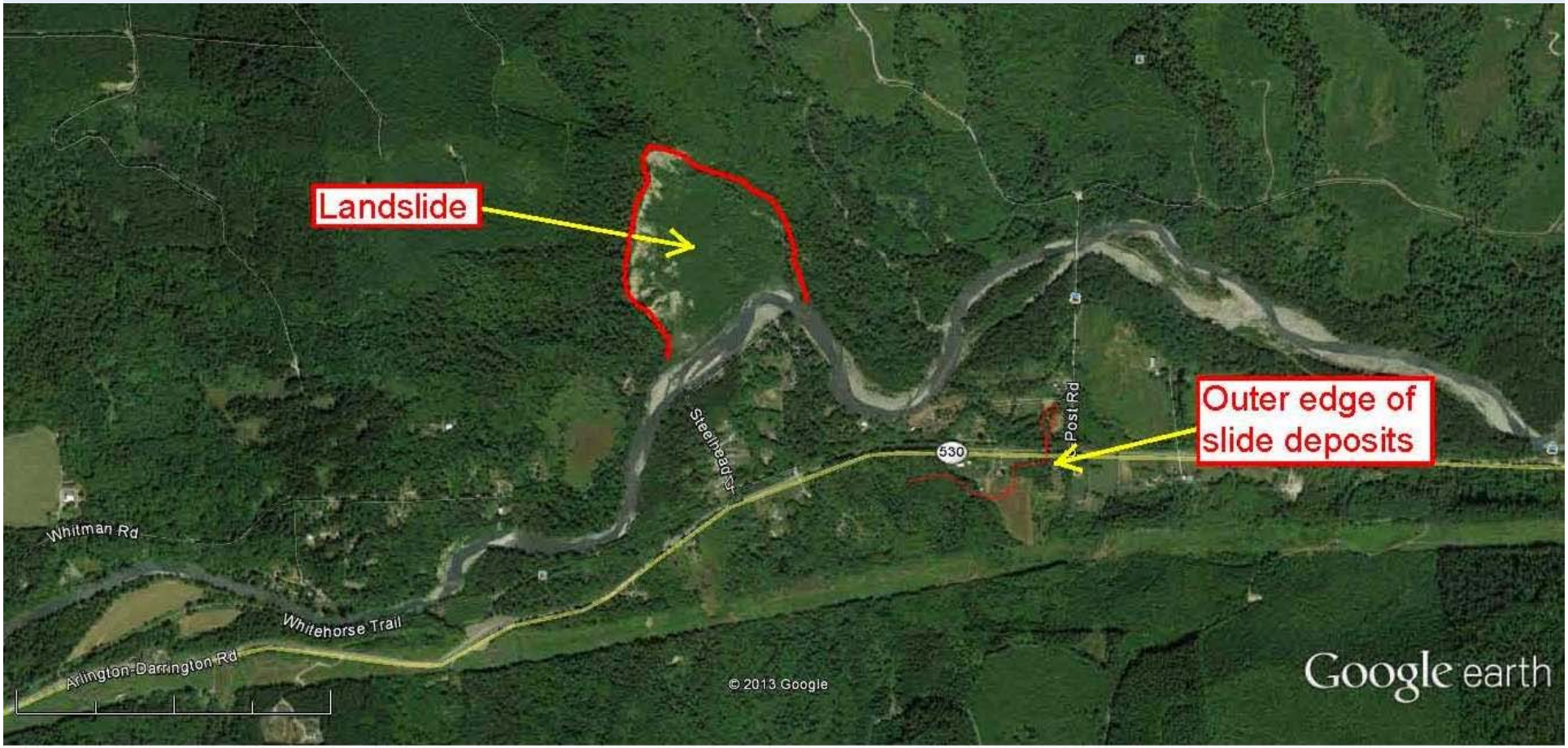
Old Ledbetter Bridge, McCracken Co.

Source: Darrom W. Keith

Source: Scott Waninger, KGS


Kentucky Geologic Map Information Service
KGS Home > Maps, Pubs, & Data > Geologic Map Service
Feedback | Tutorials | About This Service | Geologic maps: a citizen's guide (pdf: 25 MB / djvu: 2 MB) | What's New?
Legend
Layers
Geologic
Coal Thickness Measurements
Oil and Gas:
Oil & Gas Wells
Terminated Oil & Gas Permits
Oil & Gas Deviated Traces (permitted)
Oil & Gas Fields
Oil & Gas Gathering Lines (last update 1/2013)
Water:
Water Wells & Springs
Statewide Sinkhole Outlines
LiDAR-derived Sinkhole Outlines
Hazards:
KGS Landslide Data
transparency
KGS Landslide Inventory Data
1:24,000 Geologic Map Landslides
Landslide areas derived from LiDAR
Landslide areas derived from aerial ph
Areas susceptible to debris flows
Economic:
Non-Coal Quarries and Pits
Other:
KGS Core Library Holdings
Geologic Points of Interest (outcrops)
Photos & Images
Arches & Natural Bridges
Special Raster (above all layers):
LiDAR Hillshade (5 ft - select areas)
transparency
Compromised bridge abutment
Old bridge
Old landslide / bank collapse?
60
LIVINGSTON
MCCRACKEN

