



**British
Geological Survey**

NATURAL ENVIRONMENT RESEARCH COUNCIL

Applied geoscience for our
changing Earth

Application of remotely sensed data for landslide hazard assessment: ...a UK perspective

*Monitoring and Managing the Earth's Resources -
Geological Remote Sensing Group
12 December 2012*

David Boon & Stephen Grebby

Claire Dashwood, Hannah Jordan, Pete Hobbs, Lee Jones &
Helen Reeves , Catherine Pennington, Katy Freeborough

Outline

1: Background and current survey methods (Dave)

- What causes landslides
- Why and how we survey landslides
- Two 'Case Studies' applying RS data

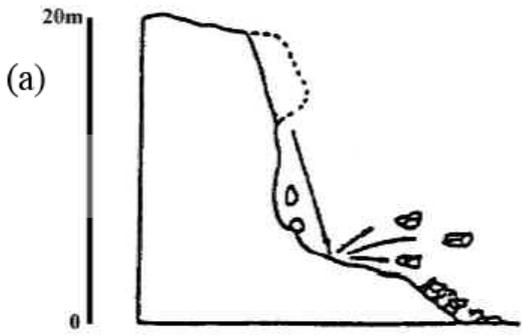
2: Towards enhanced landslide mapping (Stephen)

- Overcoming limitations with current methods
- Quantitative approach to landslide mapping
- Landslide classification in North Yorkshire using LiDAR

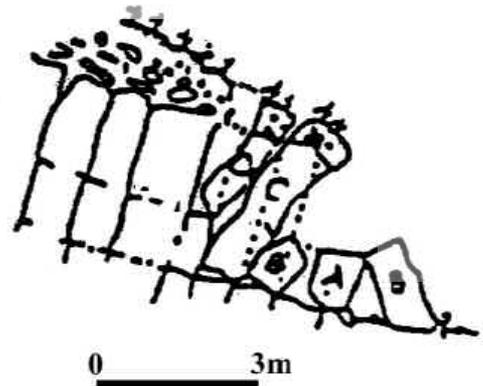
1. What is a landslide? Classification

“A downward and outward movement of slope forming materials under the influence of gravity”

FALL

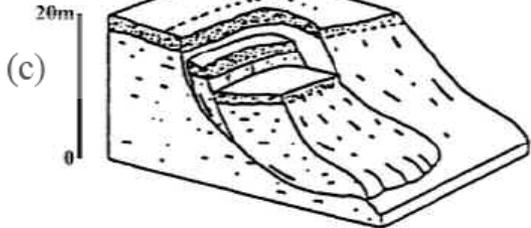


(b)

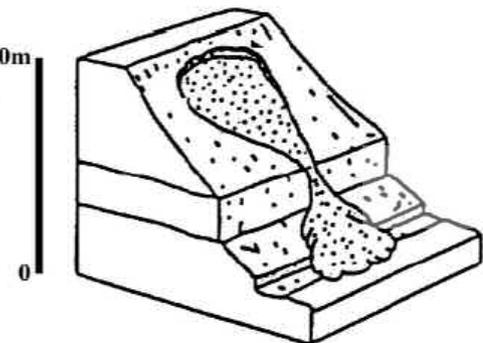


TOPPLE

SLIDE

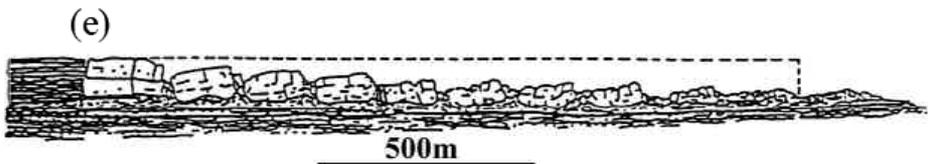


(d)



