Telerilevamento e DTM: applicazioni geomorfologiche in ambiente GIS

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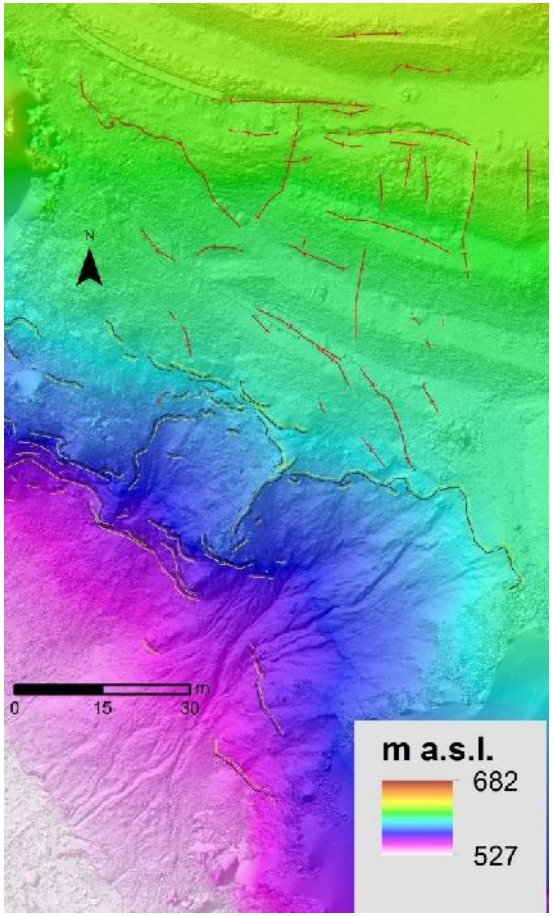
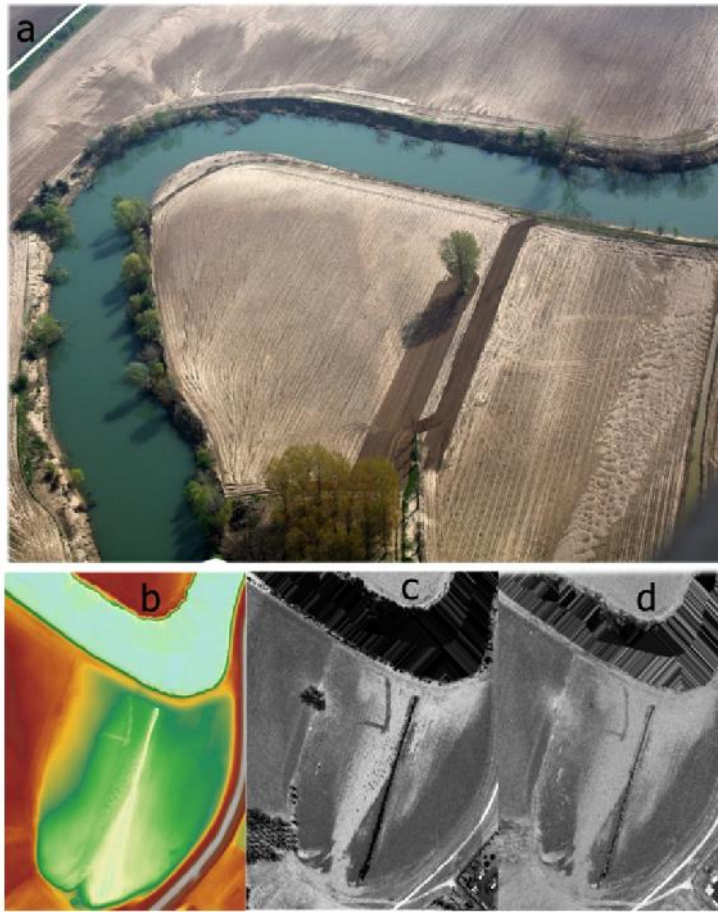




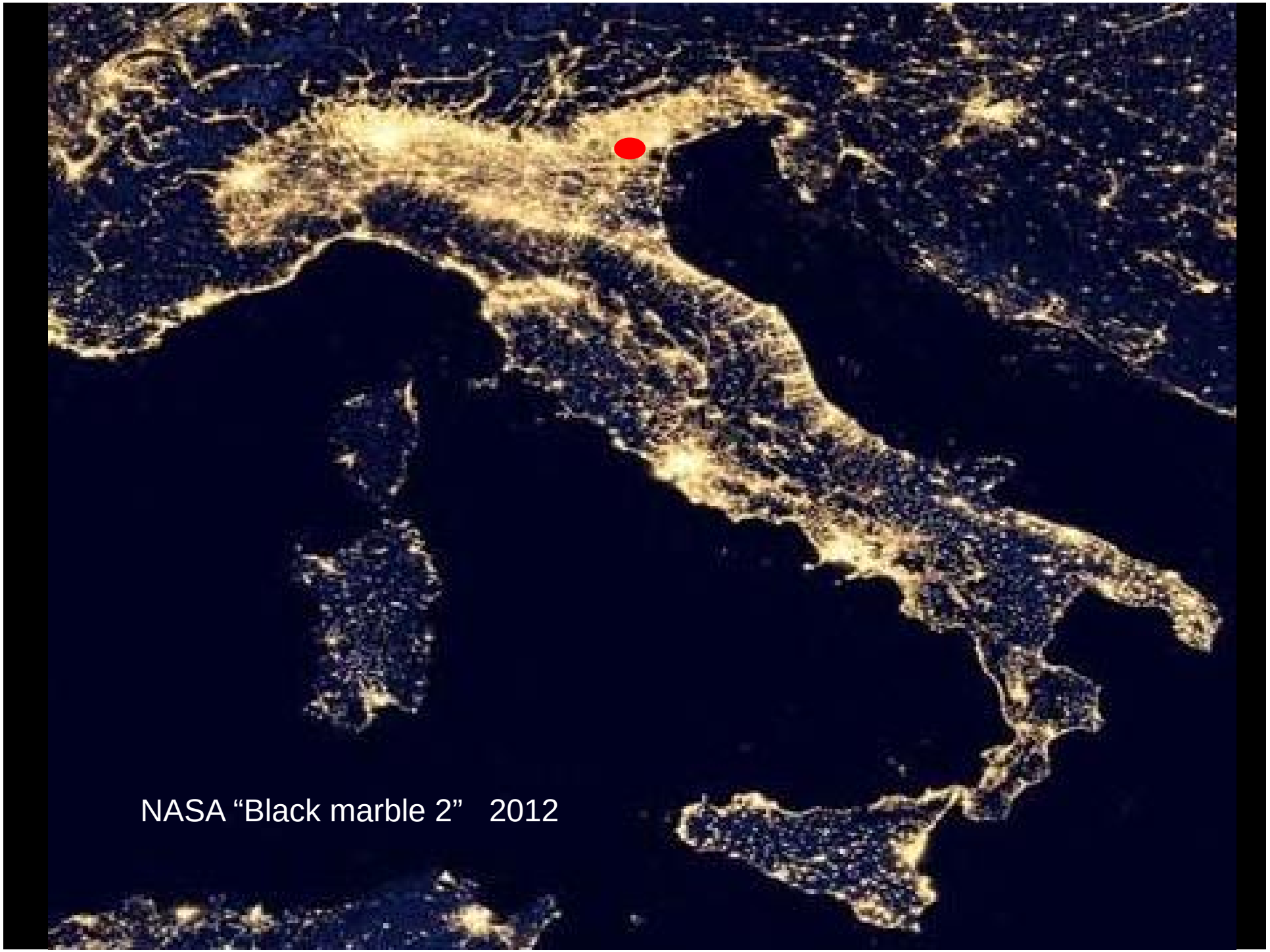
Ninfo et al. (2016) Geomorphology.

Integration of LiDAR and *cropmarks* remote sensing for the study of fluvial and anthropogenic landforms in the *Brenta-Bacchiglione* alluvial plain (NE Italy)

Introduction

The geomorphological study of alluvial plains takes great advantage from high resolution altimetry, especially in the lower relief sectors, like the area of study (mean slope ~0.4‰).

Alluvial plains are one of the privileged substrate for the human infrastructures and activity.


NASA “Black marble 2” 2012

Aims & Data

Improve the geomorphological understanding and mapping of the plain around Padova, also in the high urbanized surroundings and medieval town center

A remote sensing dedicated acquisition was carried out with LiDAR and oblique aerial images

LiDAR acquisition was possible inside the framework of the research project: "*Padova Underground: a geoarcheological investigation to the root of the city*" supported by Fondazione Cariparo.

LiDAR flow-chart

1. Pre-acquisition planning

Choosing the sensor and the optimal density of the acquisition → **Riegl LMS-Q560 waveform ~7 points/m2**

Choosing the best season and condition for the flyght → **end of the winter, bare soils**

2. Data Acqusition

Aerial LaserScanning → **(3 days in March 2011)**

Contextually Ground Control Point acquisition → **10 benckmarks in static DGPS; 2 targets about 600 points in RTK DGPS**