Oso, WA Landslide



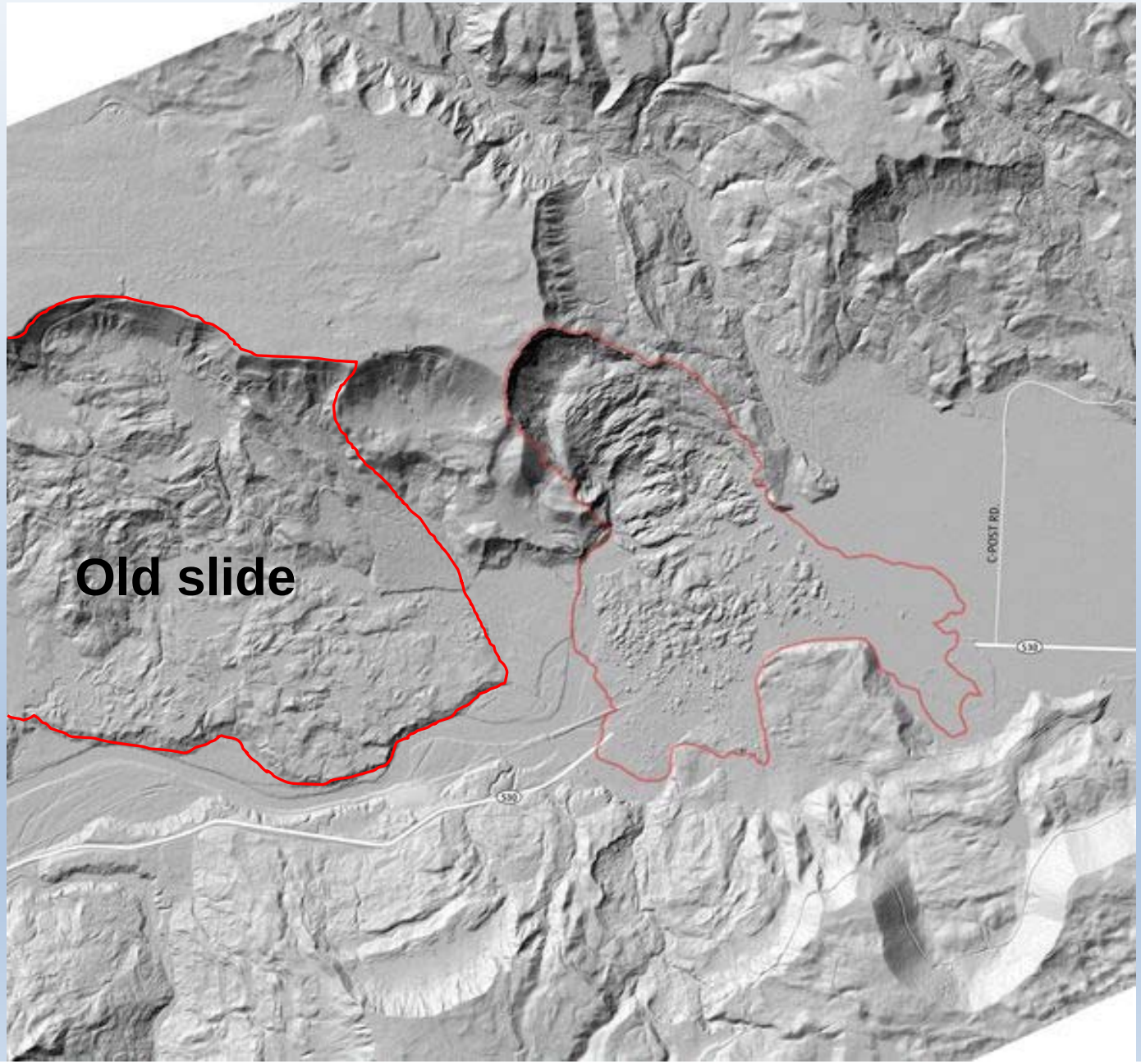
Google earth

miles 1
km 2

Oso, WA Landslide – March 22, 2014

Source: BBC/AP

Oso, WA Landslide – March 2014 LiDAR hillshade

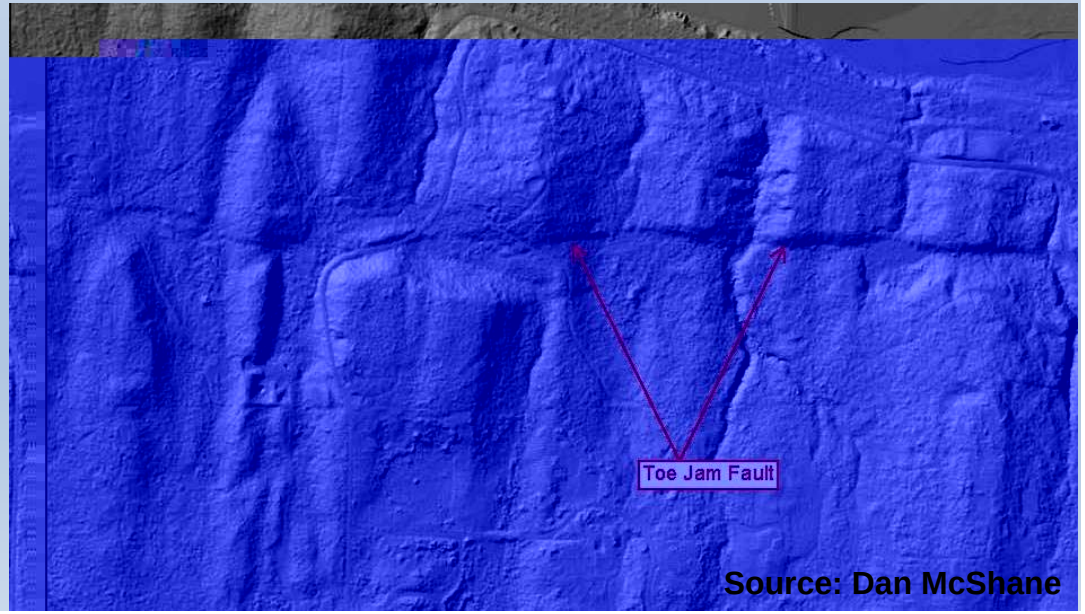


Earthquake Hazards / Fault Identification