FLOW

SPREAD



2. What causes landslides?

**Pre-
conditioning
factors**



Geology

Slope/Topography
Quaternary history
Vegetation change
Tectonic activity

**Triggering
factors**



Climate/Rainfall/Frost
Changes in water table
Loading/Unloading
Earthquake

3. Impact of landslides in the UK – Ground Risk



4. The UK landslide hazard is continually evolving...

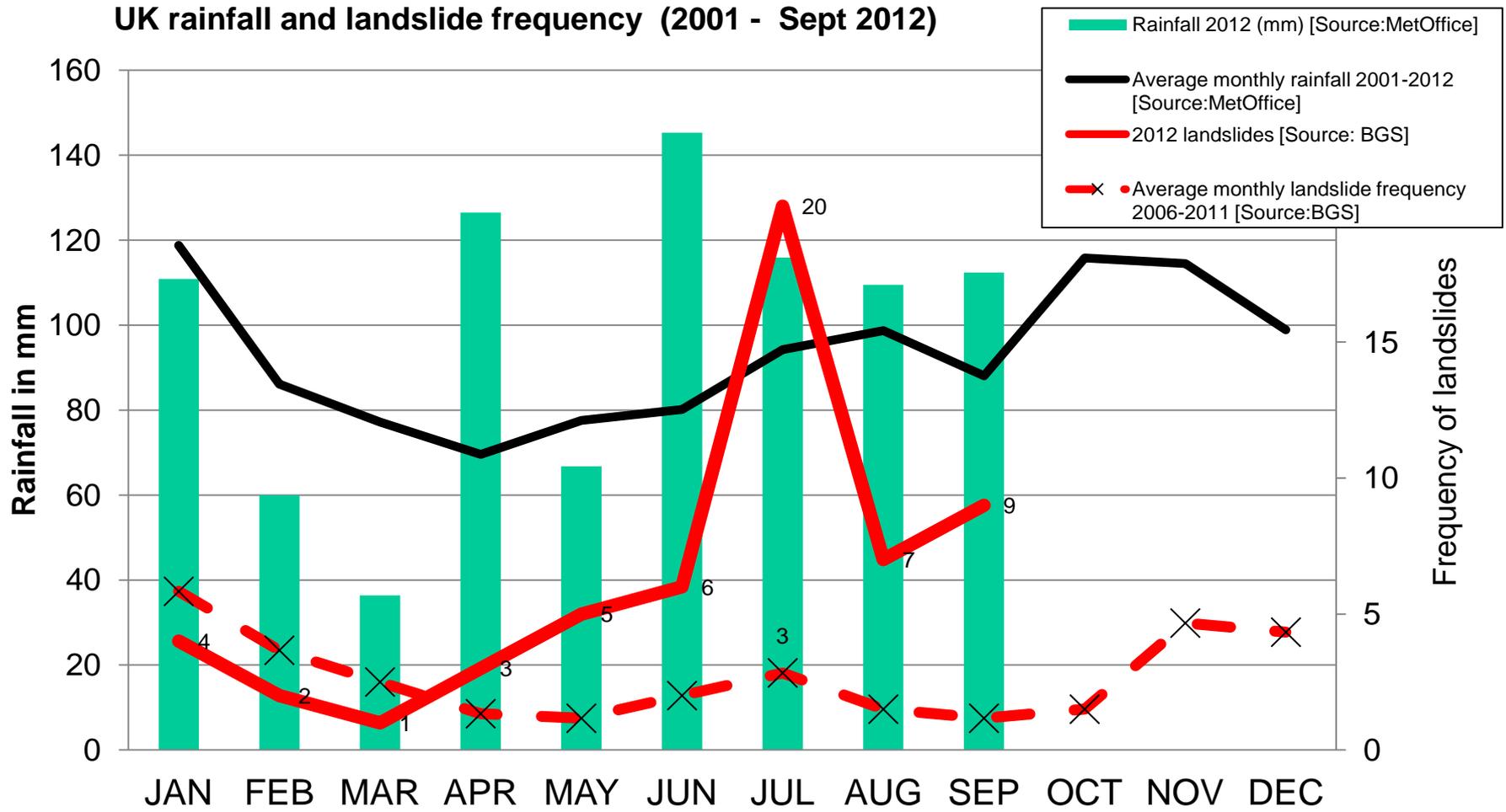
..So we are continually collecting data. What do the figures tell us?

The image shows three overlapping screenshots of BBC news websites, each reporting on a landslide incident. The top-left screenshot is from BBC NEWS ENGLAND, dated 5 December 2012, with the headline "Another landslide hits coastline Sidmouth". It features a photograph of a cliffside and text stating the landslide occurred near Pennington Point. The top-middle screenshot is from BBC NEWS CORNWALL, dated 1 December 2012, with the headline "Cracks on Looe landslide road". It includes a photograph of a road with cracks and text describing the damage to roads near Sandplace and St Martin's Hill. The top-right screenshot is from BBC NEWS BRISTOL, dated 30 November 2012, with the headline "Westerleigh rail landslide: Delays and cancellations to continue". It features a photograph of workers in orange safety gear at a construction site and text detailing the impact on rail services and the need for a temporary road.



4. The UK landslide hazard is continually evolving...

..So we are continually collecting data. What do the figures tell us?



For latest figures see: <http://www.bgs.ac.uk/science/landUseAndDevelopment/landslides/November2012.html>



