

# Landslide Inventory Mapping in Eastern Kentucky

Alexandra N. Arimes and Matthew M. Crawford



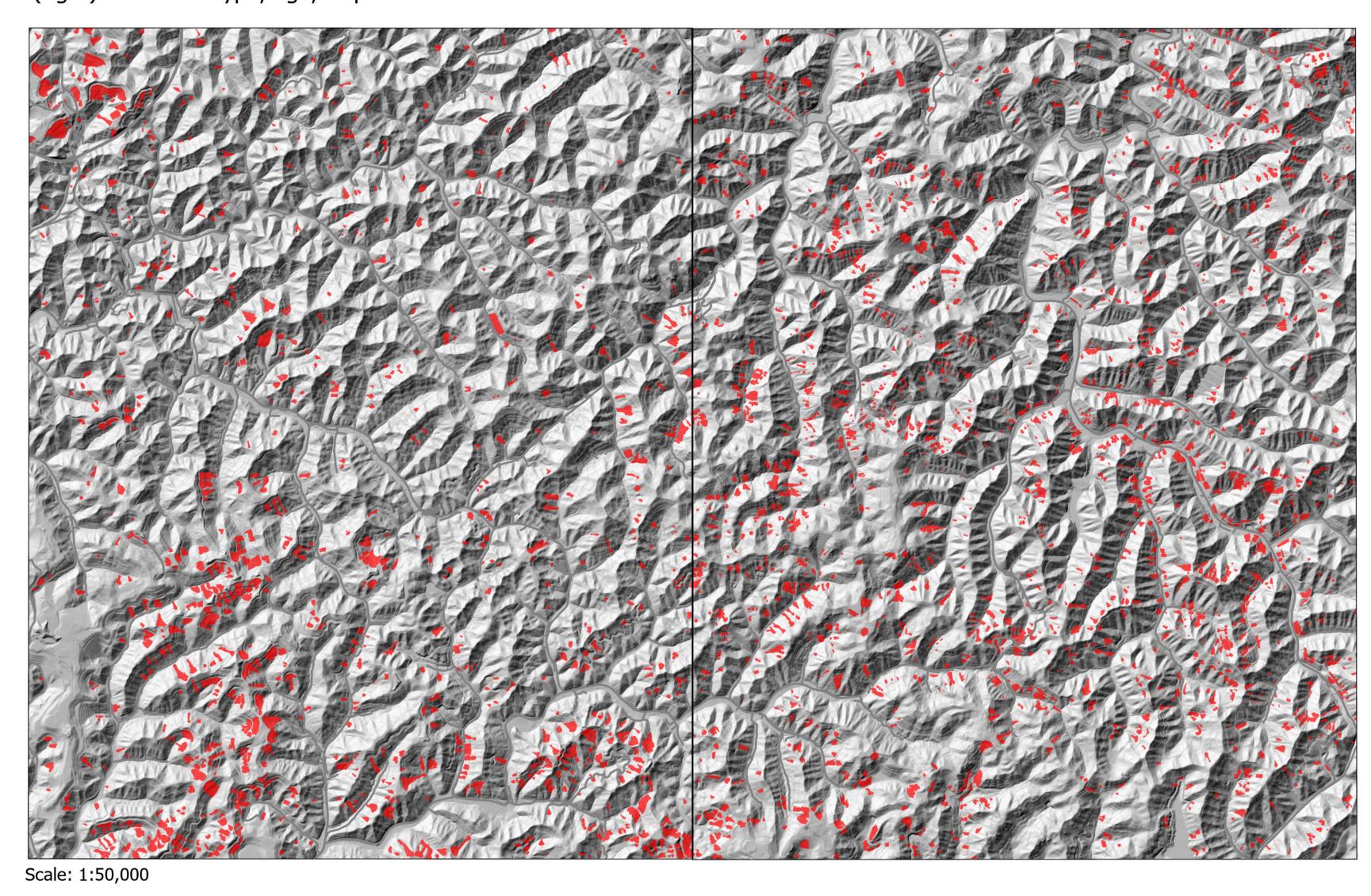
### Introduction

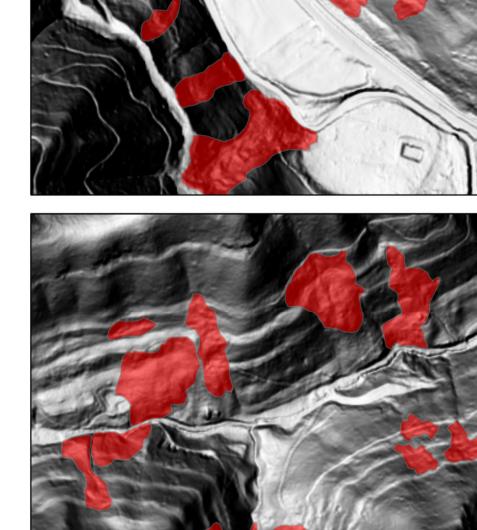
Landslides occur across the United States, causing billions of dollars in economic losses, including an estimated \$10 to \$20 million in direct costs annually within Kentucky. These events cause damage to homes, commercial property, and transportation infrastructure. Indirect costs such as road closures, decreased property values, and utility interruption are also potentially significant but are difficult to quantify. In order to better understand the causes and impacts of landslides, inventory maps represent areas that are identified as having failed by landslide processes. The level of detail ranges from broad reconnaissance to robust inventories of deposits identified with high-resolution elevation data and depict headscarps, flanks, and landslide.

Landslide inventory maps are critical information for land-use planning, situational awareness, and hazard or risk assessments. The purpose of this project was to map landslides in