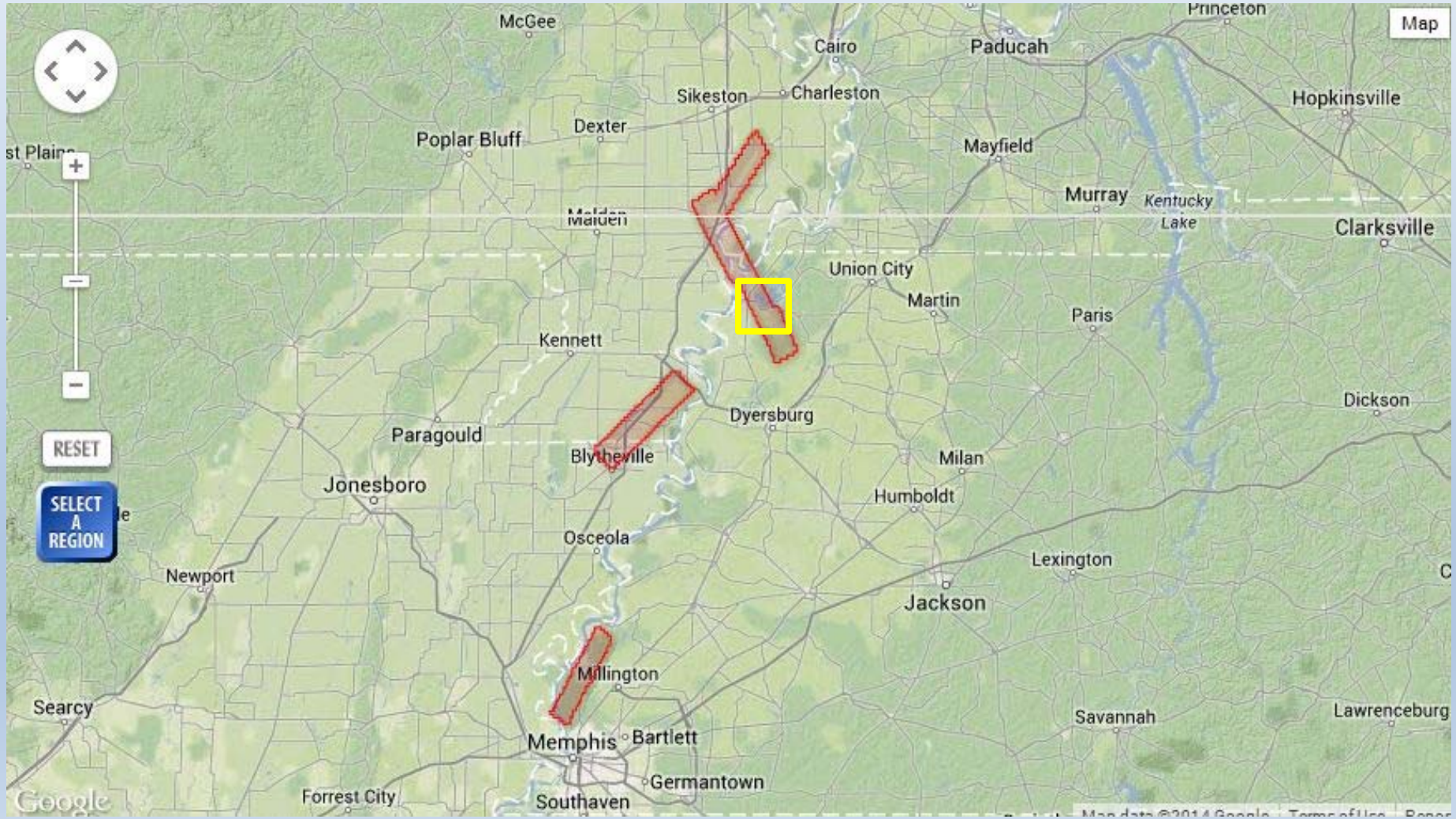
Earthquake Hazards / Fault ID

- Fault scarp detection in areas of dense vegetation
- Sense of motion or deformation
- Change detection/ground displacement caused by earthquakes