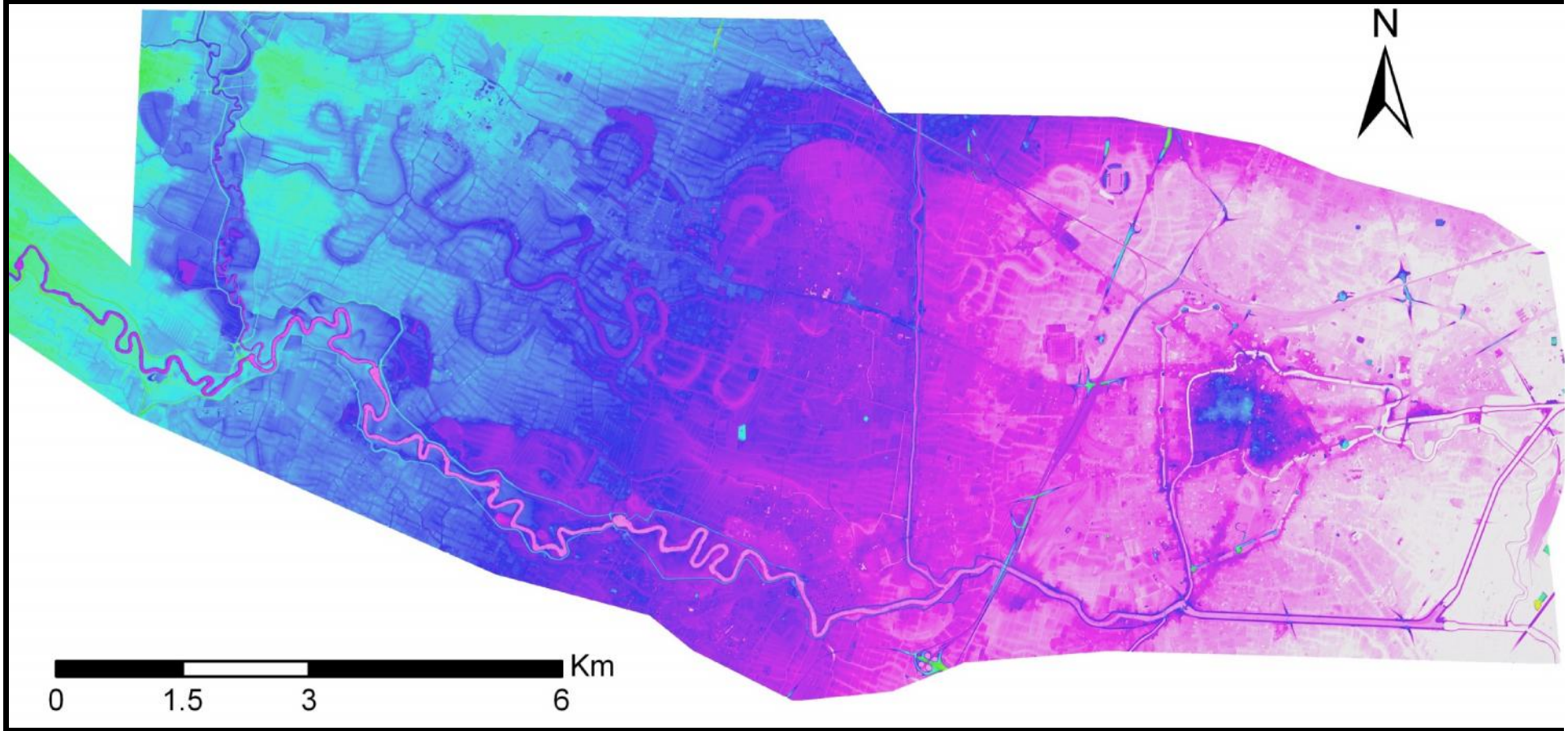
z accuracy < 5-10 cm

3. Processing data

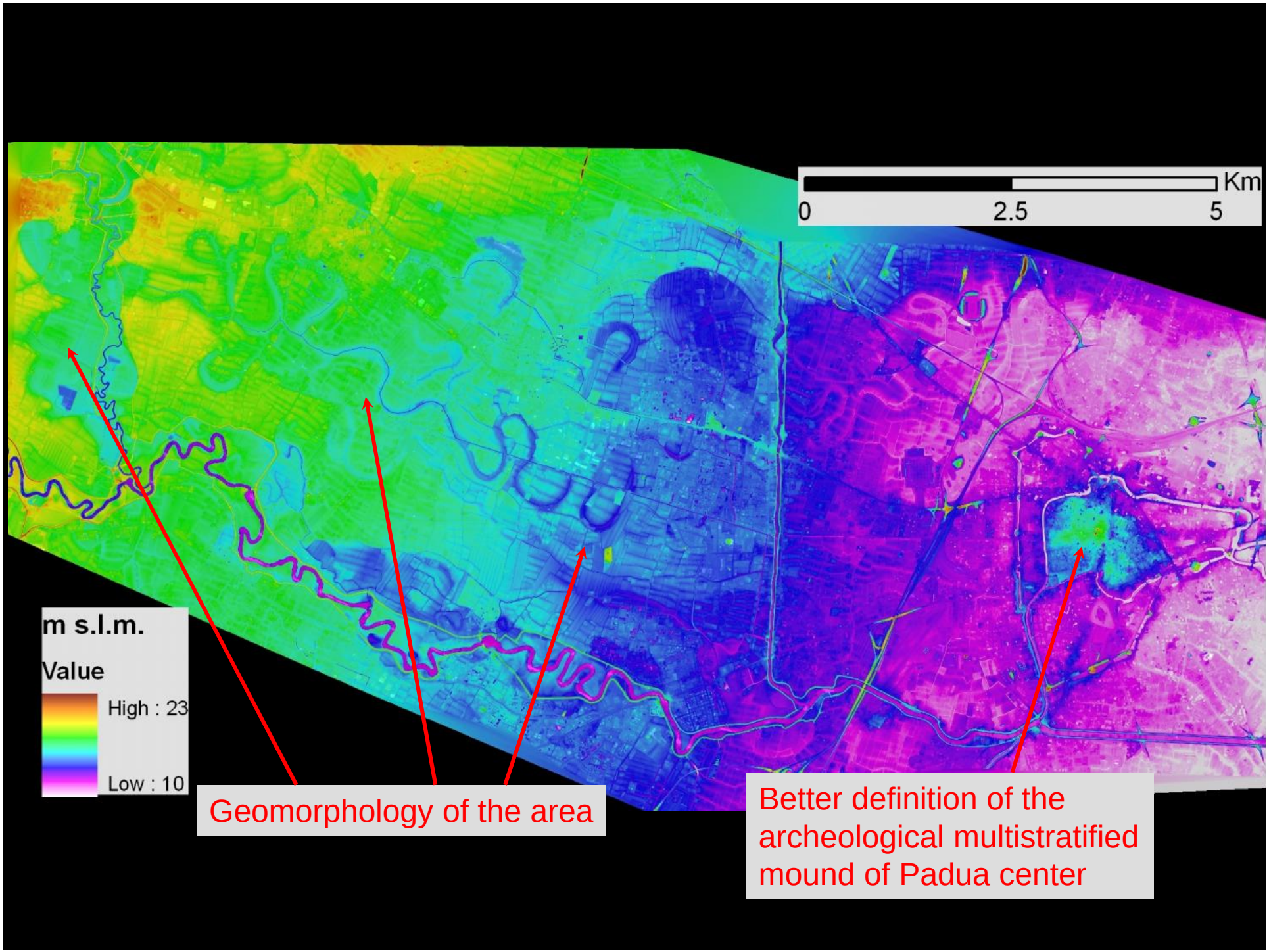
Control of accuracy

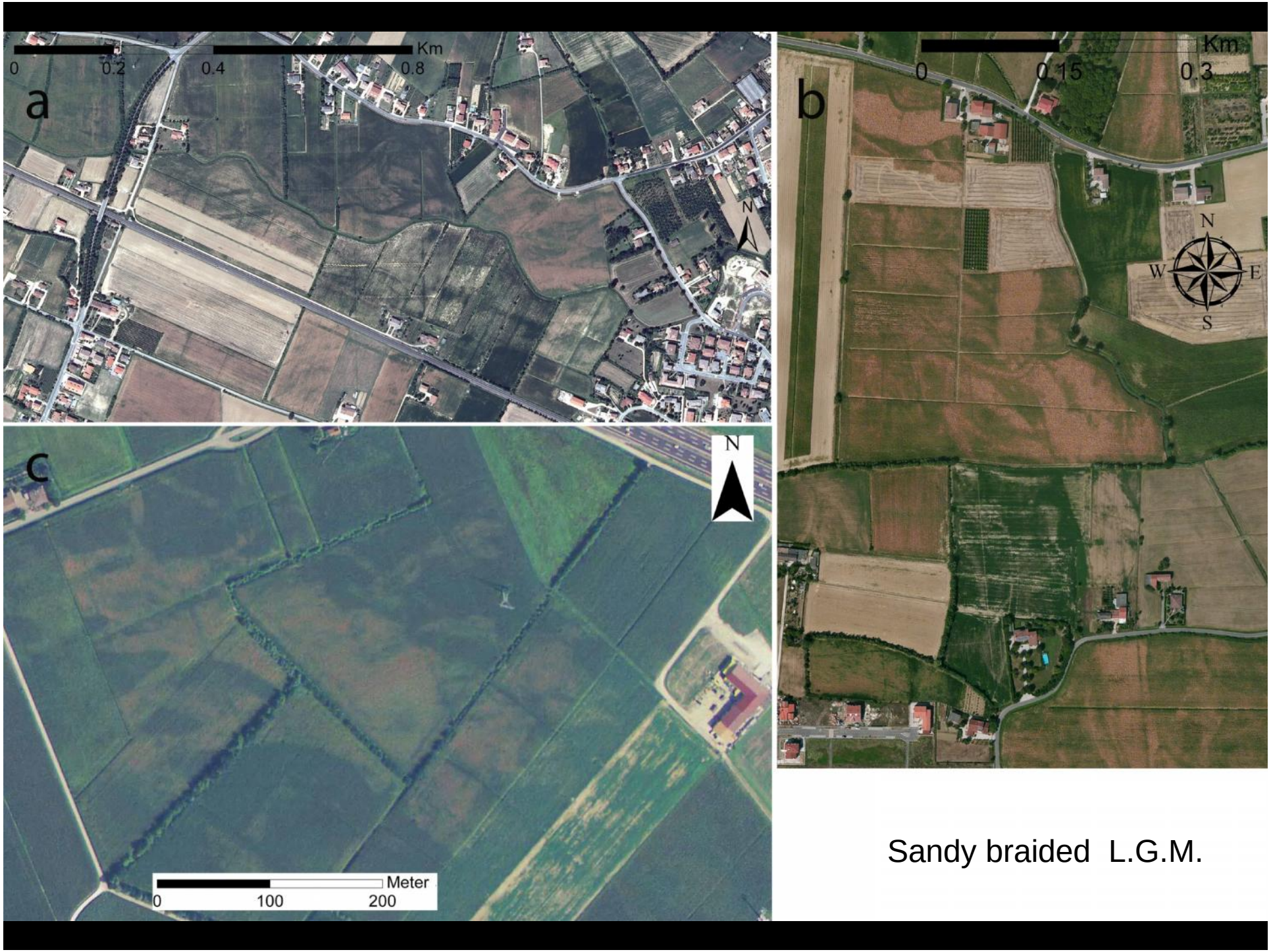
Classification of points cloud

Calibration of the "intensity" → **Geometrically calibrated**



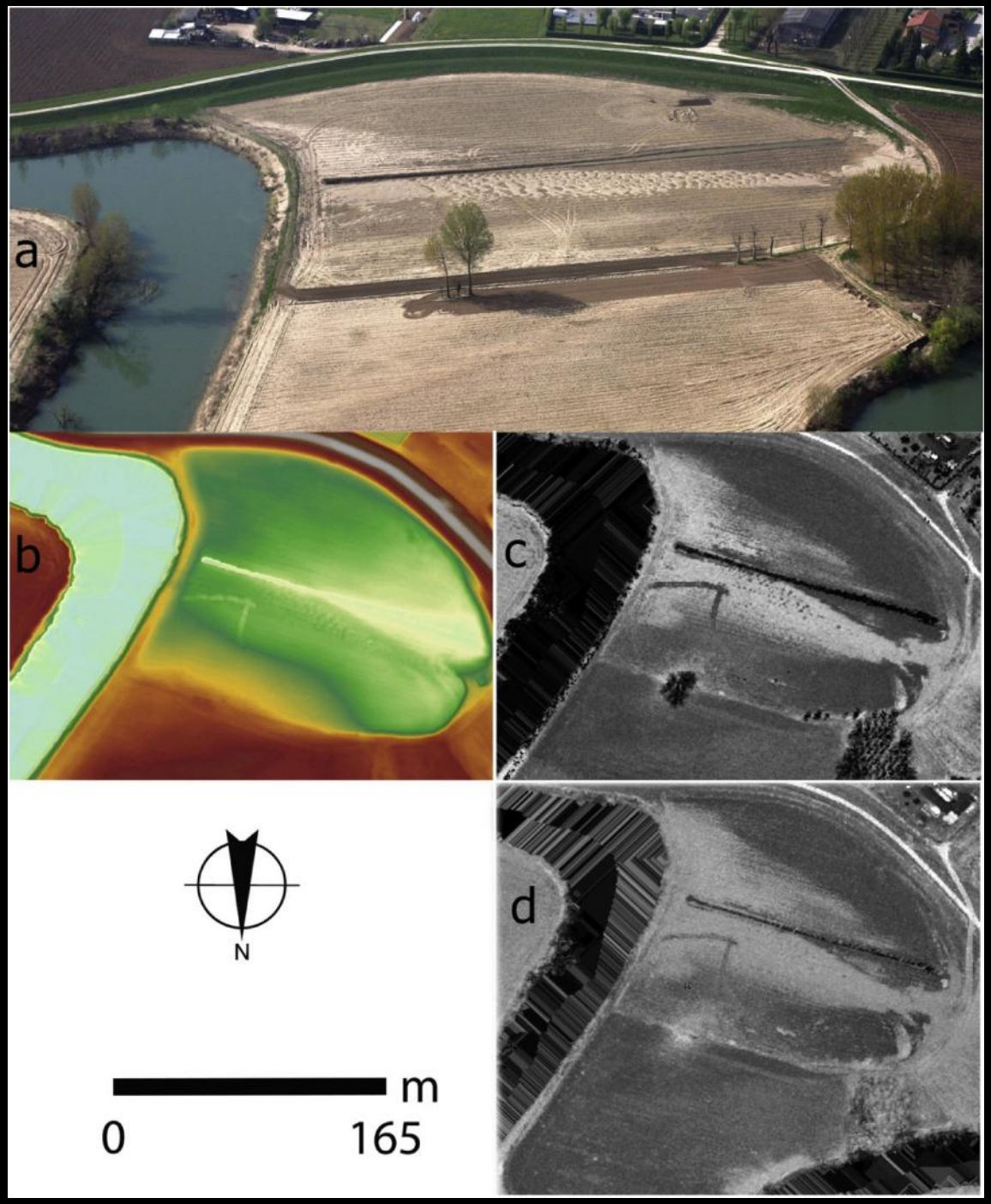
"Ground" DEM


Km
0
2.5
5
m s.l.m.
Value
High : 23
Low : 10
Geomorphology of the area
Better definition of the archeological multistratified mound of Padua center



