KGS roots go back to 1838

• 1815 William Smith publishes his geological map of England… the map that changed the world.
• 1830-1833 Charles Lyell publishes *Principles of Geology* in three volumes
• 1838-1839 William Williams Mather conducts the first geological survey of Kentucky
• 1854 David Dale Owen becomes the first State Geologist of Kentucky
• 1859 Darwin publishes *The Origin of Species*
• 1948 KGS joins the University of Kentucky by virtue of Kentucky Acts Ch. 224, Sec. 3
• 2016 The 13th geological survey of Kentucky begins
From the 2017 KGS strategic plan

• …significantly strengthen or develop new KGS expertise in fields such as quantitative spatial analysis, geostatistics, machine learning, cloud computing, public health, natural resource and environmental economics, mathematical modeling of geologic processes, and remote sensing.

• …become the recognized center of expertise for the application and integration of airborne laser scanner (LiDAR) data in support of geologic, engineering, and environmental projects in Kentucky.

• …become a nationally and internationally recognized leader in the development and distribution of 3D and 4D geologic data and maps at a variety of scales and relevant to topics of societal and economic benefit to Kentucky.
Kentucky is rich in geo-data and geo-knowledge

- Complete digital 1:24,000 geologic quadrangle coverage
- Many thematic map layers
  - Dominant lithology
  - Karst potential
  - Oil and gas information
  - Coal information
  - Non-coal economic geology
  - Landslide locations
  - Faults and structure contours
  - Soil survey coverage (SSURGO)
- Borehole, outcrop, seismic, water data
- Nearly complete airborne LiDAR coverage
- HOW DO WE PULL IT TOGETHER?
Airborne LiDAR—much more than contours!
LiDAR to visualize and understand landscapes
LiDAR landslide detection (2007 data)
LiDAR landslide detection (2012 data)
2012-2007 LiDAR land surface difference

New landslide

Elevation Change (Feet)
-13.6 -5.0
-5.0 -1.0
-1.0 - 1
1.0 - 5.0
5.0 - 19.6

Feet

0 250 500 1,000
Double Gaussian bias and noise reduction
Physics based hazard assessment with LiDAR DEMs

Weppner et al (2008, AGU)

- FOSM approximation of infinite slope FS mean ± sd
- Lognormal Prob FS < 1
- β-PERT and extreme value input distributions for this project
- Pore pressure is a random variable for each geotech unit

Weppner et al (2008, AGU)
Scenario evaluation

Weppner et al (2008, AGU)
Seismic slope stability

Prob [50 cm < Dn < 200 cm]

- 0 - 0.50
- 0.50 - 1
- Building
- Scarp
- Rivulet

Meters

0 125 250 500
Debris flow modeling

Scenario 1
$\tau_v = 16000 \text{ Pa}$

Scenario 2
$\tau_v = 12000 \text{ Pa}$

Scenario 3
$\tau_v = 8000 \text{ Pa}$

Max flow velocity (m/s)
- 0 - 5
- 5 - 10
- 10 - 15
- 15 - 20
- 20 - 25
- 25 - 30
- 30 - 35
- 35 - 40
- 40 - 45
- 45 - 50
- 50 - 55
- 55 - 60
- 60 - 65
- 65 - 70
- 70 - 75
- 75 - 80
- 80 +
Earthquake scenario modeling
LiDAR based karst terrain and sinkhole mapping
LiDAR and machine learning for sinkhole mapping
Structural geology with LiDAR
Seafloor ice gouge depth distribution
Applications to other fields: archeology

Camp Nelson
Incised meander plateau
Superimposed karst features

Serpent mound data source: OSIP
Applications to other fields: route selection
Application to other fields: indoor radon potential
Digital outcrop modeling
Digital outcrop modeling
Virtual mapping of individual features
Virtual mapping of individual features
Automated selection based on pre-defined criteria
Digital Earth Analysis Lab

- Dedicated mini-tower workstations
- 34” curved 4K displays
- 80” ultra-HD touchscreen display with dedicated server for interactive group work
- Ergonomic work desks and chairs
- MMRB high-speed internet connection
- **Cloud solutions for storage and computing**
  - Terabyte class virtual workstations
- LiDAR point cloud, terrain modeling, remote sensing, digital photogrammetry, virtual mapping, and other advanced software
- UK-wide collaboration with CSC and others