5. RS data for landslide hazard mapping

1. Office 2D/3D Aerial Photo Interpretation
(SocetSet/GeoVisionary/ARC)



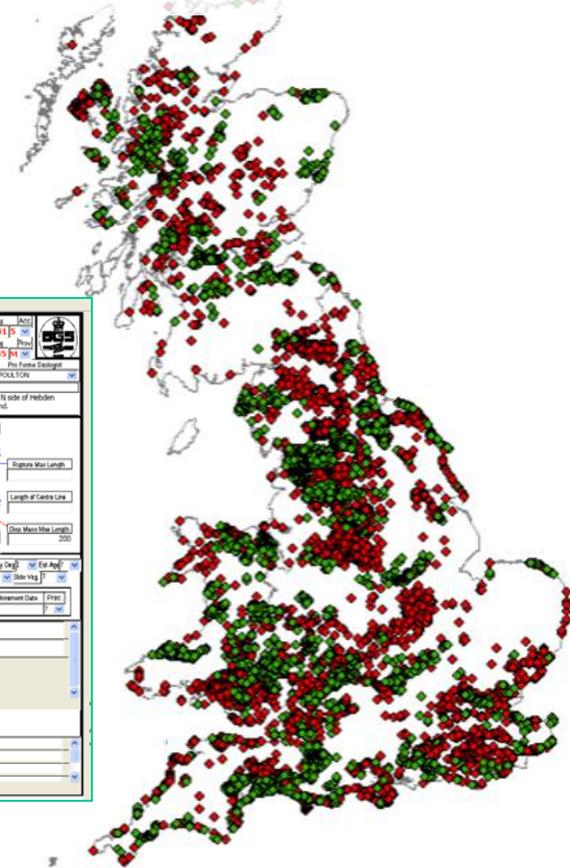
2. Field checking with AP and DTMs



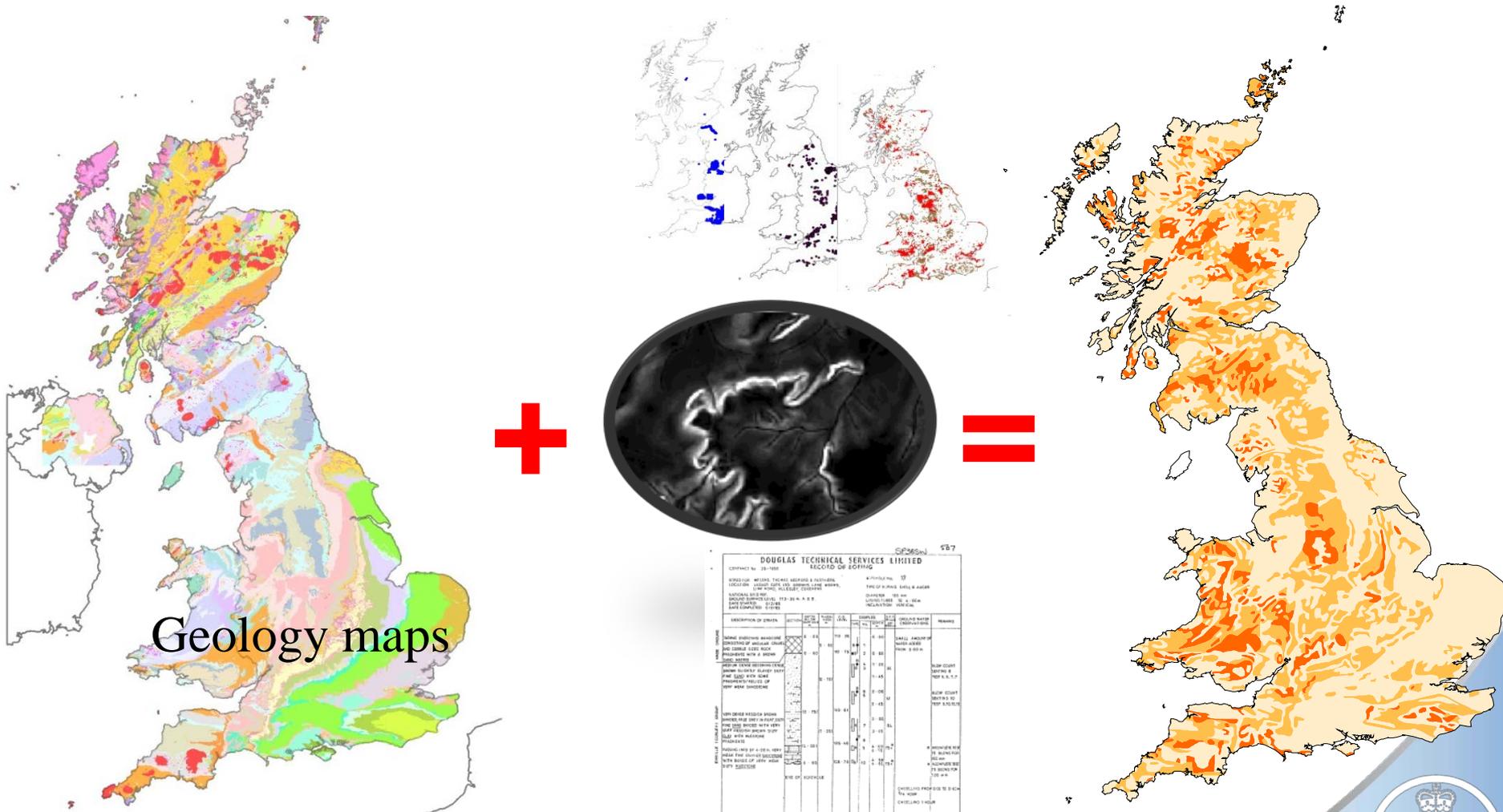
3. Update UK Landslide Inventory and maps
(National Landslide Database
Contains over 14,000 records)

Entry Page 1 | Entry Page 2 | Entry Page 3 | Entry and Update Fields

BGS Landslide Pro-Forma P1		MGR Easting	900341
Landslide ID		MGR Northing	429345
Original Number	181188	Surveyed By(BGS Code)	RADO
SRNAME.ZID		Survey Date	01/01/1999
Locality Name		Local Details	
Hidden Oak North Complex		Slope 1: Slope of ground on the N side of Hidden Wharfe, West Yorkshire, England.	
Landslide Dimensions		Elevation of Crown	200
Total Slide Length		Slipface Max Width	
Slipface Max Depth		Slipface Min Length	
Clay Mass max Depth		Length of Centre Line	
Clay Mass Max Width		Slip Mass Max Width	2000
Clay Mass Min Length		Slip Mass Min Width	
Landslide Detail		Slipface Material	ROCK
Stability		Stability Development?	
Stability Date		Stability Date	
Stability Class		Stability Class	
Stability Code		Stability Code	
Stability Comment		Stability Comment	
Moment		Style	
Type		First Movement Date	
Cause		Last Movement Date	
Comments		Comments	
Type		Comments	
Cause		Comments	
Style		Comments	
First Movement Date		Comments	
Last Movement Date		Comments	
Comments		Comments	
Record: [14] of 1			
Global Factors			
Cause		Value	Comments
JANGLE			
SPTS			
SPTS			
TERR			
Record: [14] of 4			



7. National-scale landslide hazard maps for planning



Geology maps

SFM65m 587

DOUGLAS TECHNICAL SERVICES LIMITED
SPECIALISTS OF SOFTING

CONTRACT No. 10-1100

WORK FOR: WEIR, TRENKLE, BRIDGES & FILLINGS
SPECIALISTS OF SOFTING, BRIDGES, WEIR,
AND SPECIAL LIGHTING SYSTEMS

AT: 10-1100

DATE: 10-11-00

SCALE: 1:1000

PROJECT: 10-1100

DESCRIPTION OF WORK	QUANTITY		UNIT PRICE		TOTAL PRICE		REMARKS
	NO.	UNIT	PER UNIT	TOTAL	PER UNIT	TOTAL	
1. WEIR	1	NO.	1000	1000	1000	1000	
2. TRENKLE	1	NO.	1000	1000	1000	1000	
3. BRIDGES	1	NO.	1000	1000	1000	1000	
4. FILLINGS	1	NO.	1000	1000	1000	1000	
5. SPECIAL LIGHTING SYSTEMS	1	NO.	1000	1000	1000	1000	