Sandy braided L.G.M.


N
Km
0
0.25
0.5
1
c
e
d
f



The floodplain of the Bacchiglione River, which was flooded during the November 2010 event.

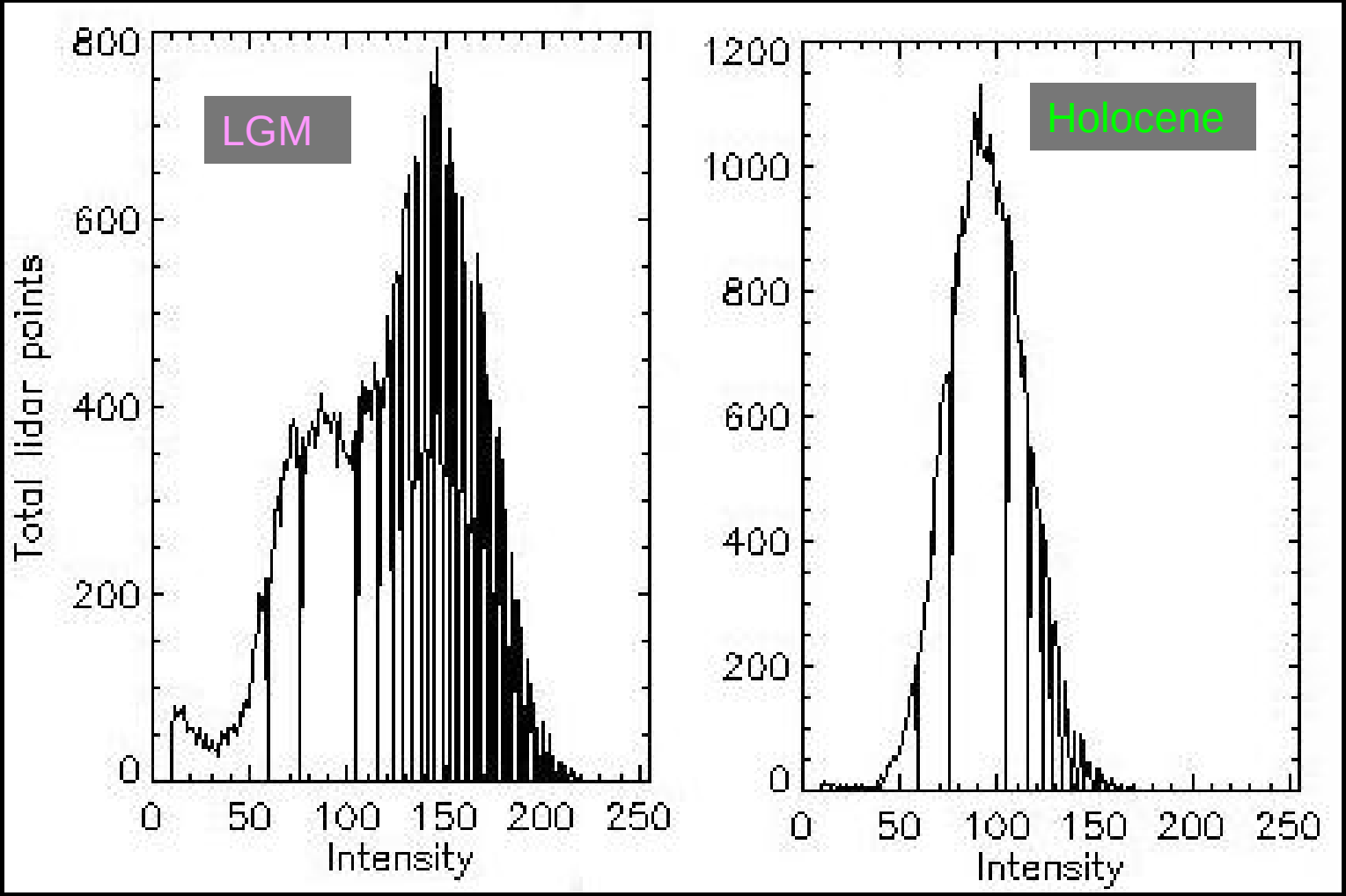
(a) oblique photo (March 2011);

(b) LiDAR DTM;

(c) minimum LiDAR intensity;

(d) maximum LiDAR intensity.

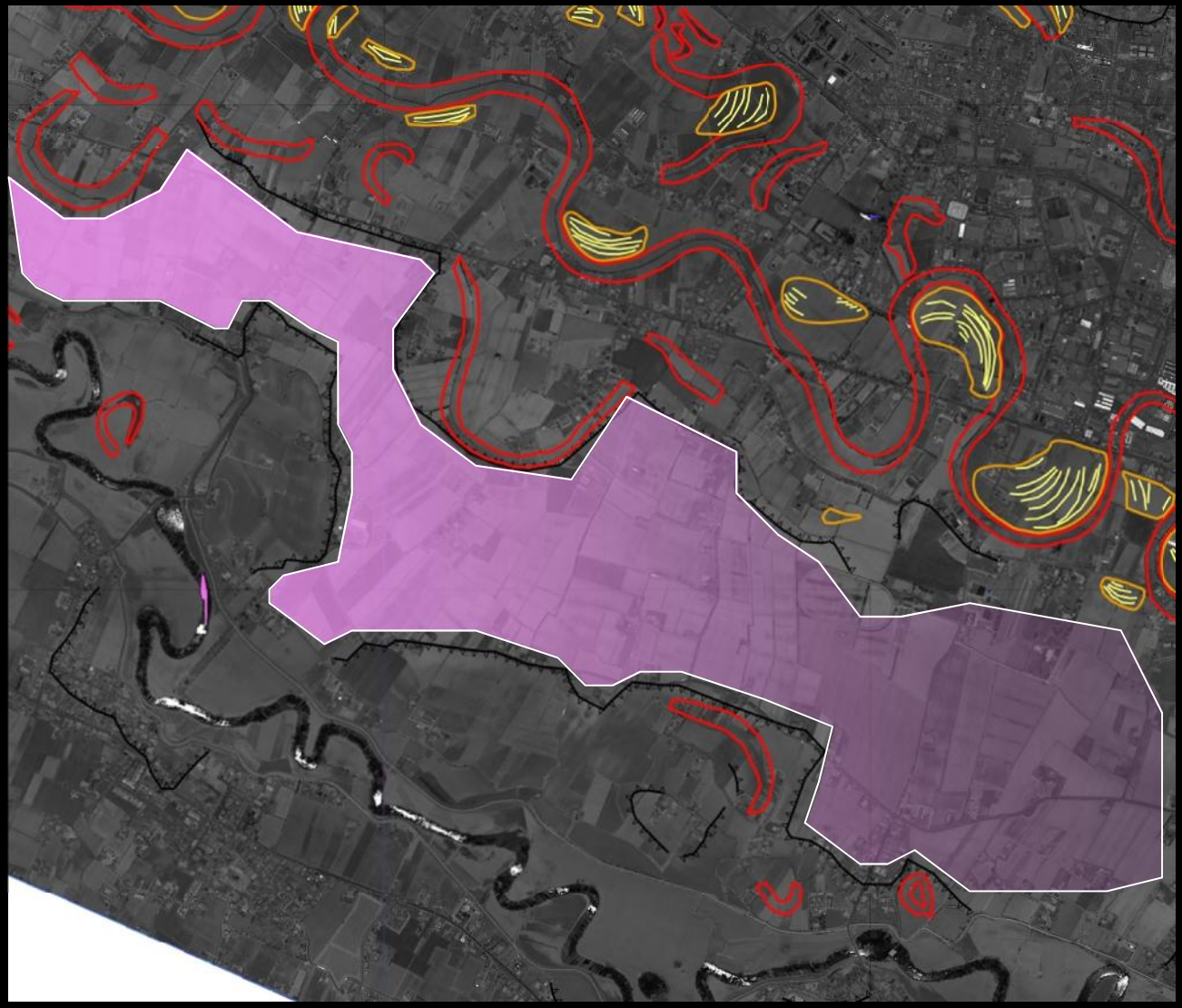
Some morphologies have shown specific reflectance in the laser “intensity”