Fault ID in western Washington

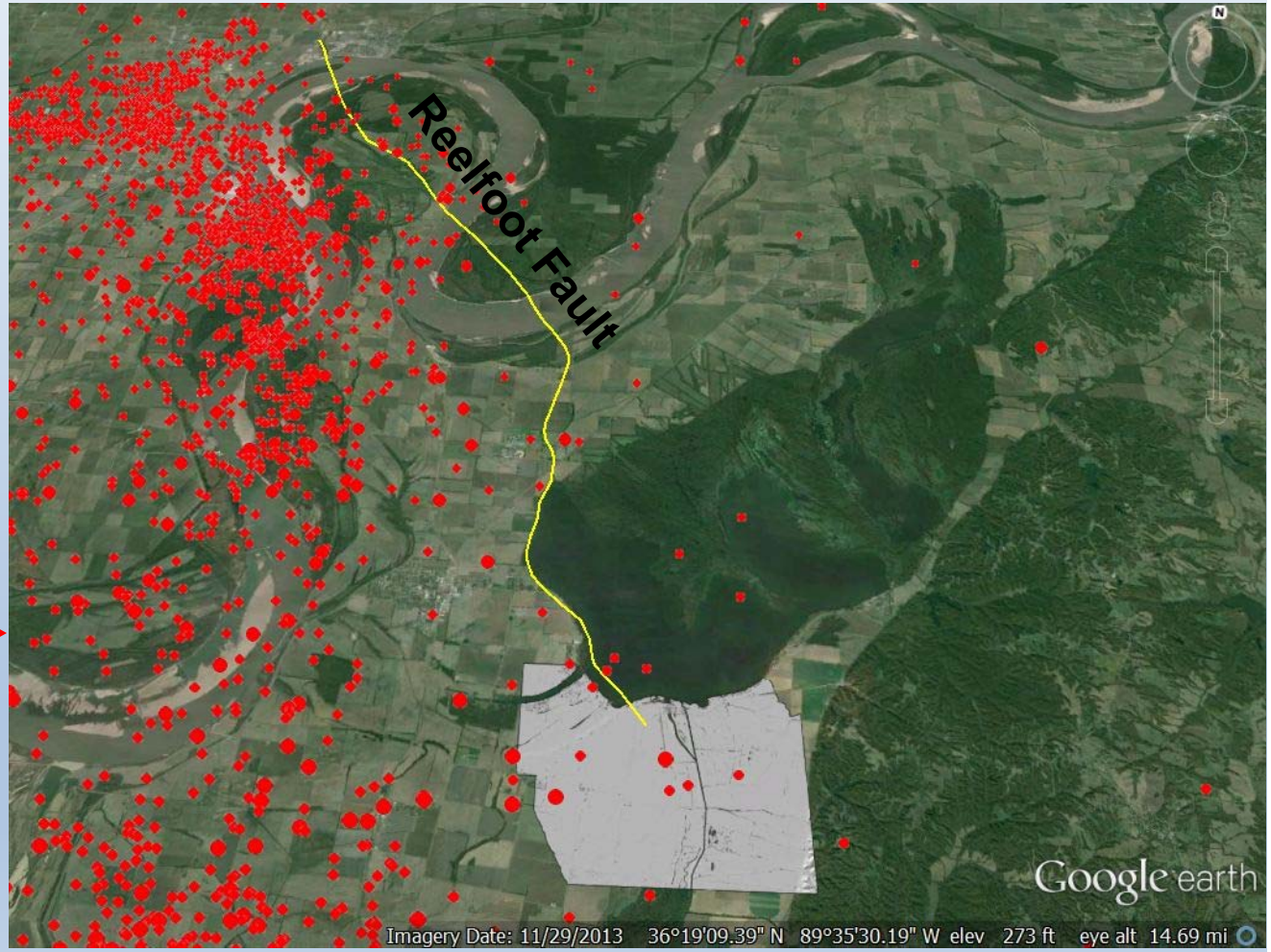


- Central U.S. LiDAR, New Madrid Seismic Zone
- Target areas developed by USGS and regional scientists
- Targets include the Blythville Arch, Meeman-Shelby lineament, and the Reelfoot scarp