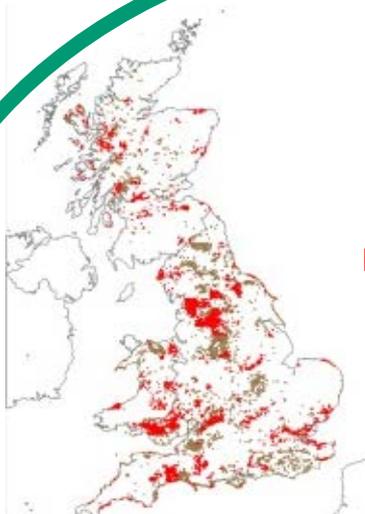
NOTES:
1. ALL WORK TO BE DONE IN ACCORDANCE WITH THE SPECIFICATIONS AND DRAWINGS.
2. THE CONTRACTOR SHALL BE RESPONSIBLE FOR OBTAINING ALL NECESSARY PERMITS AND APPROVALS.
3. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING UTILITIES AND STRUCTURES.
4. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING VEGETATION AND LANDSCAPE.
5. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING ROADS AND PATHS.
6. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING BUILDINGS AND STRUCTURES.
7. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING POWER LINES AND CABLES.
8. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING TELEPHONE LINES AND CABLES.
9. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING WATER MAINS AND PIPES.
10. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING SEWER MAINS AND PIPES.
11. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING GAS MAINS AND PIPES.
12. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING RAILWAY LINES AND TRACKS.
13. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING AIRCRAFT ROUTES AND AIRPORTS.
14. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING NAVIGATION CHANNELS AND PORTS.
15. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING HISTORICAL MONUMENTS AND BUILDINGS.
16. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING CULTURAL HERITAGE AND LANDSCAPE.
17. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING NATURAL RESOURCES AND ENVIRONMENT.
18. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING SOCIAL INFRASTRUCTURE AND SERVICES.
19. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING COMMUNITY AMENITIES AND FACILITIES.
20. THE CONTRACTOR SHALL BE RESPONSIBLE FOR THE PROTECTION OF ALL EXISTING PUBLIC UTILITIES AND SERVICES.



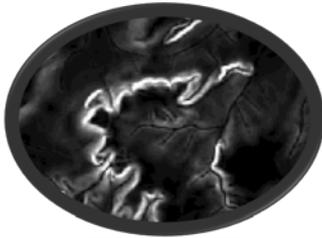
10. Improving landslide hazard mapping



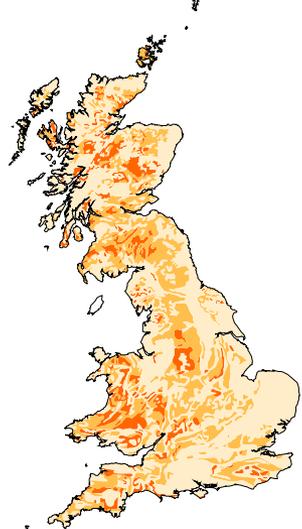
Geological information



Landslide inventory



Slope processes information

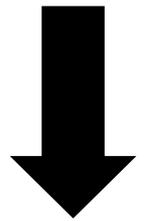


Landslide susceptibility

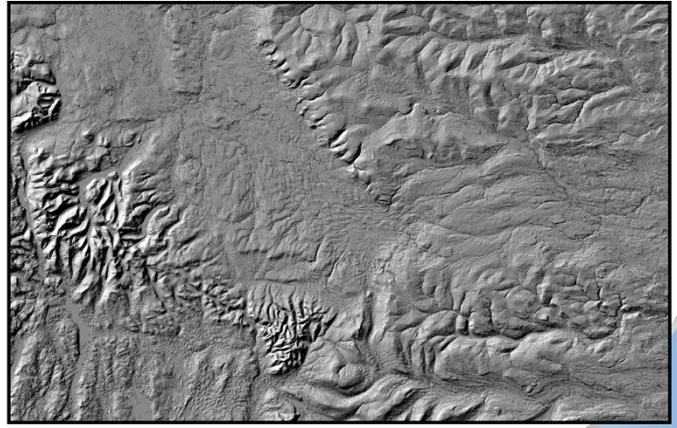
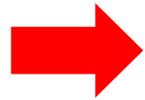
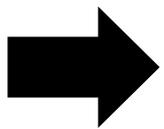
Knowledge and data!