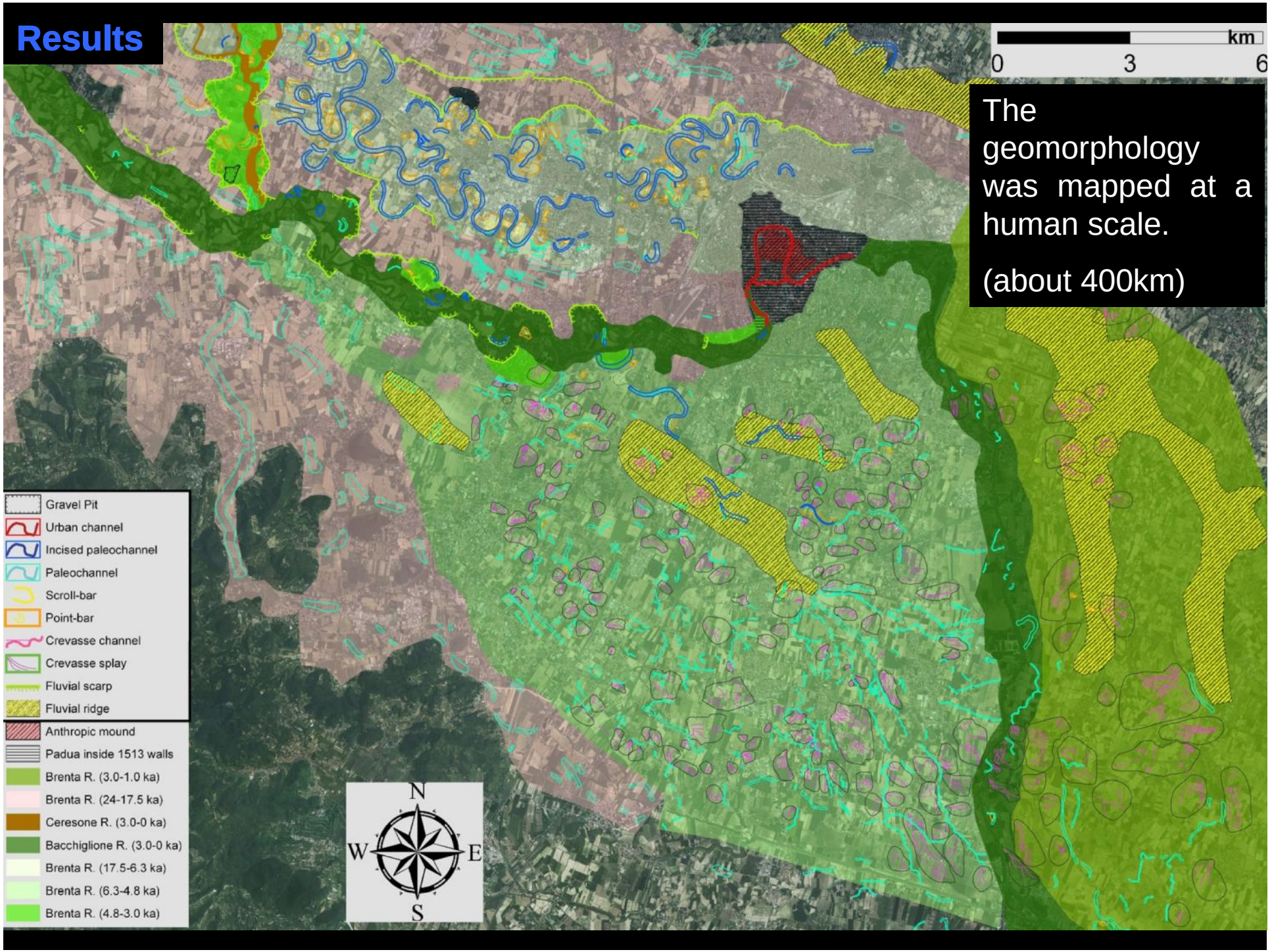
Point cloud frequency on two test areas on the left (LGM) soils with argillic and calcic horizons, on the right Holocene.

Intensity helps to map LGM Interfluves

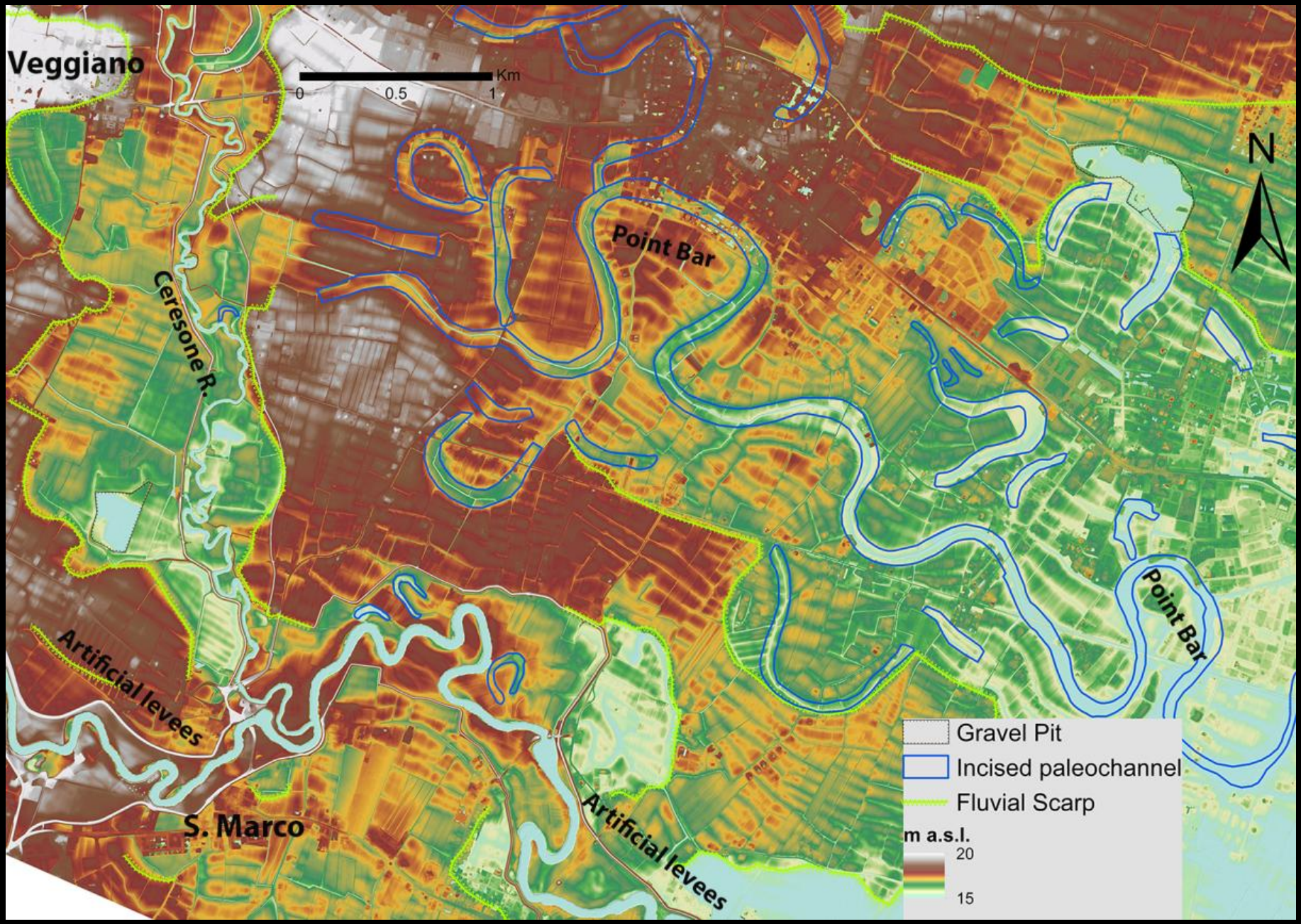
Maximum Intensity: defined as the max values of the points, calculated on a raster of 1 m cell size