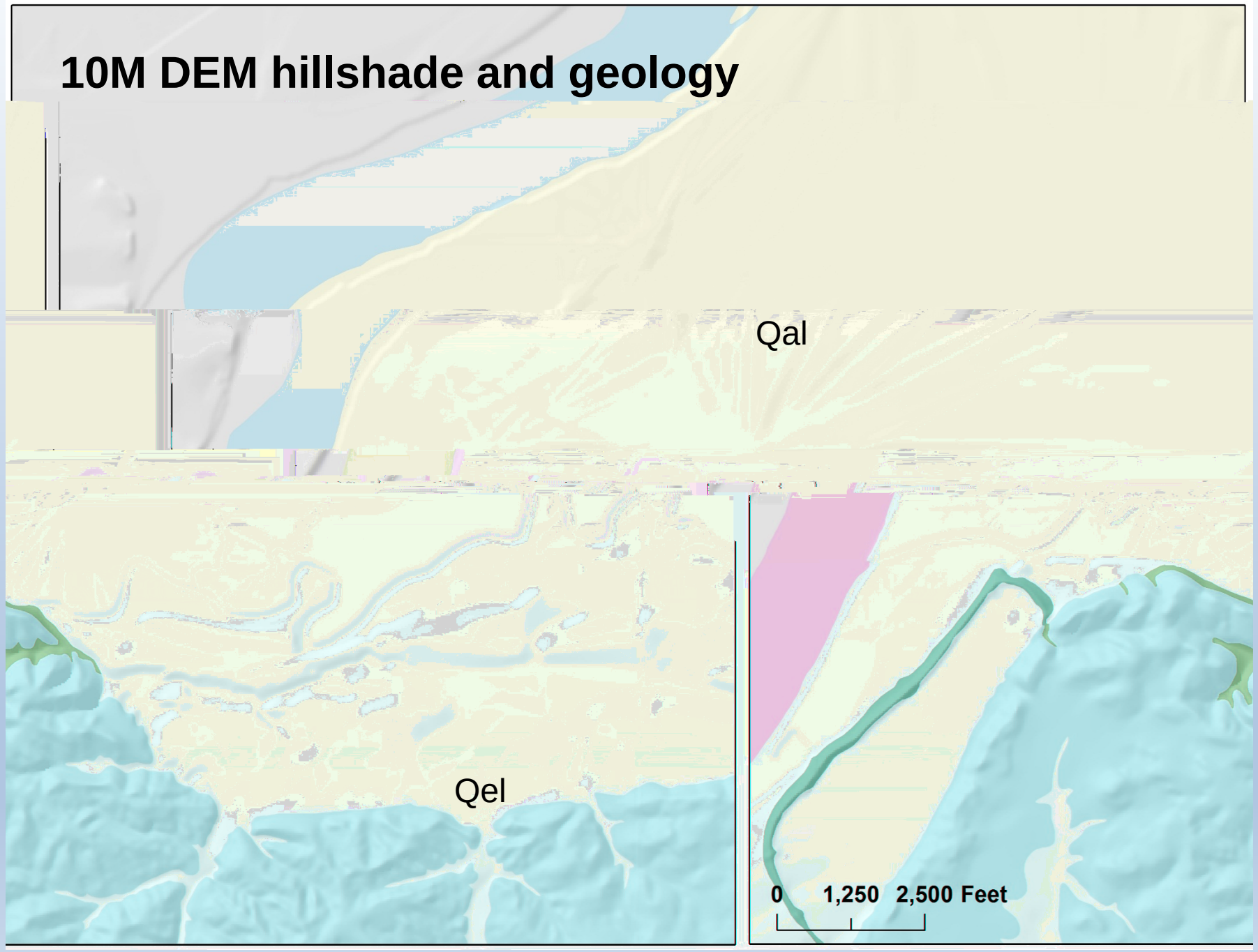
Earthquake Hazards / Fault ID

- Point cloud data, ground class
- DEMS (GeoTiff, Arc ASCII grids)
- Hillshade
- Google Earth →

