UC 1226, Automated Landslide Detection

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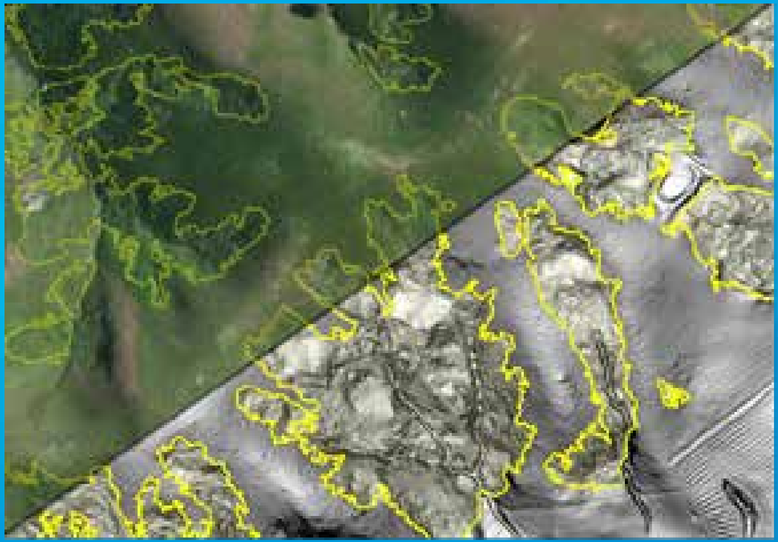
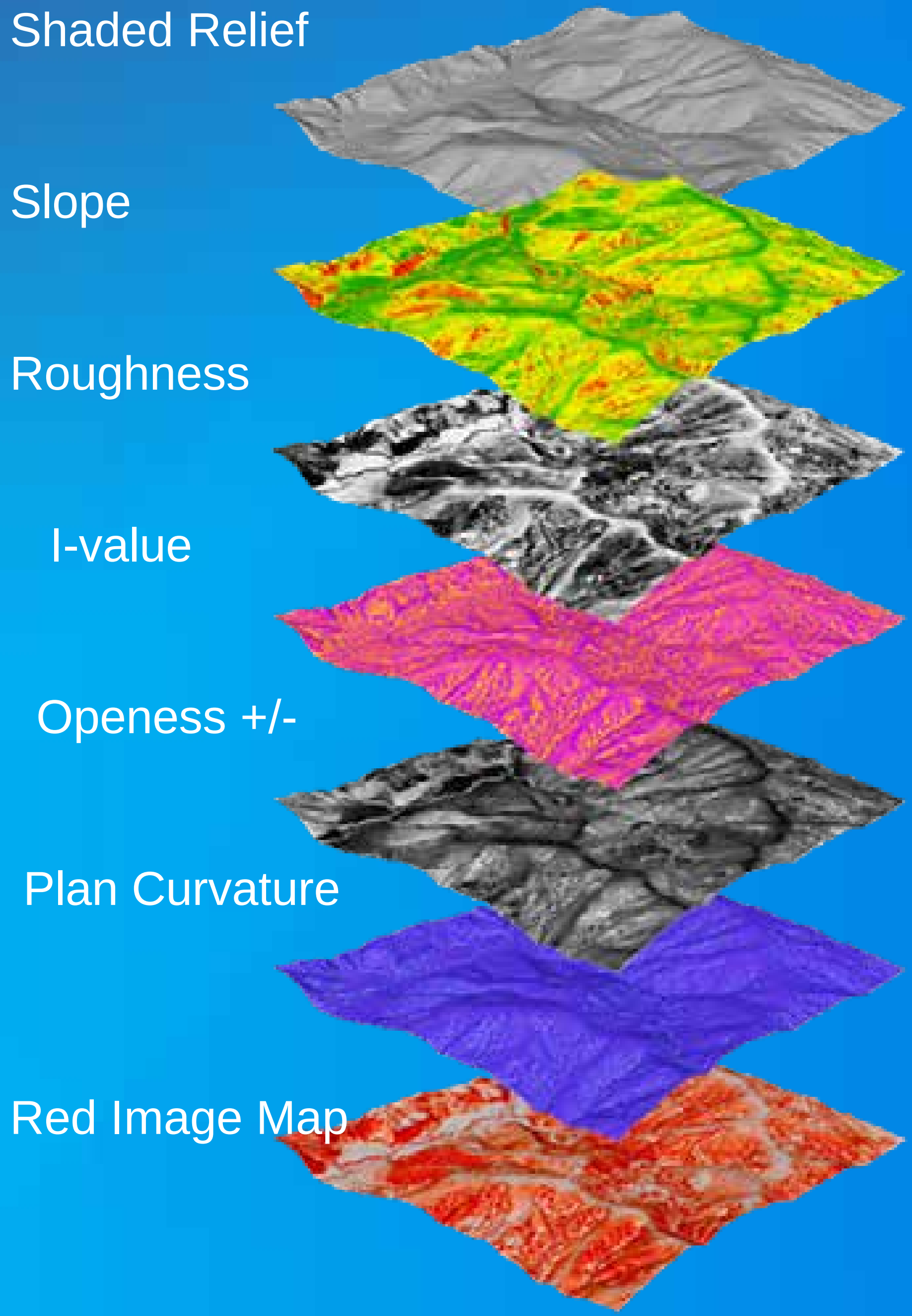