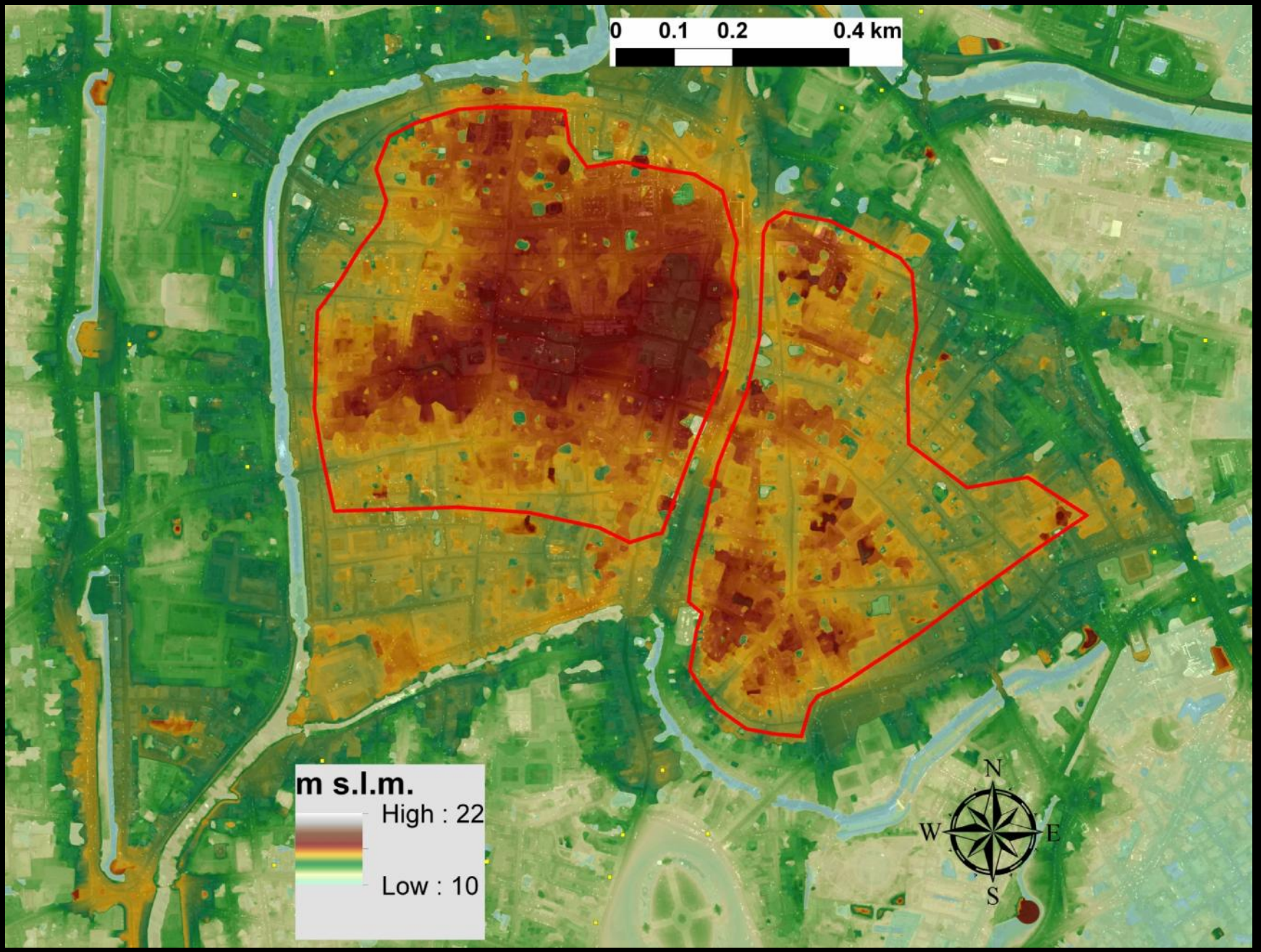
Results


km
0
3
6
The geomorphology was mapped at a human scale.
(about 400km)
Gravel Pit
Urban channel
Incised paleochannel
Paleochannel
Scroll-bar
Point-bar
Crevasse channel
Crevasse splay
Fluvial scarp
Fluvial ridge
Anthropic mound
Padua inside 1513 walls
Brenta R. (3.0-1.0 ka)
Brenta R. (24-17.5 ka)
Ceresone R. (3.0-0 ka)
Bacchiglione R. (3.0-0 ka)
Brenta R. (17.5-6.3 ka)
Brenta R. (6.3-4.8 ka)
Brenta R. (4.8-3.0 ka)
N
W
E
S

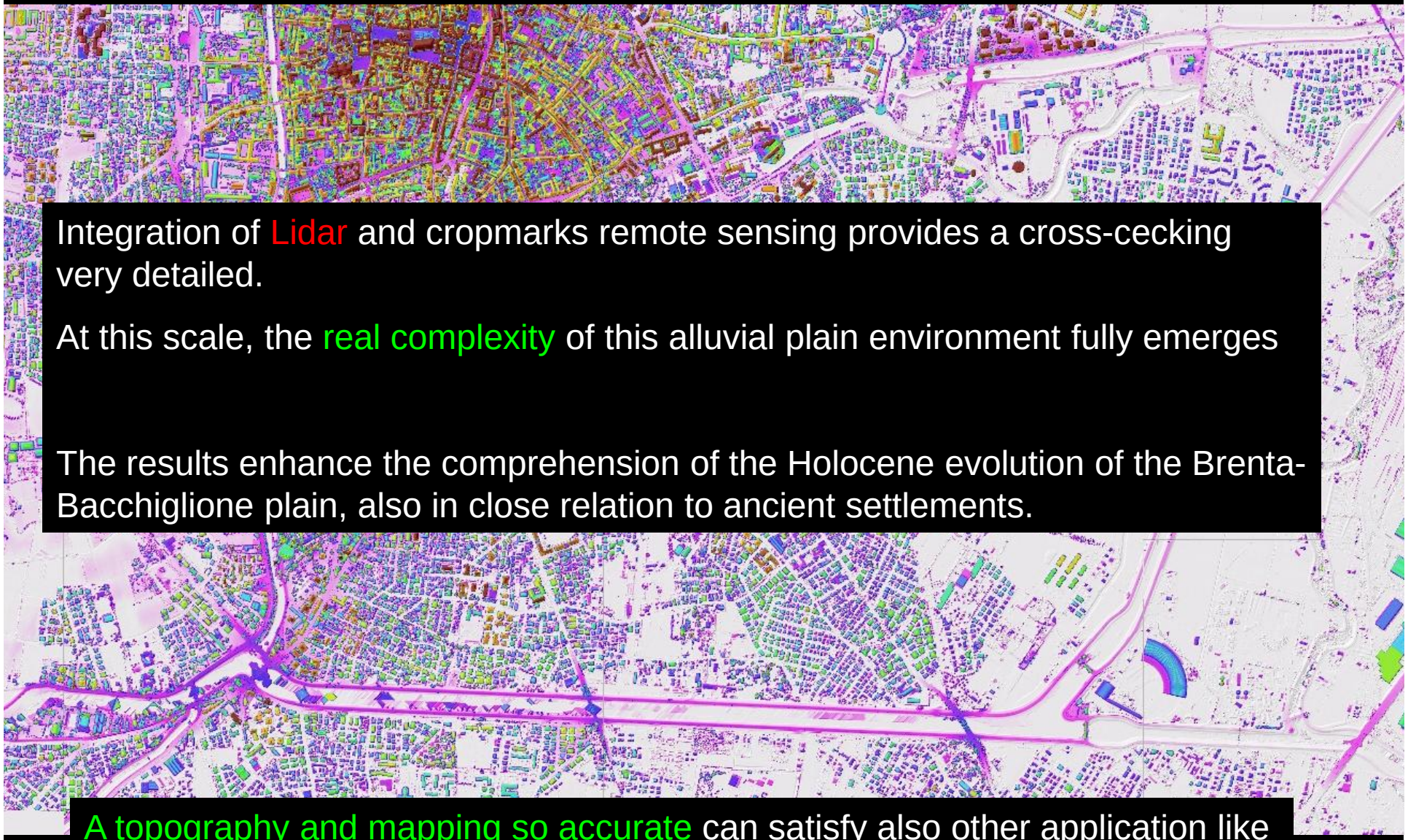
Flood threat linked to bacchiglione R. activity and geomorphological setting



Applicazioni per la mappatura geoarcheologica/archeologia preventiva.



Conclusion

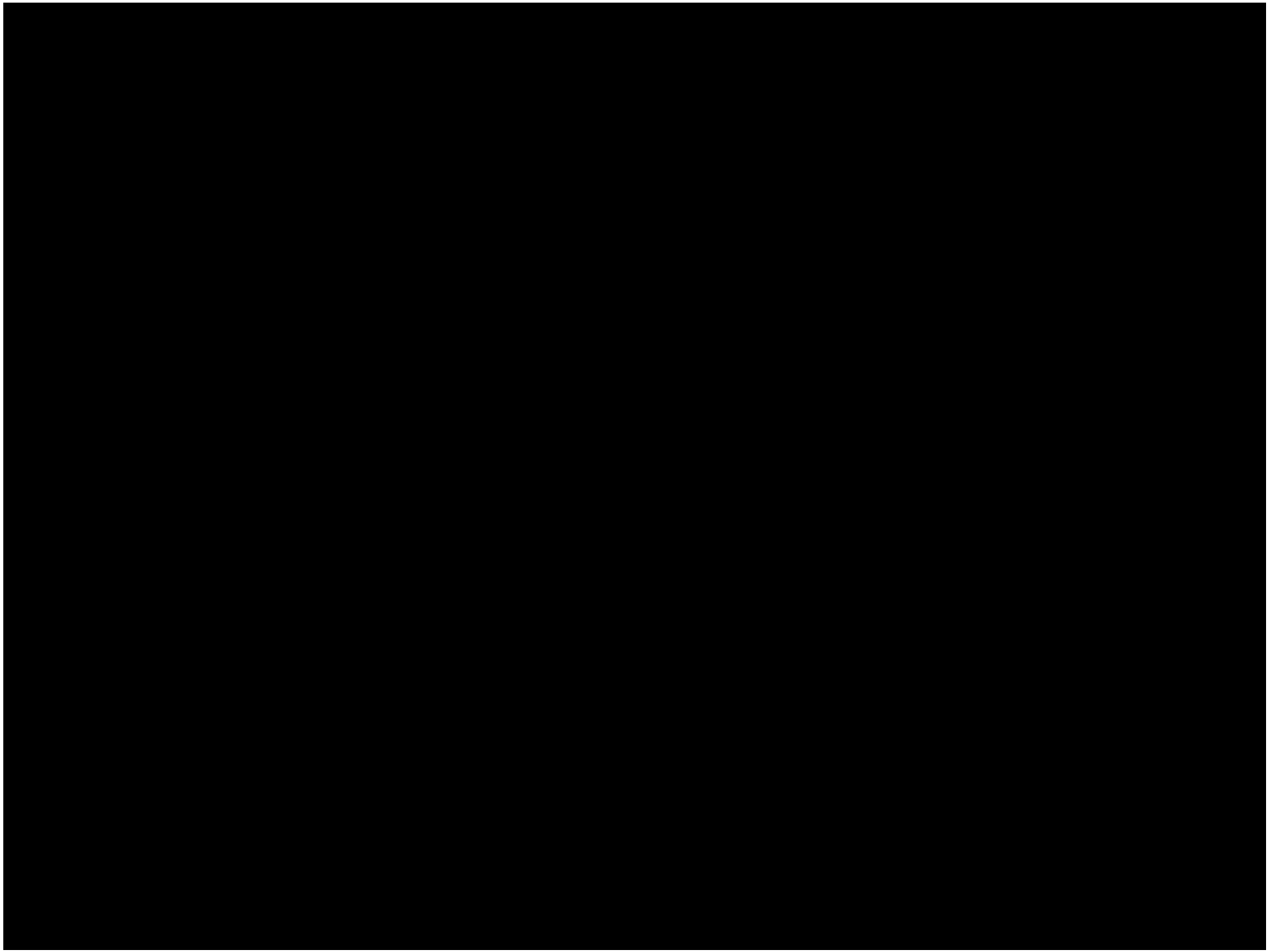


Integration of Lidar and cropmarks remote sensing provides a cross-cecking very detailed.