the Hindman and Kite 7.5-minute quadrangles in Knott County, Kentucky. Using the statewide available airborne lidar, lidar-derived DEM, and several elevation derivative maps, we mapped 2,844 landslides in the two quadrangles. Because Knott County has two separate lidar acquisition dates (2012 and 2019) we were able to supplement and further analyze the inventory by differencing the DEMs

### **Inventory Map**

We primarily used the multi-directional hillshade to identify hillslope geomorphic features and digitize the extent of landslide deposits. To support these interpretations, we used secondary, derivative maps including slope, curvature, plan curvature, aerial photography, traditional hillshade, and contours. We identified 882 slides in Hindman (left) and 1,962 slides in Kite

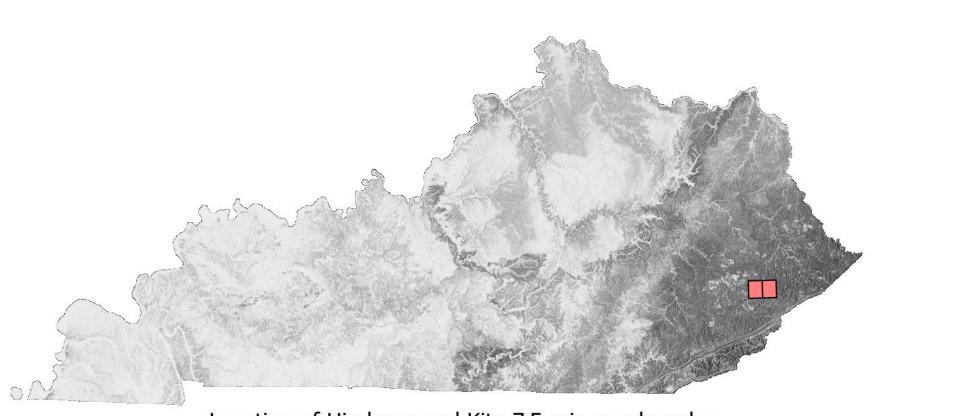




The resolution and clarity of lidar-derived multi-directional hillshades allowed for the identification of landslide headscarps, flanks, secondary scarps, landslide toes, and hummocky terrain. Landslide extents were digitized consistently around these features, mainly starting along the landslide crown.