11. Primary limitations of current landslide mapping

Financial and practical constraints with fieldwork

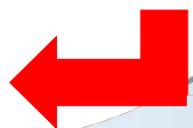


Increasing dependency on remotely sensed data

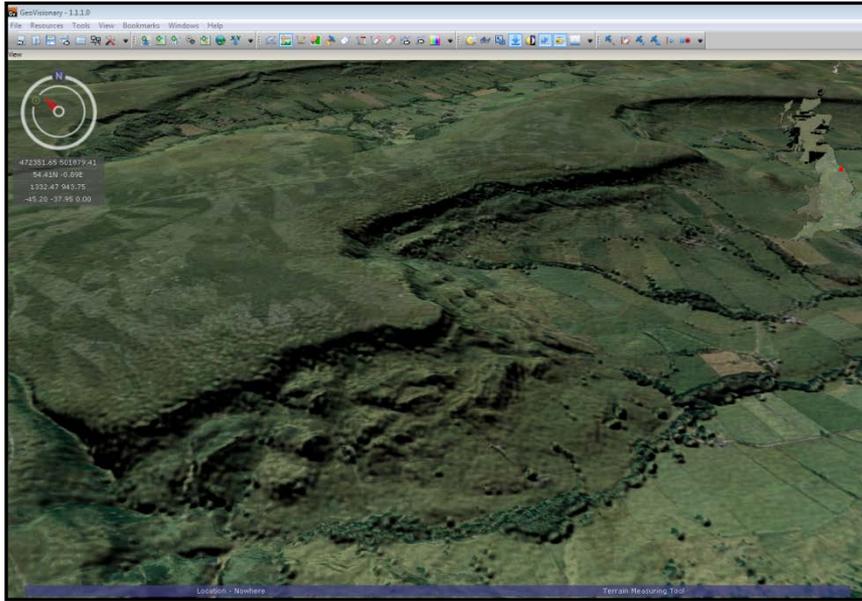


National-scale Nextmap 5-m DTM

Visual identification/mapping can be inefficient and subjective



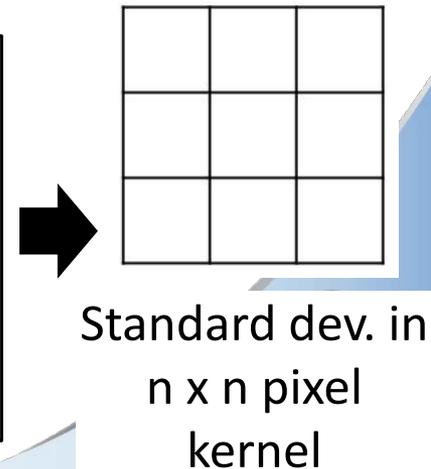
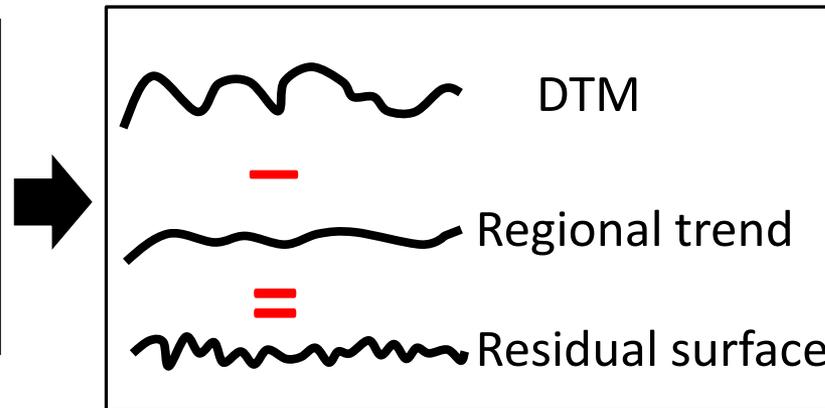
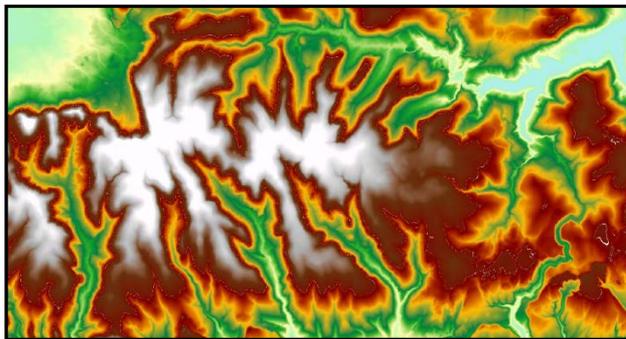
11. Quantitative approach to landslide mapping