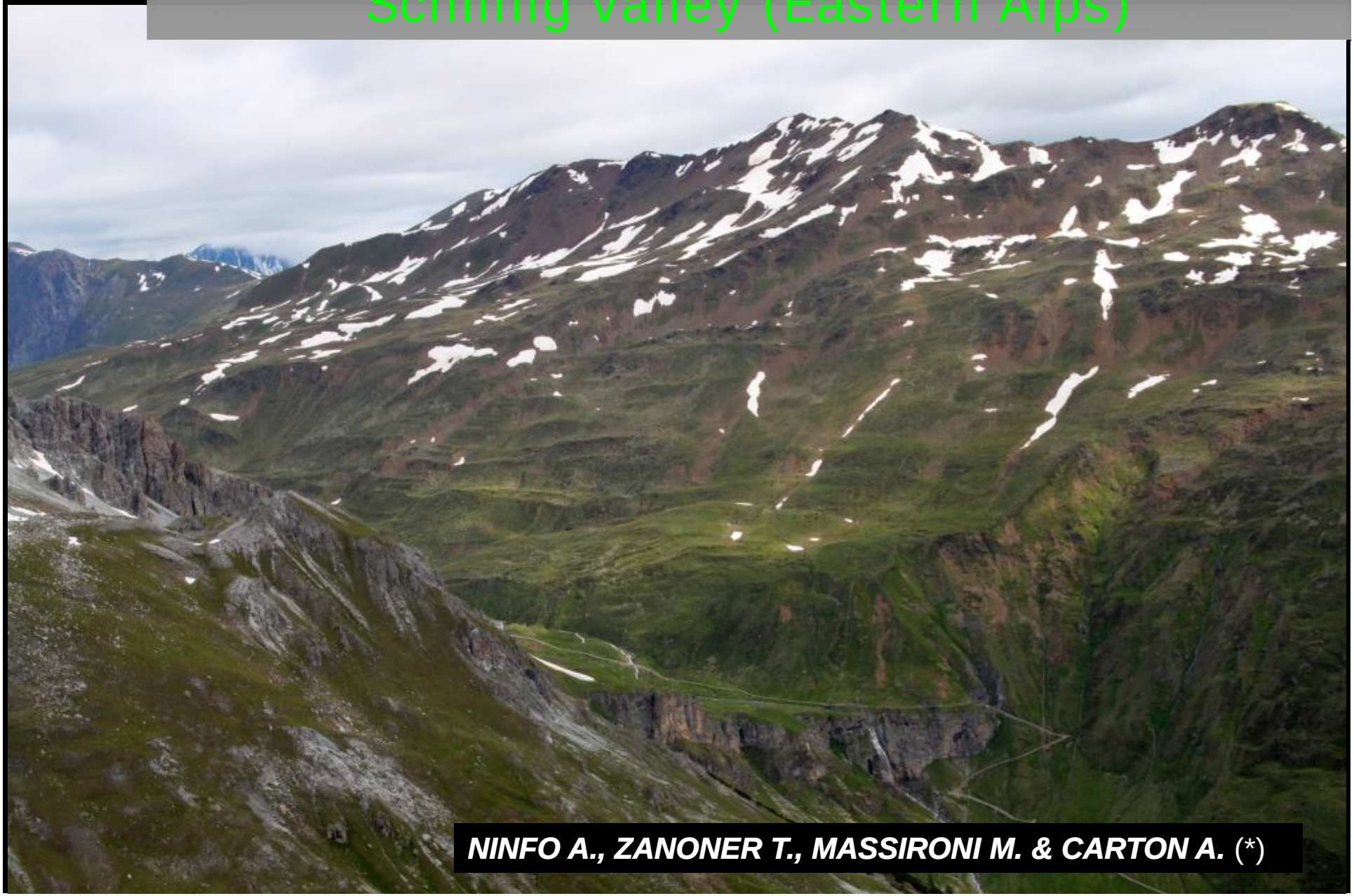
At this scale, the real complexity of this alluvial plain environment fully emerges

The results enhance the comprehension of the Holocene evolution of the Brenta-Bacchiglione plain, also in close relation to ancient settlements.

A topography and mapping so accurate can satisfy also other application like the fllod risk, the infrastructures planning, microsismic zonation etc.



DSGSD geomorphometry. The case of Schlinig valley (Eastern Alps)



NINFO A., ZANONER T., MASSIRONI M. & CARTON A. (*)

Introduction

- DSGSDs may occur on all rock types although are more common on highly foliated metamorphic lithologies (Agliardi et al., 2009).

- DSGSDs are characterized by specific landforms, the most distinctive ones being double ridges, scarps, counterscarps, trenches (Zischinsky 1966, 1969; Ter-Stepanian 1966; Beck 1968; Agliardi et al. 2001)

- These morphostructures can be classified in between landslides and tectonic landforms (Persaud & Pfiffner 2004; Ustaszewski et al. 2008).

Hillsade (315)

We focused on the Schlinig valley (Eastern Alps, South Tyrol) because it is affected by numerous DSGSDs types, evolving on various lithologies, which are in tectonic contact along a major alpine fault

1
Kilometers

Aims

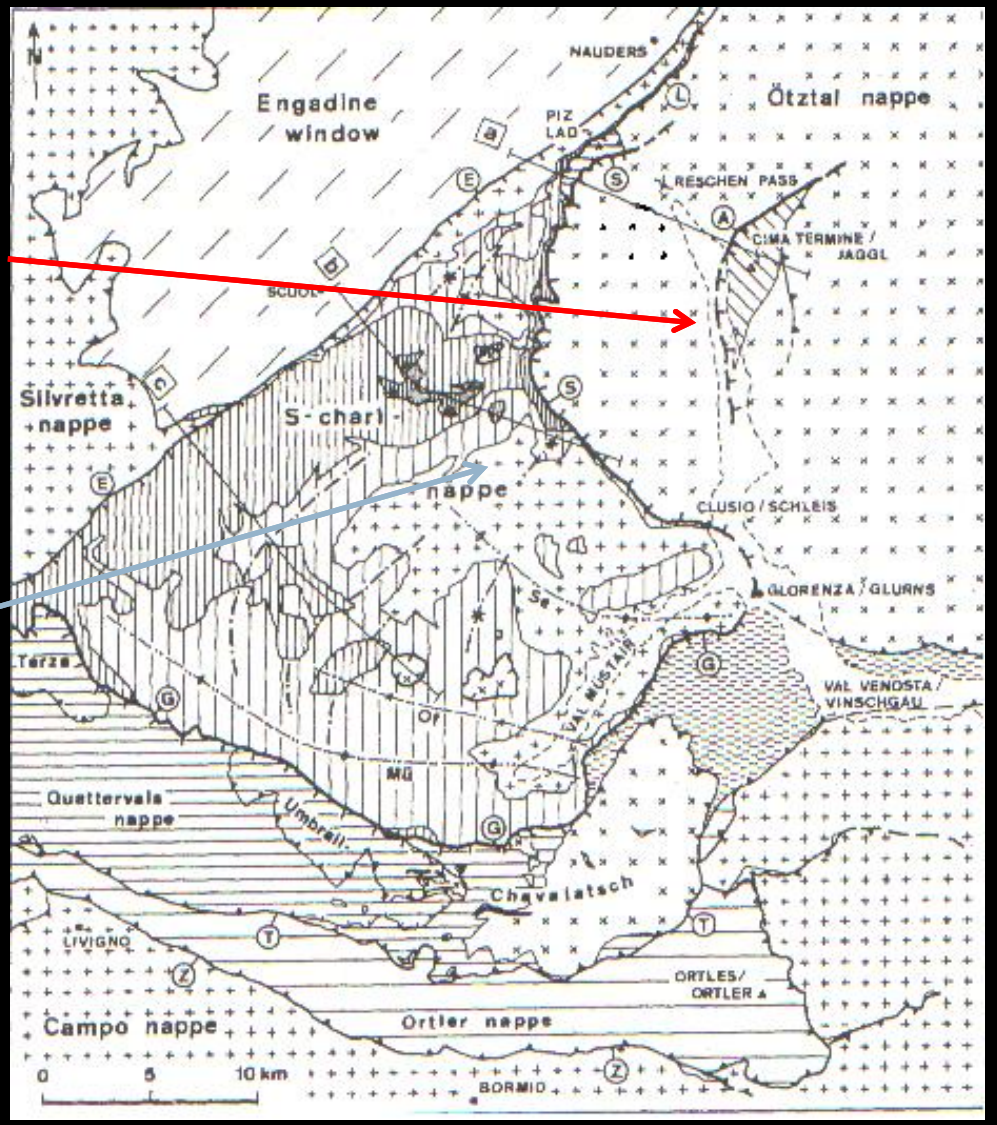
- Geological, structural and morphometrical characterization of the Slingia valley
- Geomorphometry of DSGDs diagnostic landforms (morphostructures)
- To propouse a methodology that can improve the DSGSDs geomorphological identification and mapping.
- Contribute to a more objective identification of DSGSDs phenomena

Sovrapposizione di due falde di ricoprimento austroalpine:
FALDA DELL'OTZTAL e FALDA DI S-CHARL