Aerial imagery (top left) and Quantum Spatial enhanced relief DEM (bottom right) with classified landslide areas

- **Comprehension of geologic processes is of great concern to many modern industries such as infrastructure planning, energy distribution, forestry management, and emergency response. Utilizing an automated approach, Quantum Spatial has developed an accurate and efficient methodology, which detects areas of failed terrain using high-resolution LiDAR data (15 pts/m2). The result is a robust, efficient, cost-effective dataset that indicates the presence of landslides, fault lines and other forms of failed terrain.**
- **LiDAR modeling reveals subtle surface features that are undetectable via aerial photographs or field observation, which leads to unparalleled richness in topographic models. Quantum Spatial LiDAR accuracies (RMSEz 3-5 cm) are second to none, providing the necessary foundation for assessing terrain attributes associated with landslides.**



Quantum Spatial achieved a 95% accuracy for landslide detection

34	0.1726			
1	0.24756			
13	0.30845		*Combined Statistics*	
22	0.31021			
6	0.31854		Mean	1.732074211
35	0.31905		Standard Error	0.236954732
3	0.37420		Median	1.01773
4	0.39281		Mode	#N/A
2	0.42849		Standard Deviation	1.78927099
0	0.45063		Sample Variance	3.201490676
20	0.5145		Minimum	0.03156
39	0.53566		Maximum	9.88945
36	0.61741		Count	57
17	0.6674		Confidence Level(95.0%)	0.474757498
32	0.67104			
16	0.74108			
19	0.84023			
18	0.87136			
26	0.90898			
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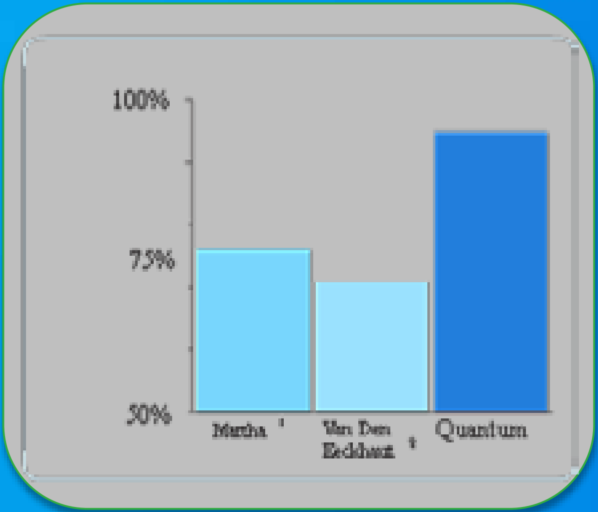
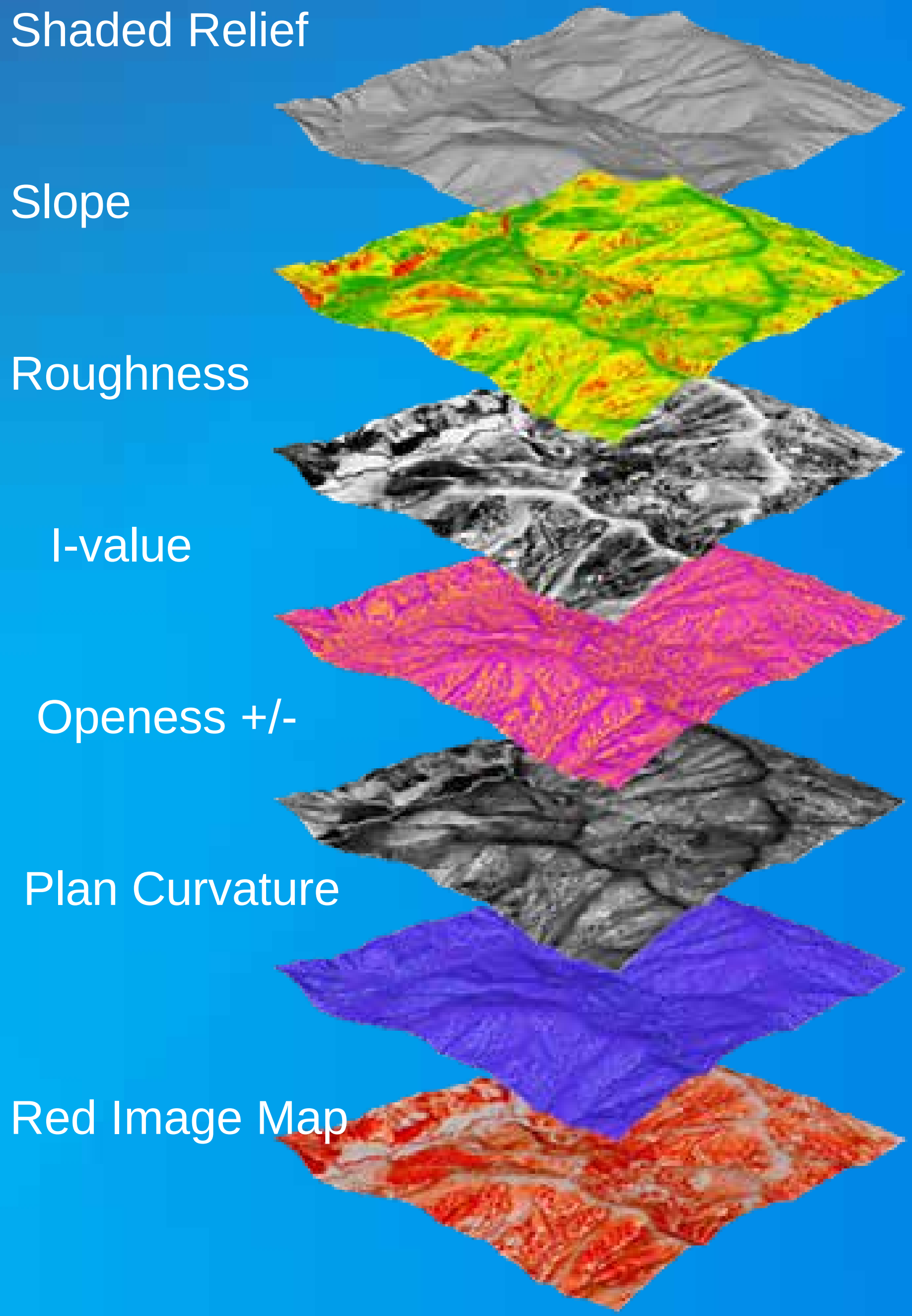
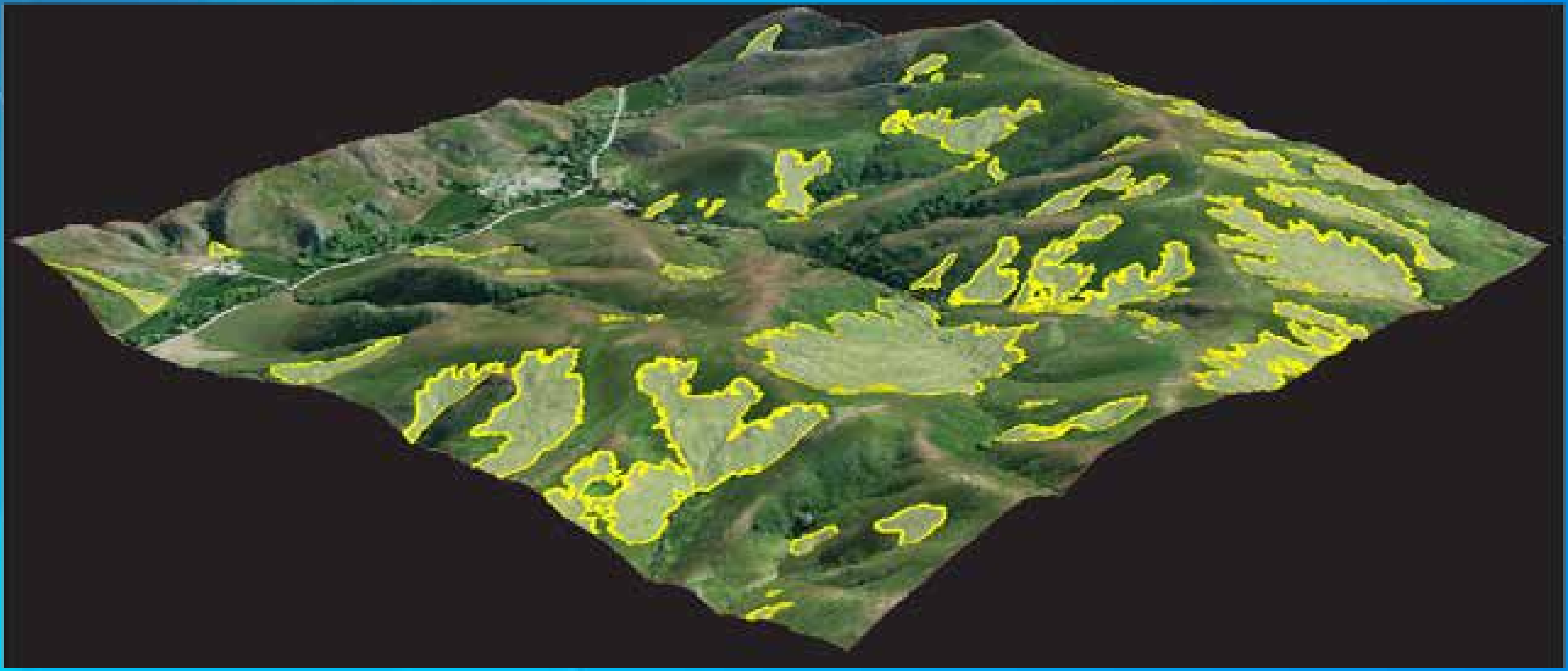