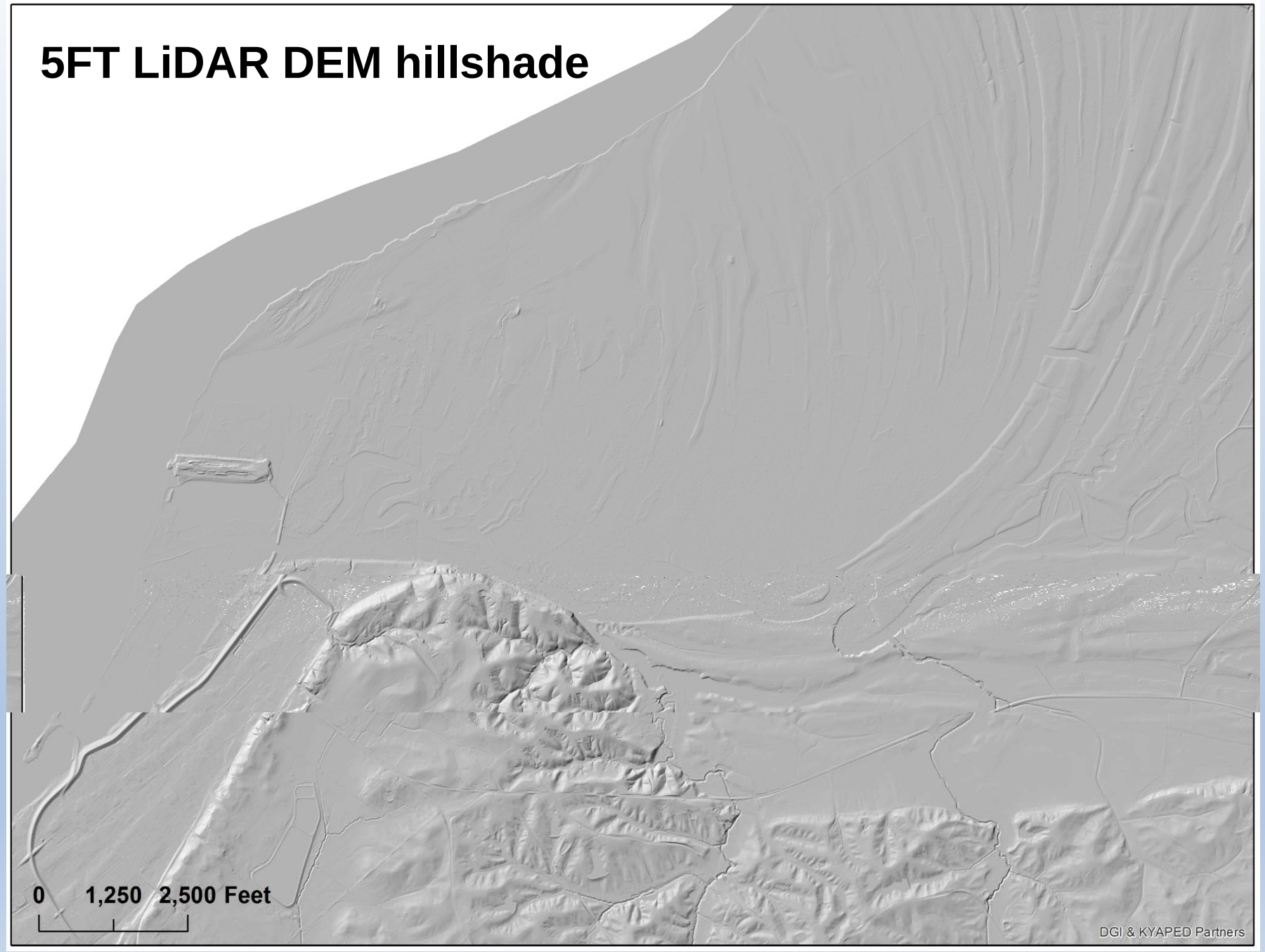


Geologic Mapping

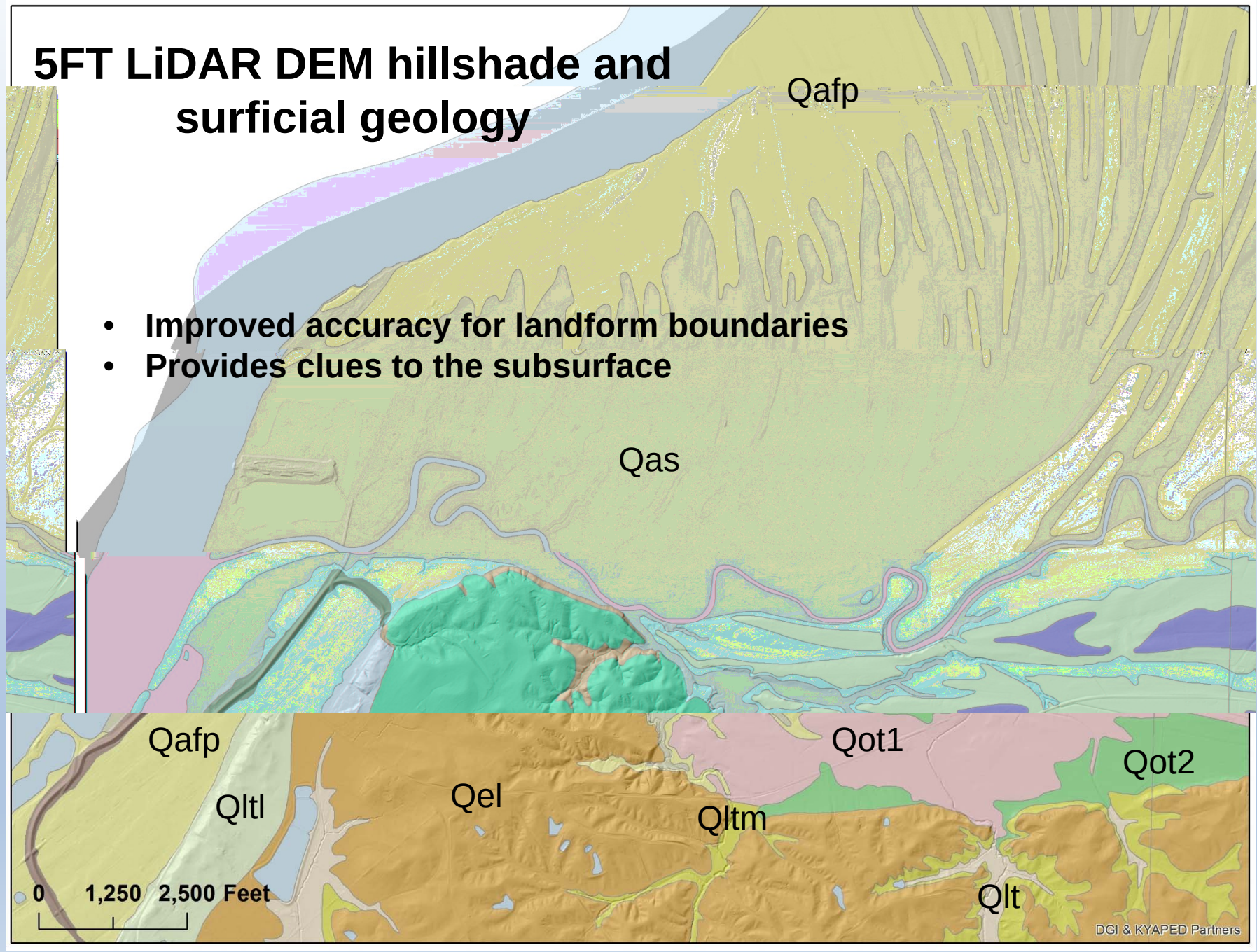
10M DEM hillshade and geology