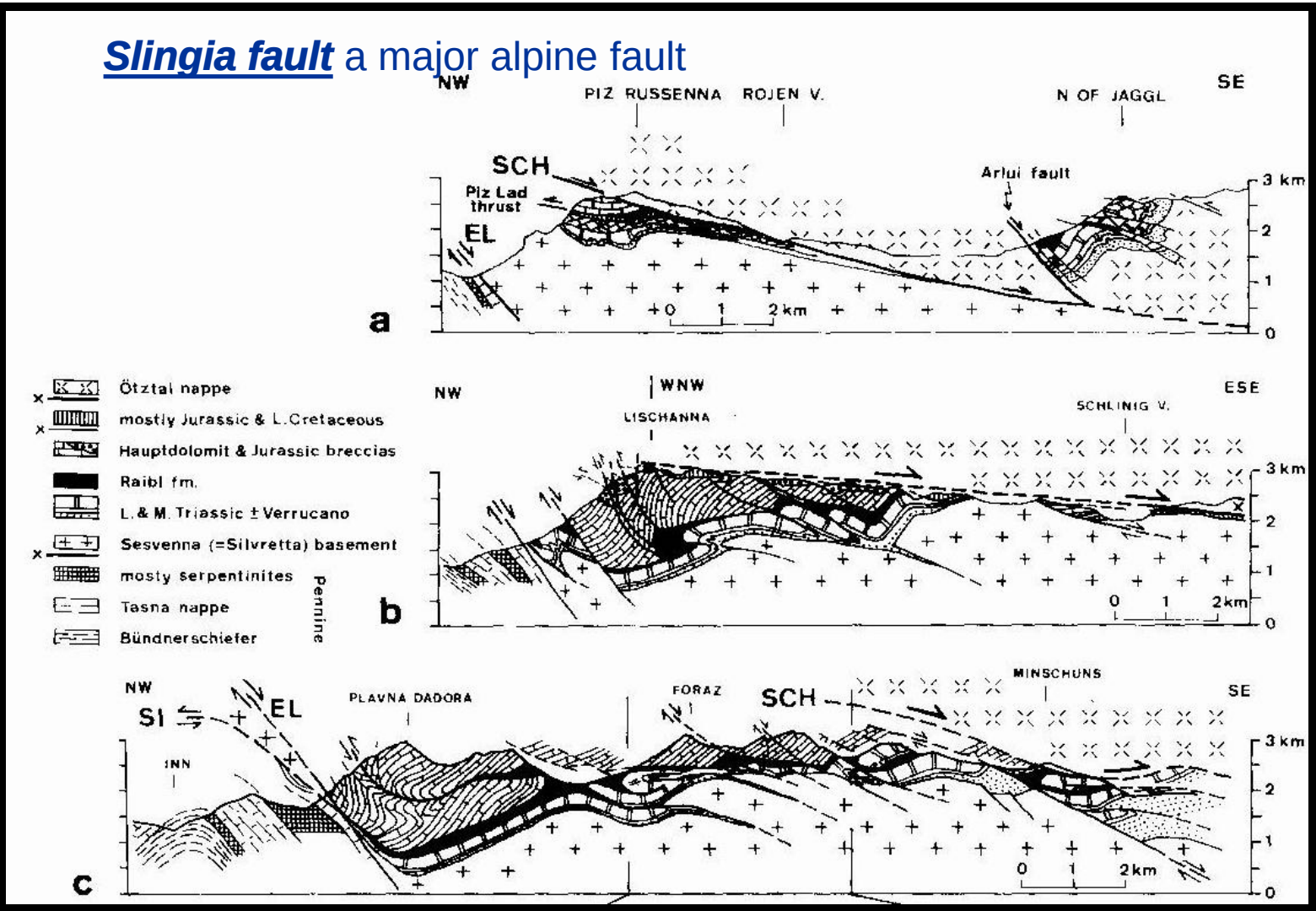
Falda dell'Otztal-Silvretta: elemento più elevato rappresentato dal basamento cristallino

Falda di S-charl-Umbrail: elemento tettonico sottostante identificato da basamento cristallino e copertura permo-mesozoica

Basamenti polimetamorfici che hanno subito metamorfismo di età Varisica (facies anfibolitica) e Alpino (facies scisti verdi)