Quantum Spatial classification accuracy compared to results from two notable, published studies

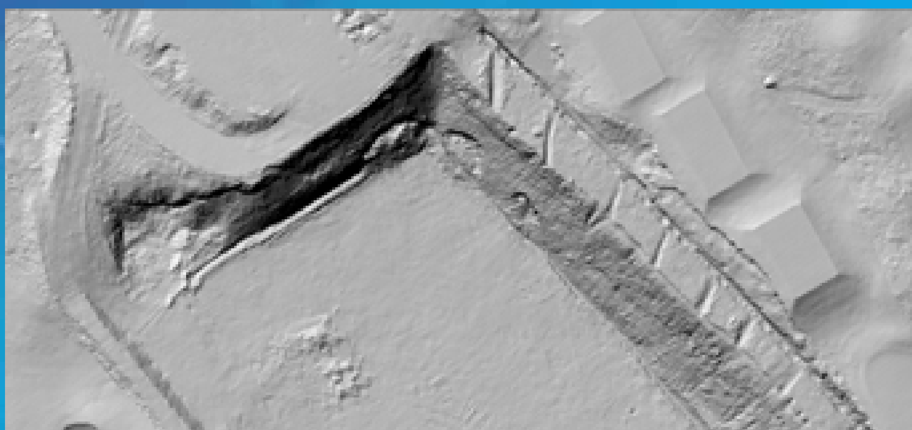
- Landslide detection relies on a detailed bare-earth DEM derived from a LiDAR ground model. Ground-classified LiDAR points are first processed to create a variety of raster images which reveal different landform features unique to landslides and faults. These images are then used as inputs for a series of semi-automated classification steps. The various algorithms include
- a combination of iso-clustering, principal component analysis, and support vector machines, which result in an initial landslide classification.
- A step-wise procedure systematically pares the model, excluding non-landslide and non-fault areas from the analysis (e.g., cultivated fields, roads, lakes) that may appear in the initial processing steps.

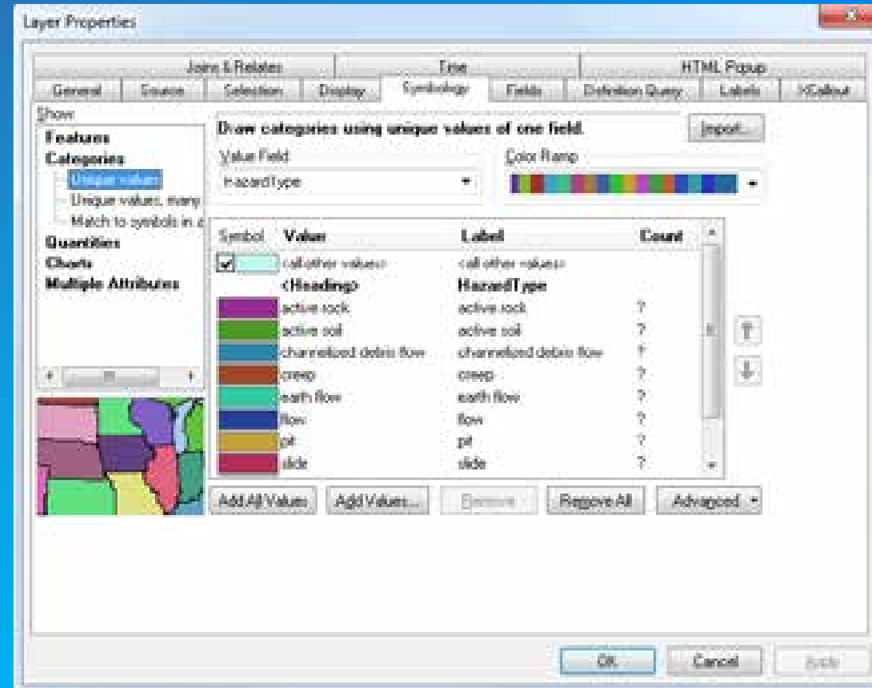


- Iso-Clustering is used to separate the survey region into several distinct classes. This classification technique is an iterative optimization procedure that repeatedly assigns cluster centers, based on the multi-dimensional, topographic characteristics of each input raster image. After each classification step, the algorithm evaluates the results by measuring the minimum distances within each cluster. Each iteration of the procedure causes unique morphological clusters to migrate together.