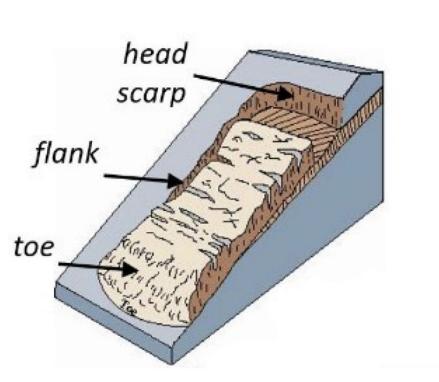
Field checked and confirmed mapped



# Confidence Ranking

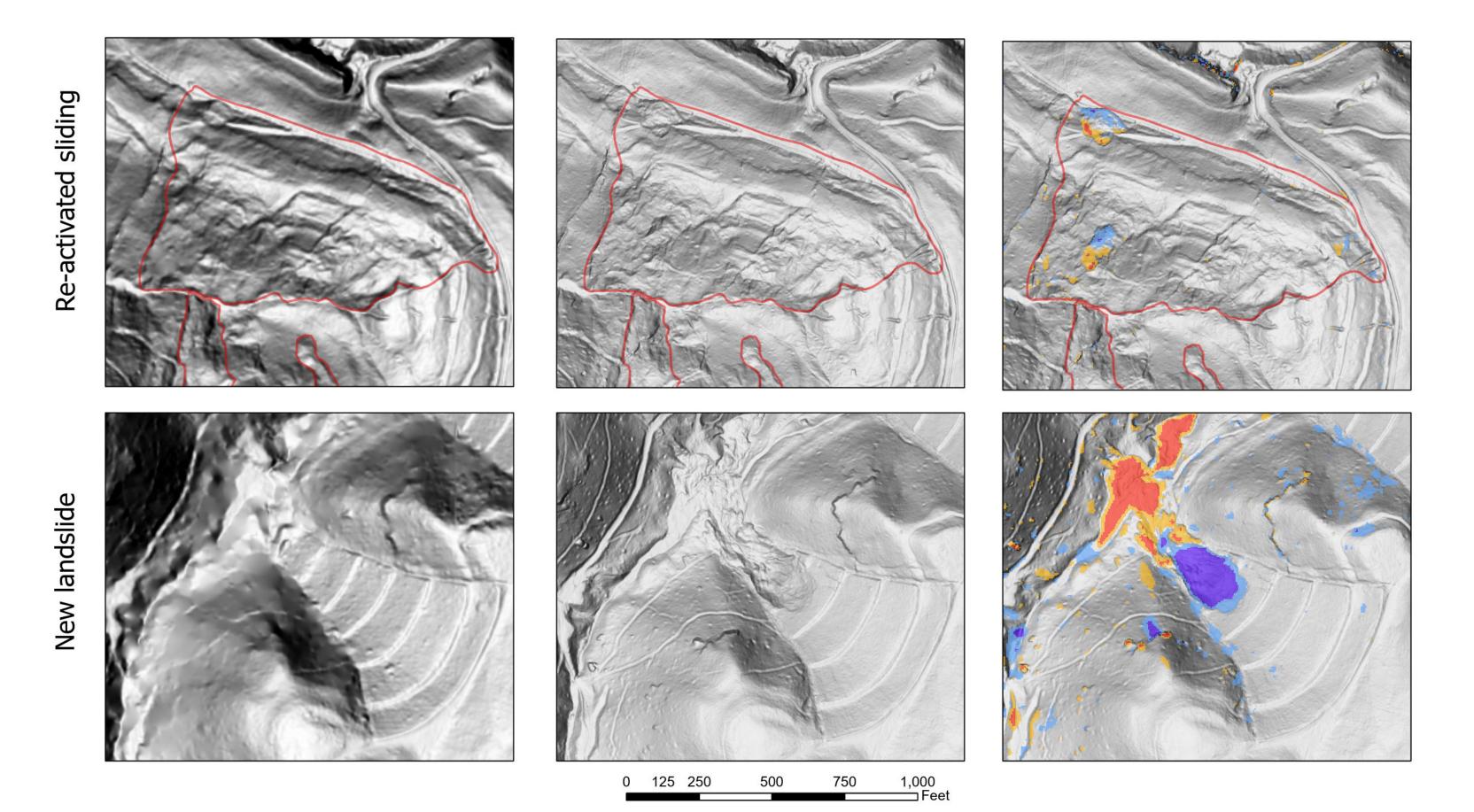
We used a confidence rating system based on methods developed by the Oregon Department of Geology and Mineral Industries, which qualitatively describes a confidence that a landslide was interpreted correctly,