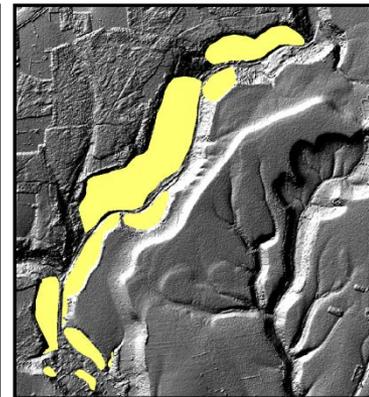
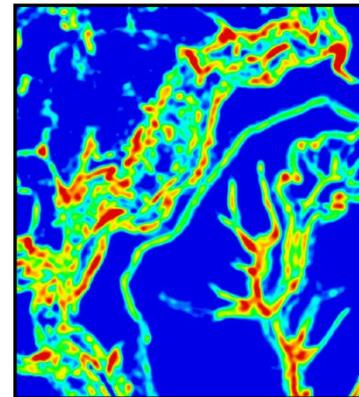
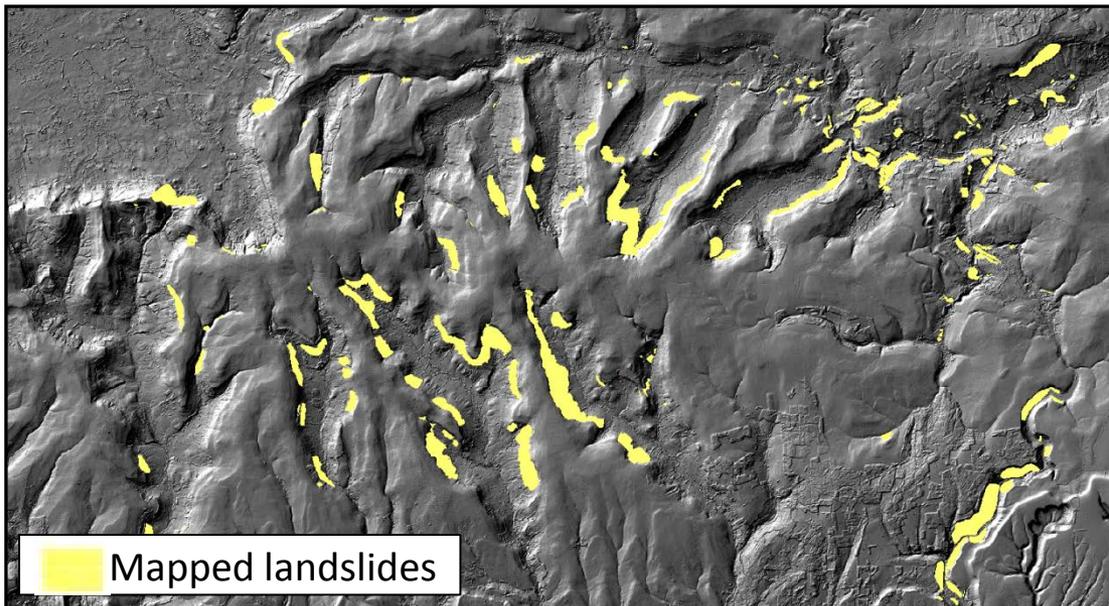
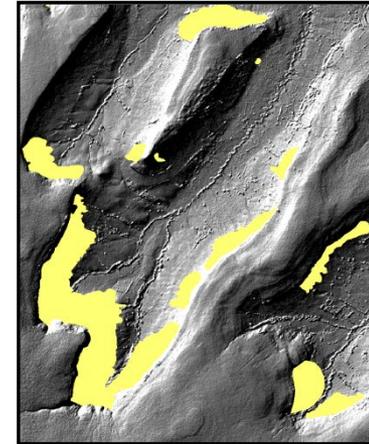
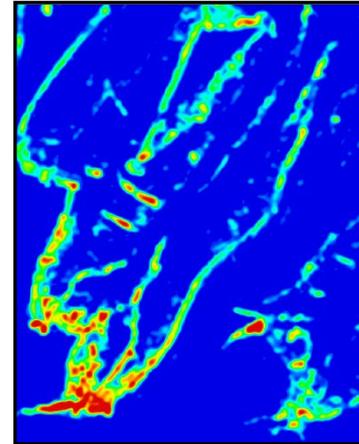
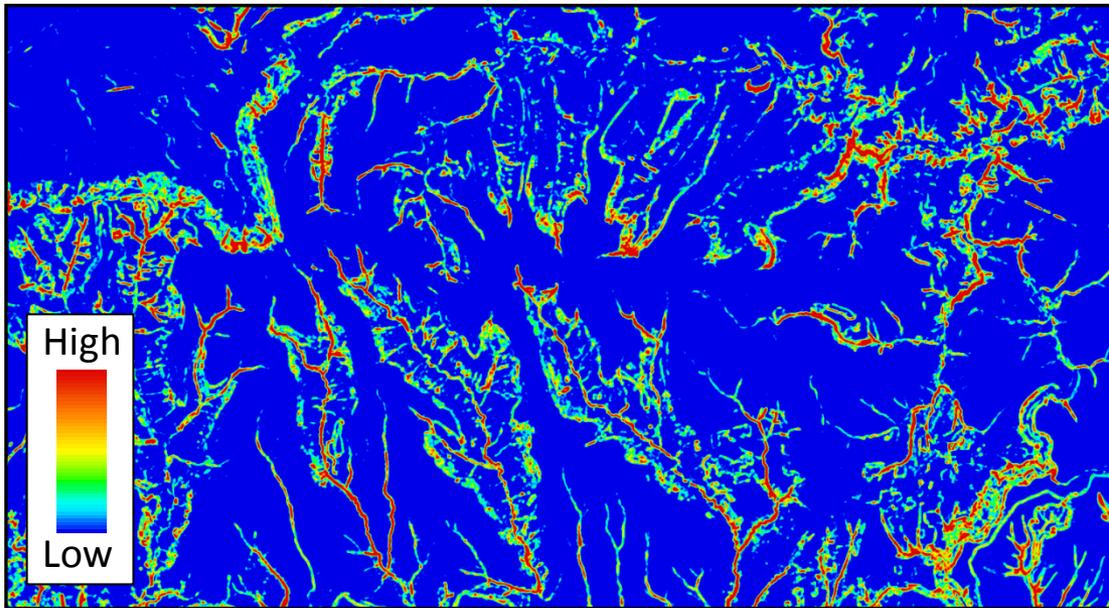
Landslides typically have a distinct topographic expression:

- Non-slipped terrain is smooth
- Slipped terrain is relatively rough and hummocky