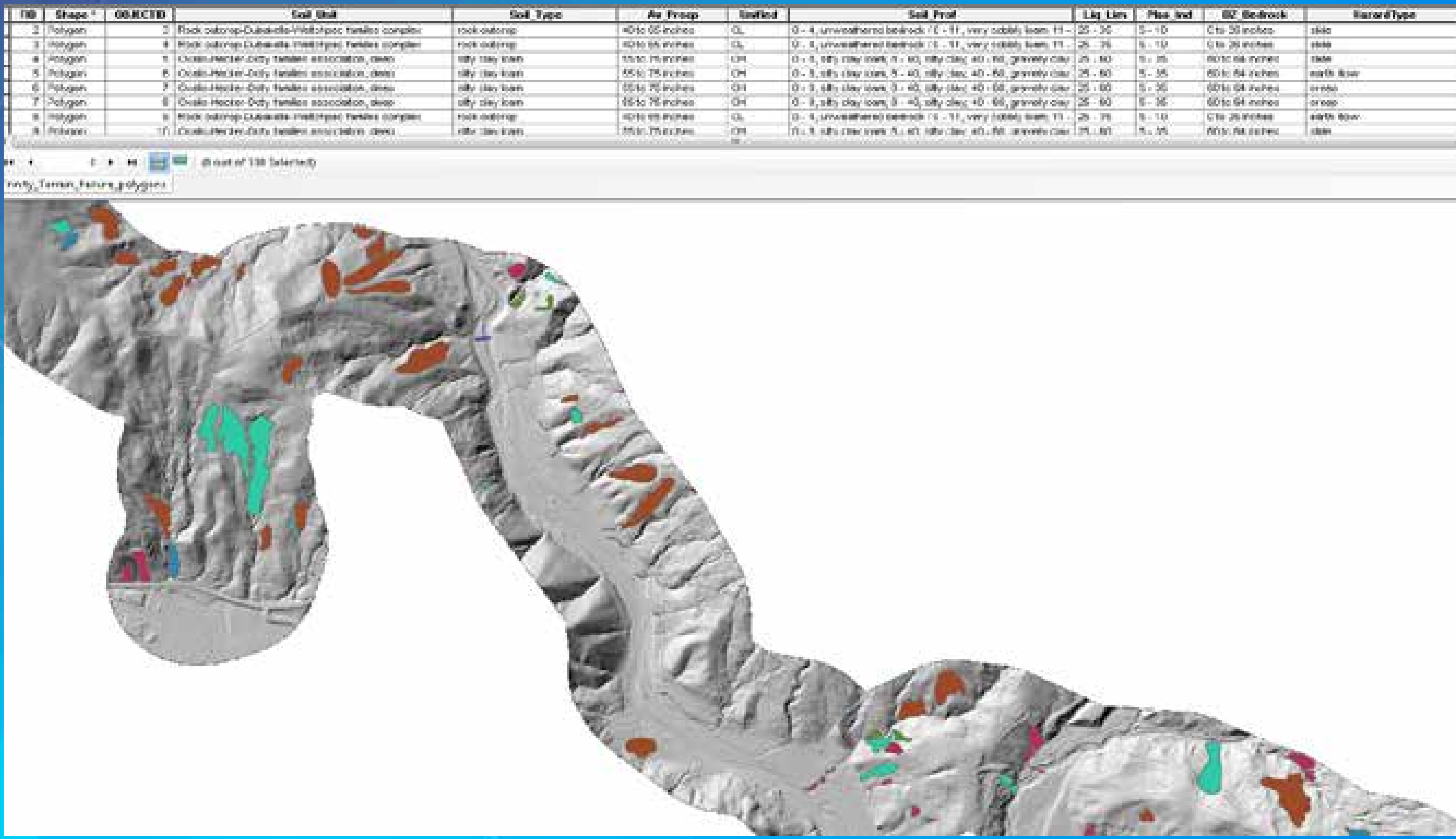


- **Once the automated detection is completed, manual editing is performed to eliminate false-positives and to refine the geometry of landslide delineations and fault lines.**