Feature	Not visible	Slightly visible	Slightly visible + support	Moderately visible	Moderately visible + support	Clearly visible	Clearly visible + support
Headscarp	0	1-2	3–4	5–6	7–8	9	10
Flanks	0	1-2	3–4	5–6	7–8	9	10
Toe	0	1-2	3–4	5–6	7–8	9	10
Hummocky	0	1-2	3–4	5–6	7–8	9	10

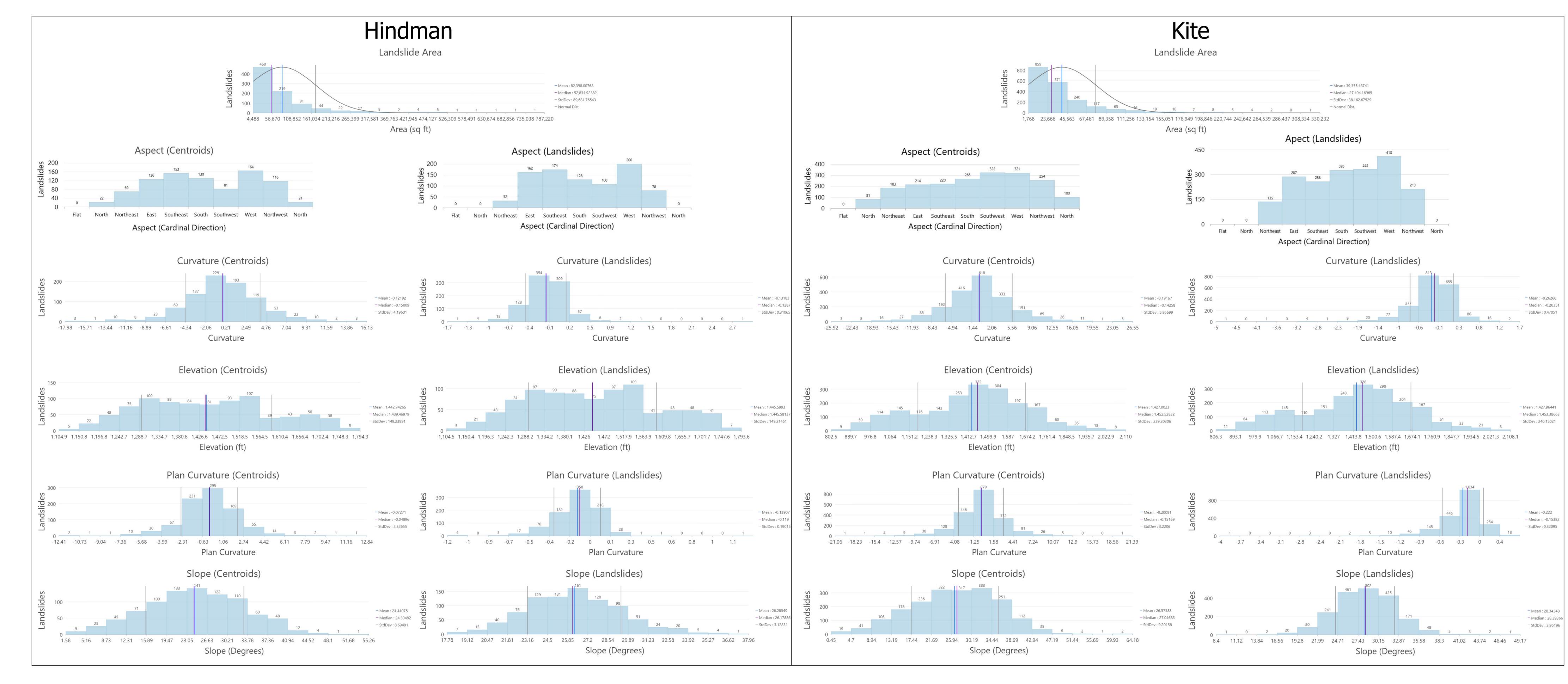


Confidence	% Total
.ow (≤10)	0.56
/ledium (11-29)	55.03
ligh (≥30)	44.41

valuable information to the inventory.