5FT LiDAR DEM hillshade



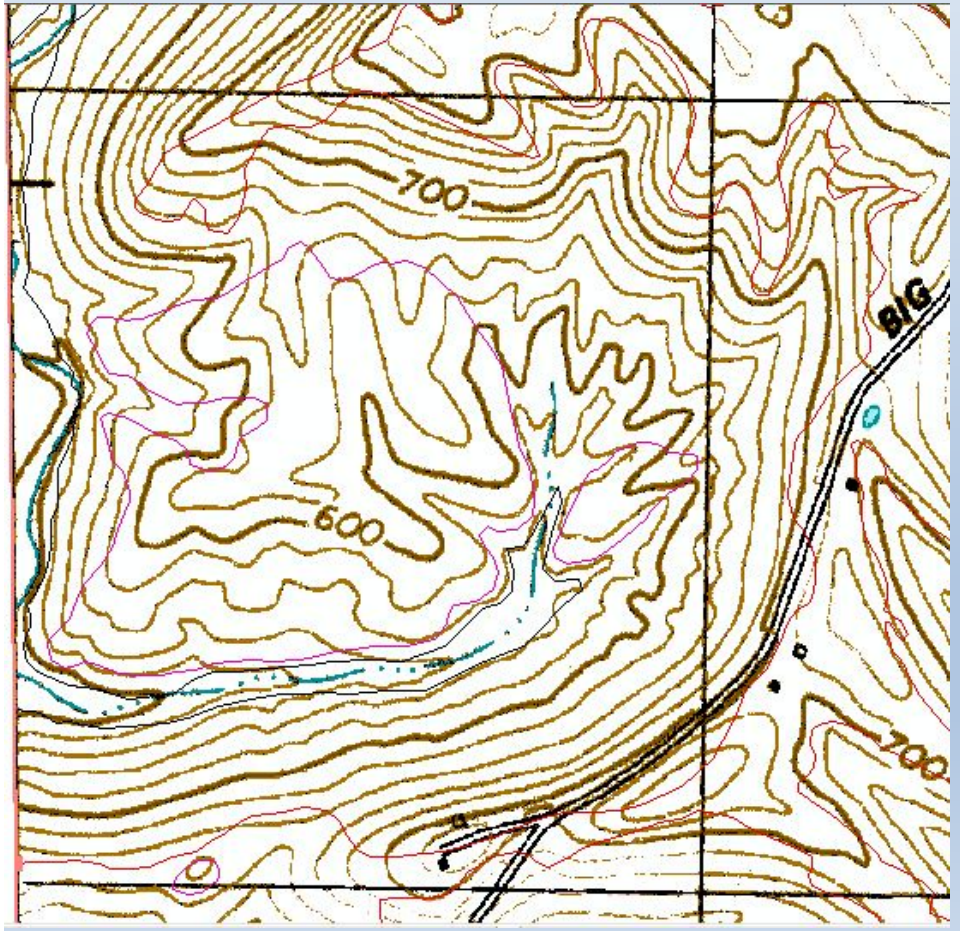
5FT LiDAR DEM hillshade and surficial geology