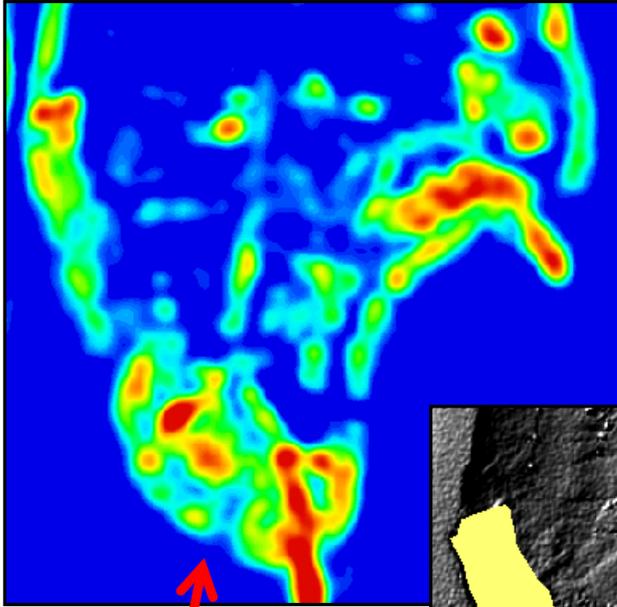
Surface Roughness



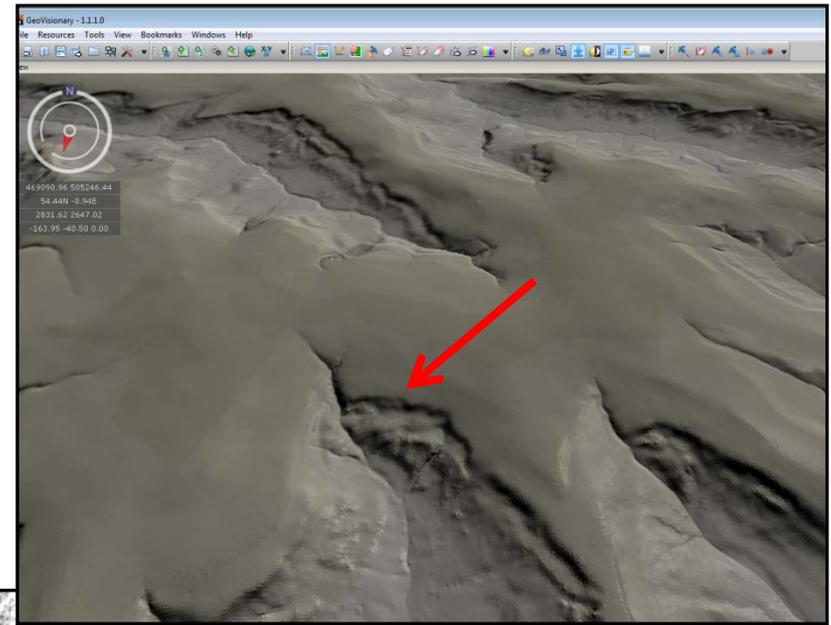
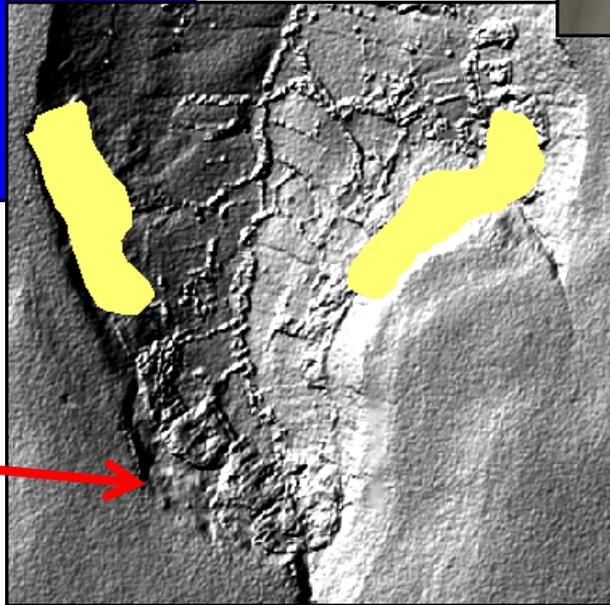
12. Landslide mapping using surface roughness



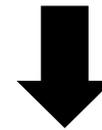
...surface roughness continued



Unmapped
landslide?



- 5-m Nextmap DTM can be used to identify deep-seated landslides through roughness
- Not suitable for mapping shallow landslides and coastal hazards



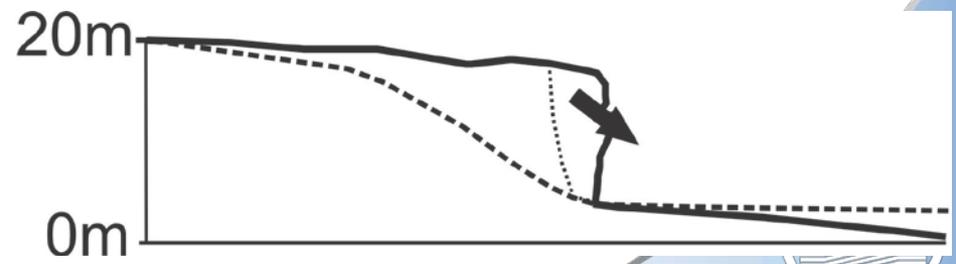
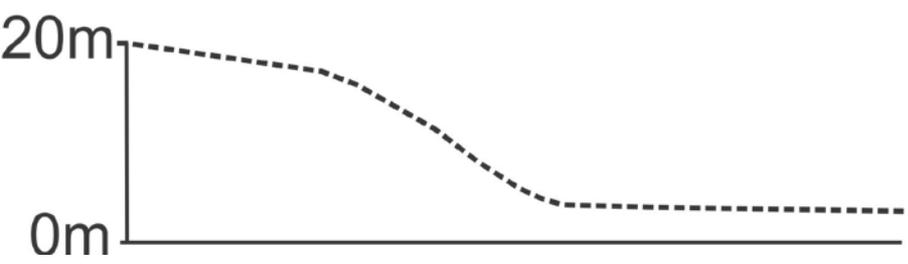
LIDAR – Terrestrial & Airborne