Histograms were generated for geomorphologic variables including area, aspect, curvature, plan curvature, elevation, and slope using landslide centroids and the actual landslide polygon extent.

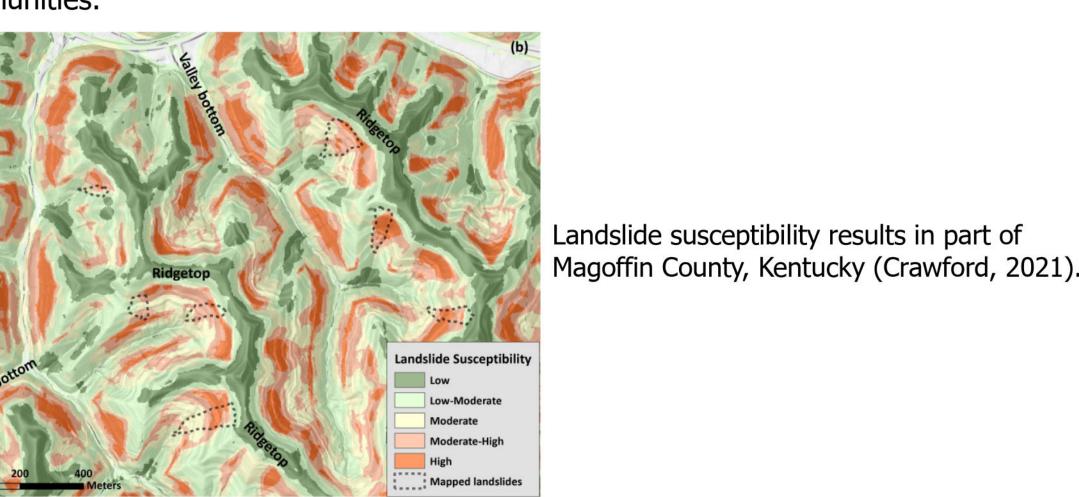


## Statistical Findings

- Mean landslide area for the Hindman quadrangle is 82,398 sq ft. Mean landslide area for the Kite quadrangle is 39,355 sq ft.
- 100% of Hindman landslides and 98.3 % of Kite landslides fell between 16-38°
- For plan curvature, all landslides skew slightly toward convex values. Mean values are -0.13 and -0.22 for Hindman and Kite respectively. Most of the landslides for both quadrangles were between -0.6-0.4. Traditional curvature values are similar for both quadrangles.
- Most landslides occur on west-facing slopes, however, there was no favored aspect direction for landslides in the Hindman quadrangle as the eastward, southward, and westward directions had total similar amount of landslide occurrence. 48.7% of mapped slides in the Kite quadrangle favor the westward directions.
- Data acquired using the landslide centroid less accurately represented the inventory because there is a larger range of values for all geomorphologic variables and the histograms all tended to be more equally distributed. The equal distribution was particularly noticeable for the curvature histograms

# Future Application

The landslides mapped in this project will be used to support current KGS landslide susceptibility and risk modeling for eight counties in eastern Kentucky. The inventory will be used to compile hillslope variables and model landslide susceptibility using multiple the machine learning techniques. The thousands of landslides, identified with high confidence, in this project will allow for strong model accuracy and the generation of practical maps to be used by stakeholders in landslide-prone



#### Landslide susceptibility results in part of

#### References

Burns, W.J. and Madin, I.P., 2009, Protocol for inventory mapping of landslide deposits from light detection and ranging (LIDAR) imagery, Oregon Department of Geology and Mineral Industries, Special Paper 42.

Crawford, M.M., Dortch, J.M., Koch, H.J., Killen, A.A., Zhu, J., Zhu, Y., Bryson, L.S., and Haneberg, W.C., 2021, Using landslide-inventory for a combined bagged-trees and logistic regression approach to landslide susceptibility in eastern Kentucky, United States, Quarterly Journal of Engineering Geology and Hydrogeology http:// doi.org/10.1144/qjegh2020-177

#### Acknowledgements

The authors would like to thank Hudson J. Koch, Jason M. Dortch, Elizabeth L Adams, Rachel Nobel-Varney, Douglas C. Curl, Mike Ellis, William C. Haneberg, and all who helped orchestrate the Paul E. Potter Internship Program.