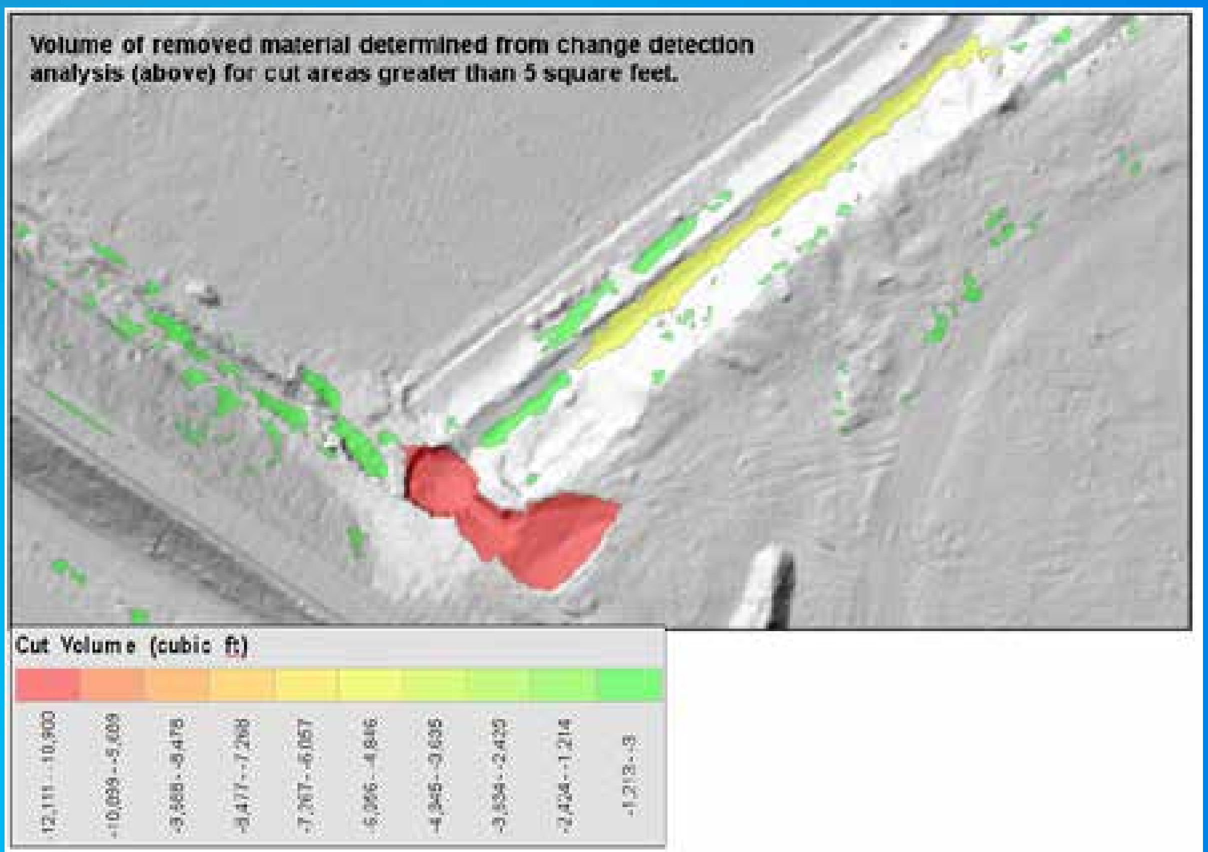




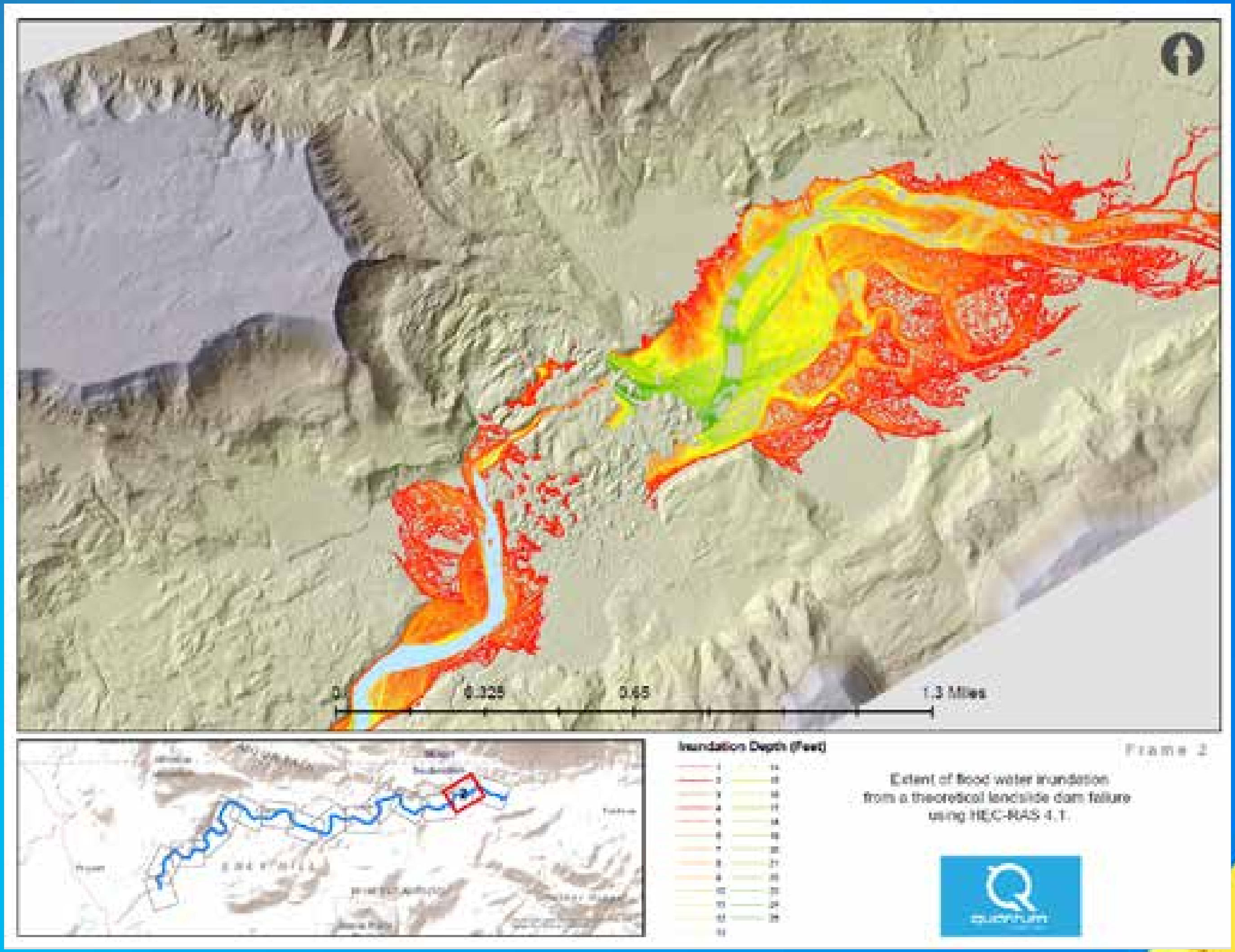
- **Upon completing landslide delineation, the landslide areas are automatically assigned respective slope angle, aspect, mean annual precipitation, vegetation cover, and soil attributes.**



Next, we hope to incorporate volume analytics to move us toward a predictive model.



And help mitigate risk management for these known hazards



And leverage our knowledge to discover insights yet to be realized

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