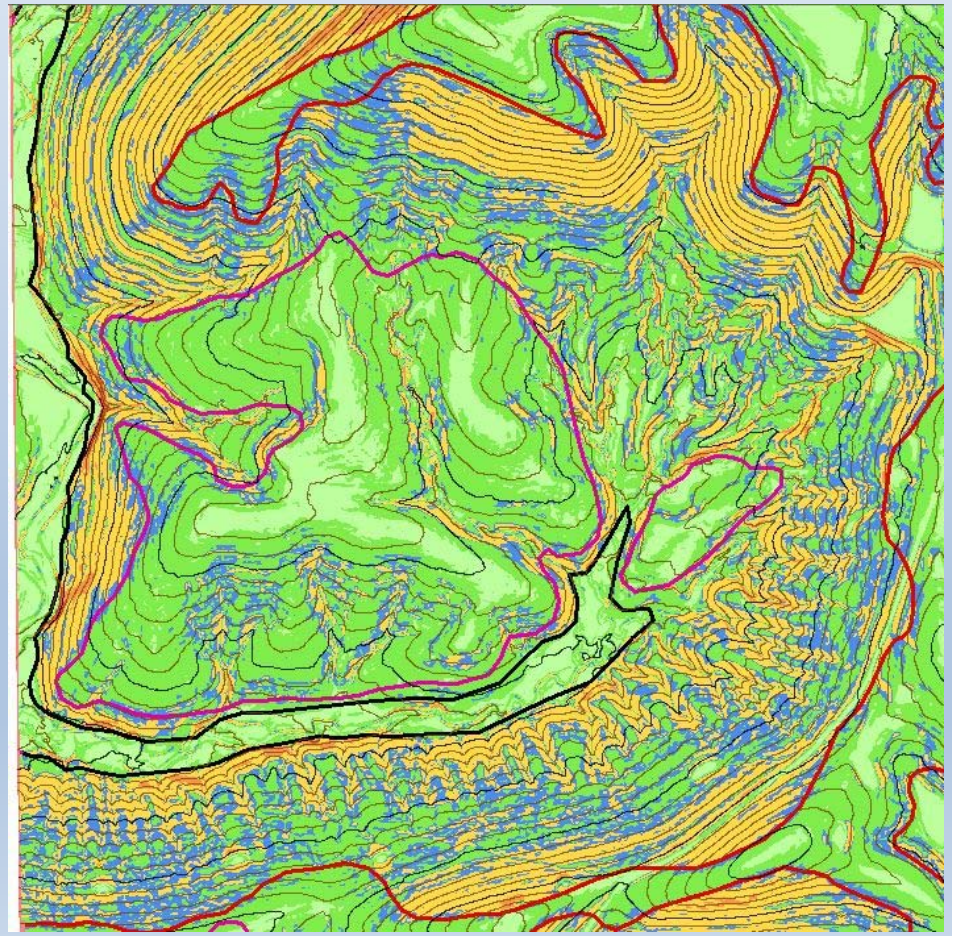
- **Improved accuracy for landform boundaries**
- **Provides clues to the subsurface**

LiDAR used to create slope maps and detailed contour lines, which helps to distinguish detailed map units.

1:24,000-scale topo map



Slope and contours generated from LiDAR



From USGS 3D Elevation Program (3DEP). Conservative benefits estimates for businesses use of 3DEP for **Kentucky**

Rank	Business use	Annual benefits (millions)
1	Agriculture and precision farming	$1.73
2	Natural resources conservation	1.54
3	Flood risk management	1.33
4	Infrastructure and construction management	0.62
5	Forest resources management	0.20
6	Geologic resource assessment and hazard mitigation	0.14
7	Aviation navigation and safety	0.07
8	Renewable energy resources	0.03
9	River and stream resource management	0.01
10	Coastal zone management	0.01
	Other	0.01
	Total	5.69

Source: USGS Fact Sheet 2014-3012

Thank you!

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