13. Advantages of Terrestrial LiDAR data for cliffs

'Best available' DEM: NextMap (5-m) viewed in GeoVisionary



DEM from Terrestrial LiDAR 10-mm Viewed in GeoVisionary



14. Advantages of Airborne LiDAR data

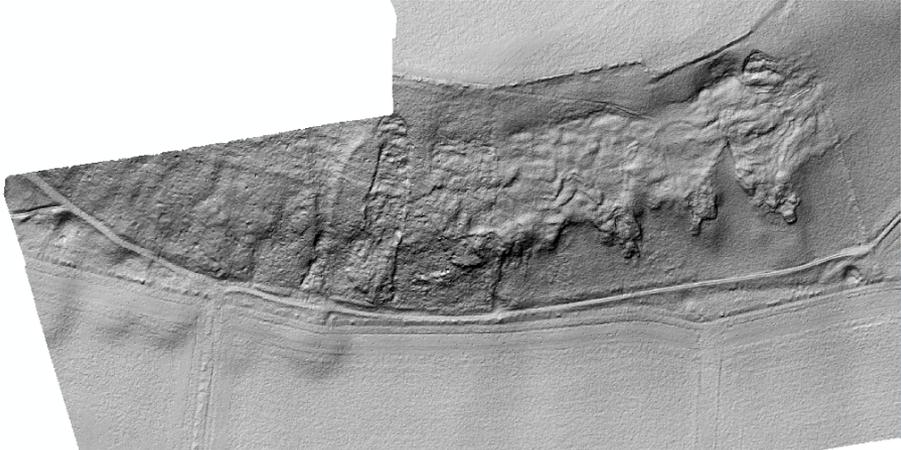
High-resolution DTMs



Identifying shallow landslides



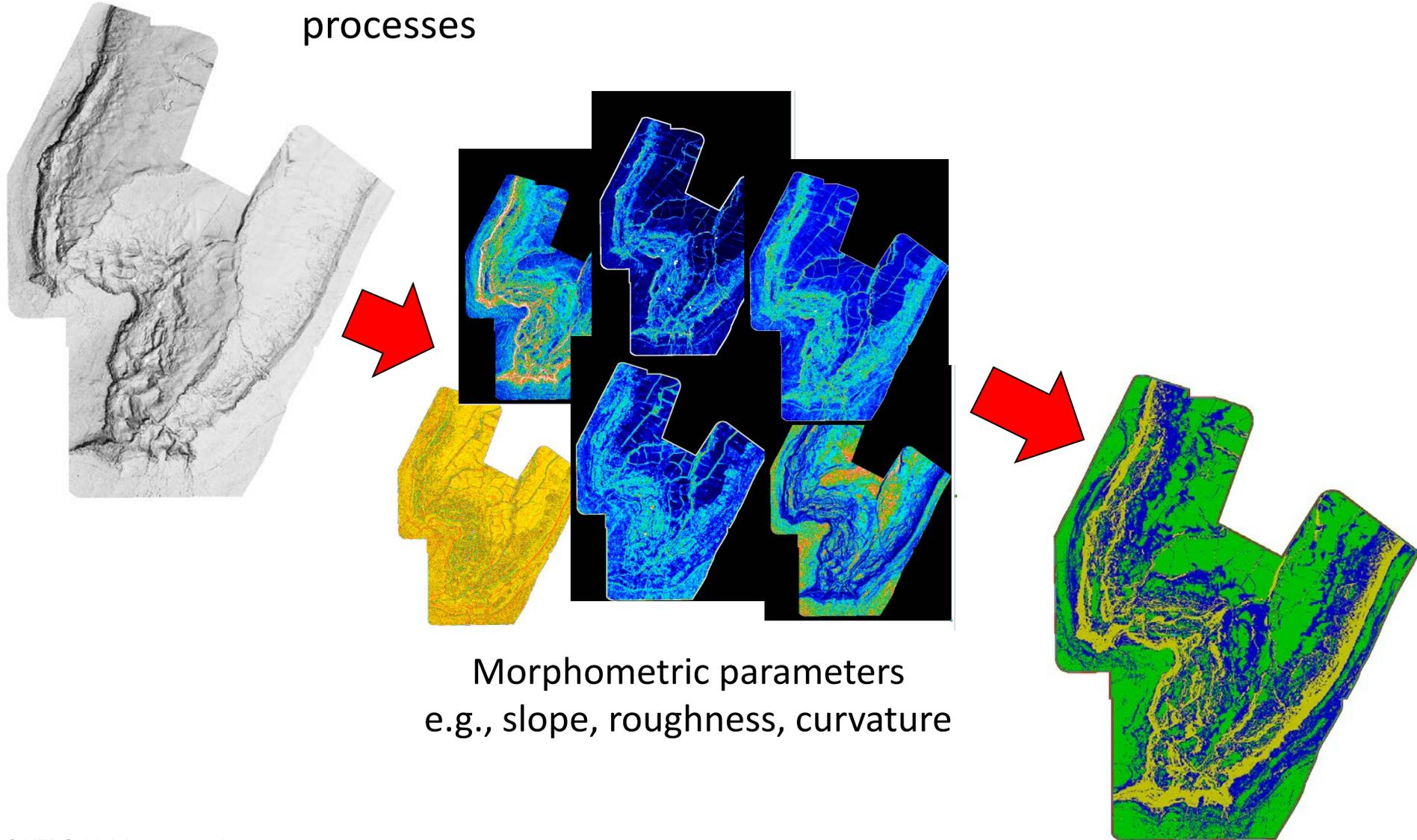
5-m Nextmap DTM



0.25-m LiDAR DTM

15. Classification of landslide morphology

- Landslide morphology can improve knowledge of slope processes



Conclusion

- Landslide inventory and slope processes knowledge are essential for landslide hazard mapping
- Remotely sensed data plays an ever increasing role in geohazard studies for engineering and planning
- High-resolution topographic data and quantitative analysis can improve knowledge – inventory and slope processes
- Feed knowledge back into susceptibility mapping
- Integration of quantitative and qualitative techniques has potential to deliver efficiency gains