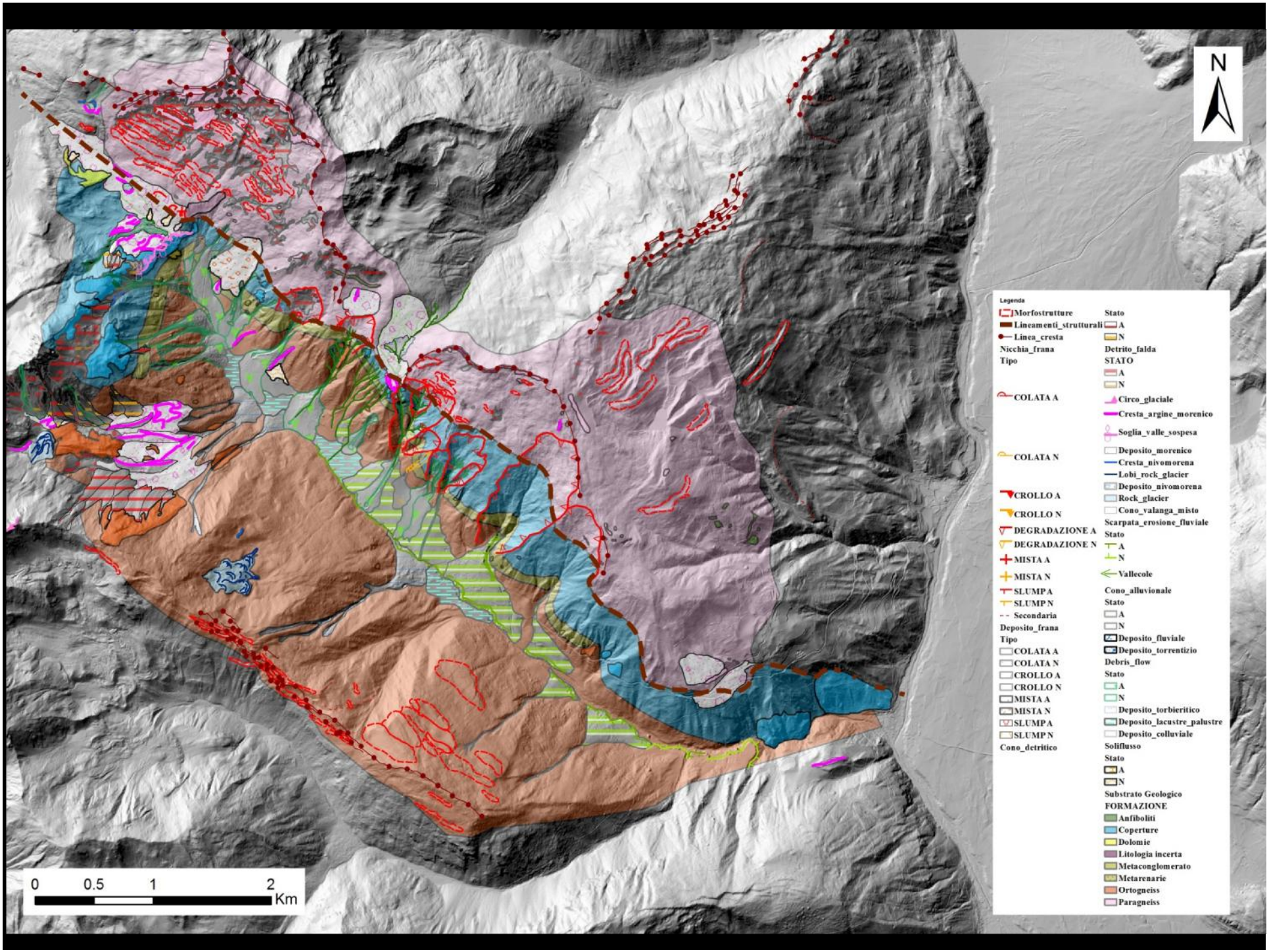


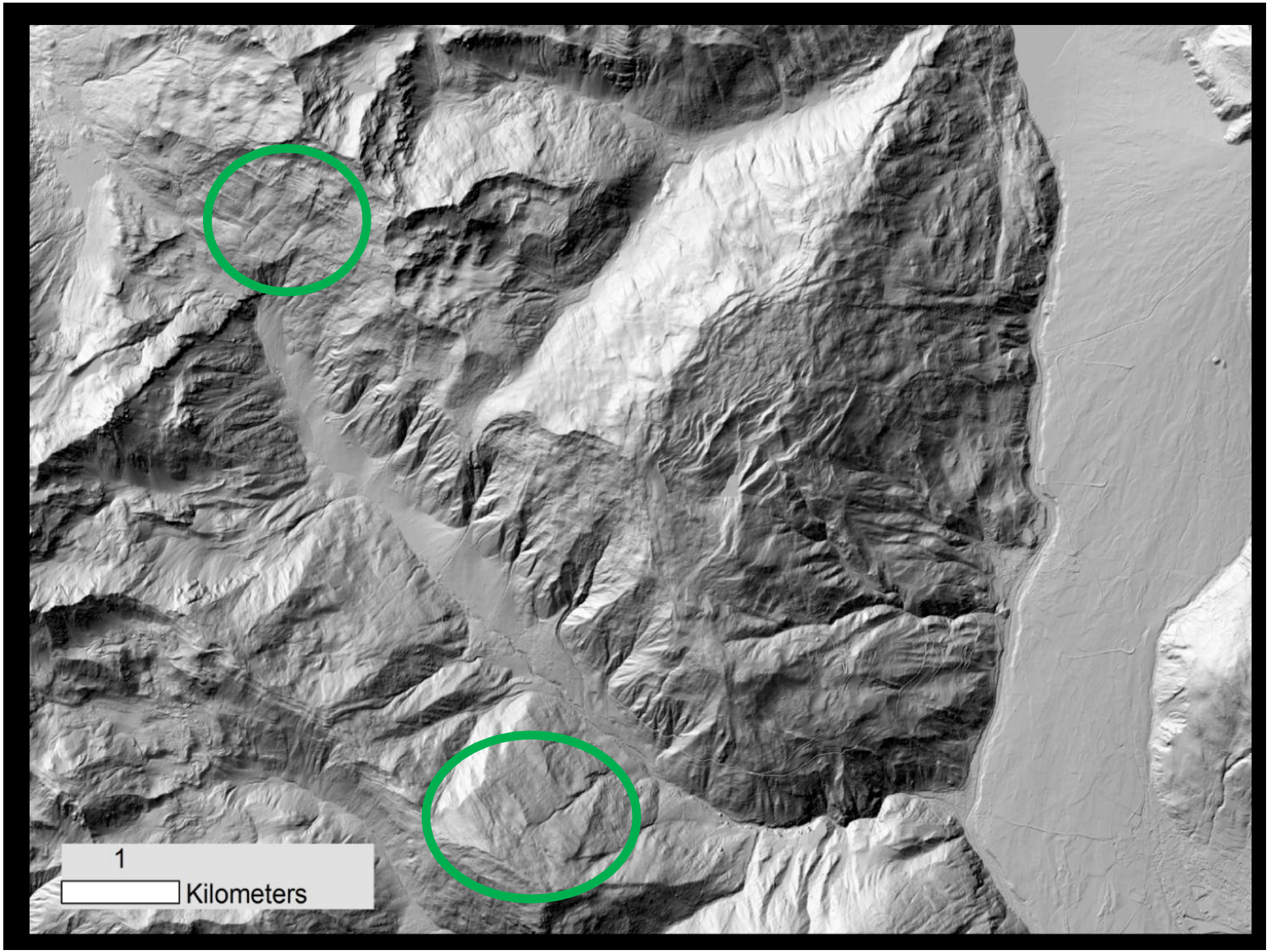
Slingia fault a major alpine fault



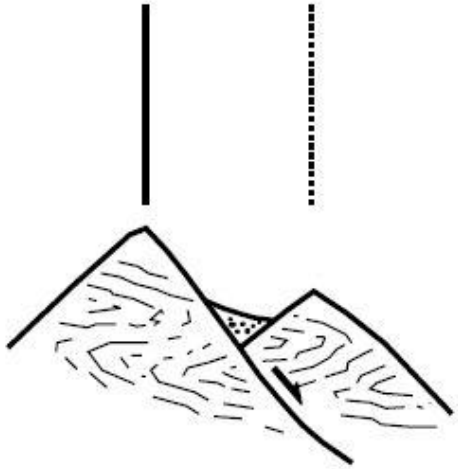
Faglia a basso angolo (10-15°) immergente a ENE; è il limite tettonico tra le 2 falde austroalpine

- Zona di shear duttile associata a trasporto verso Ovest della Falda dell'Otztal (Schmid & Haas, 1989)
- Riattivata come faglia trastensiva nel tardo Cretaceo (Froitzheim et al., 1997) e nuovamente in compressione nel terziario

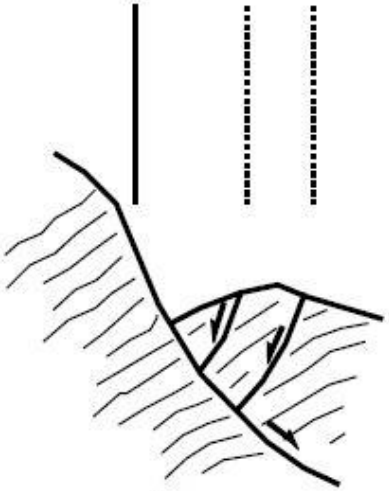

N
Legenda
Morfostrutture
Lineamenti_strutturali
Linea_cresta
Nicchia_frana
Tipo
COLATA A
COLATA N
CROLLO A
CROLLO N
DEGRADAZIONE A
DEGRADAZIONE N
MISTA A
MISTA N
SLUMP A
SLUMP N
Secondaria
Deposito_frana
Tipo
COLATA A
COLATA N
CROLLO A
CROLLO N
MISTA A
MISTA N
SLUMP A
SLUMP N
Cono_detritico
Stato
A
N
Detrito_falda
STATO
A
N
Circo_glaciale
Cresta_argine_morenico
Soglia_valle_sospesa
Deposito_morenico
Cresta_nivomorena
Lobi_rock_glacier
Deposito_nivomorena
Rock_glacier
Cono_valanga_misto
Scarpata_erosione_fluviale
Stato
A
N
Vallecole
Cono_alluvionale
Stato
A
N
Deposito_fluviale
Deposito_torrentizio
Debris_flow
Stato
A
N
Deposito_torbieritico
Deposito_lacustre_palustre
Deposito_colluviale
Soliflusso
Stato
A
N
Substrato Geologico
FORMAZIONE
Anfiboliti
Coperture
Dolomie
Litologia incerta
Metaconglomerato
Metarenarie
Ortogneiss
Paragneiss
0
0.5
1
2
Km


1
Kilometers

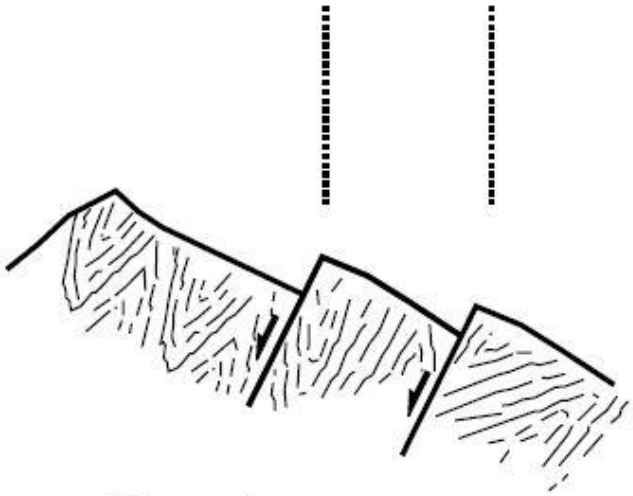
Morfostrutture DGPV



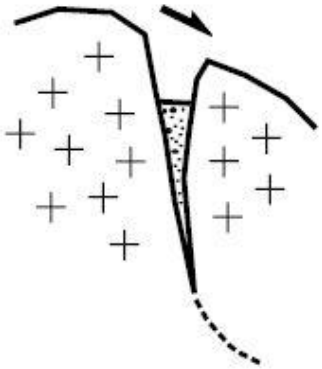
Doubled ridges
DR

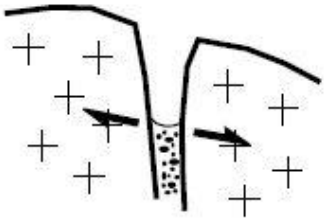


Scarps
S

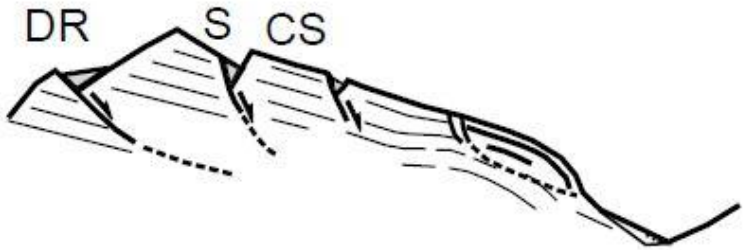


Counterscarps
CS





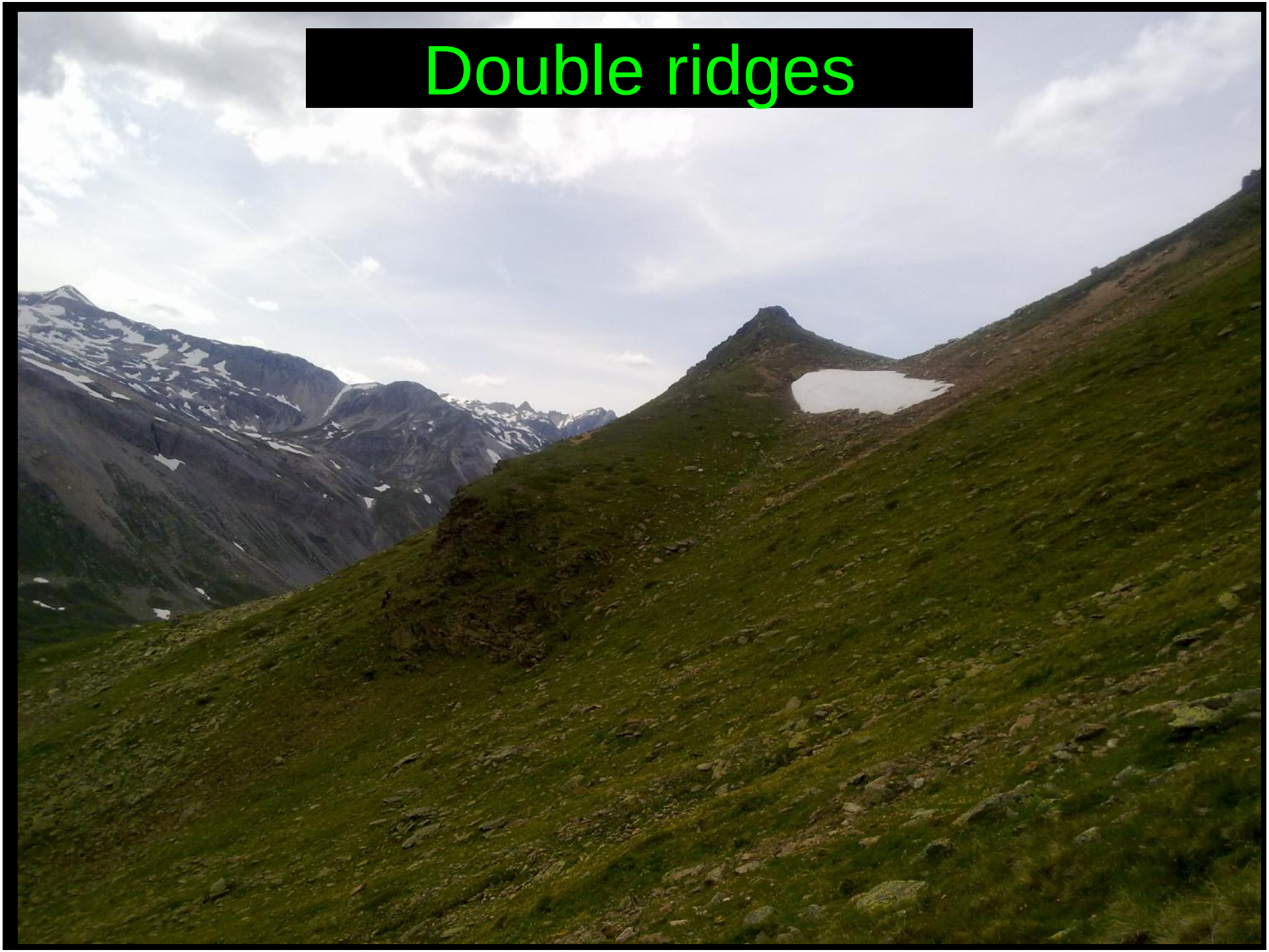
Trenches



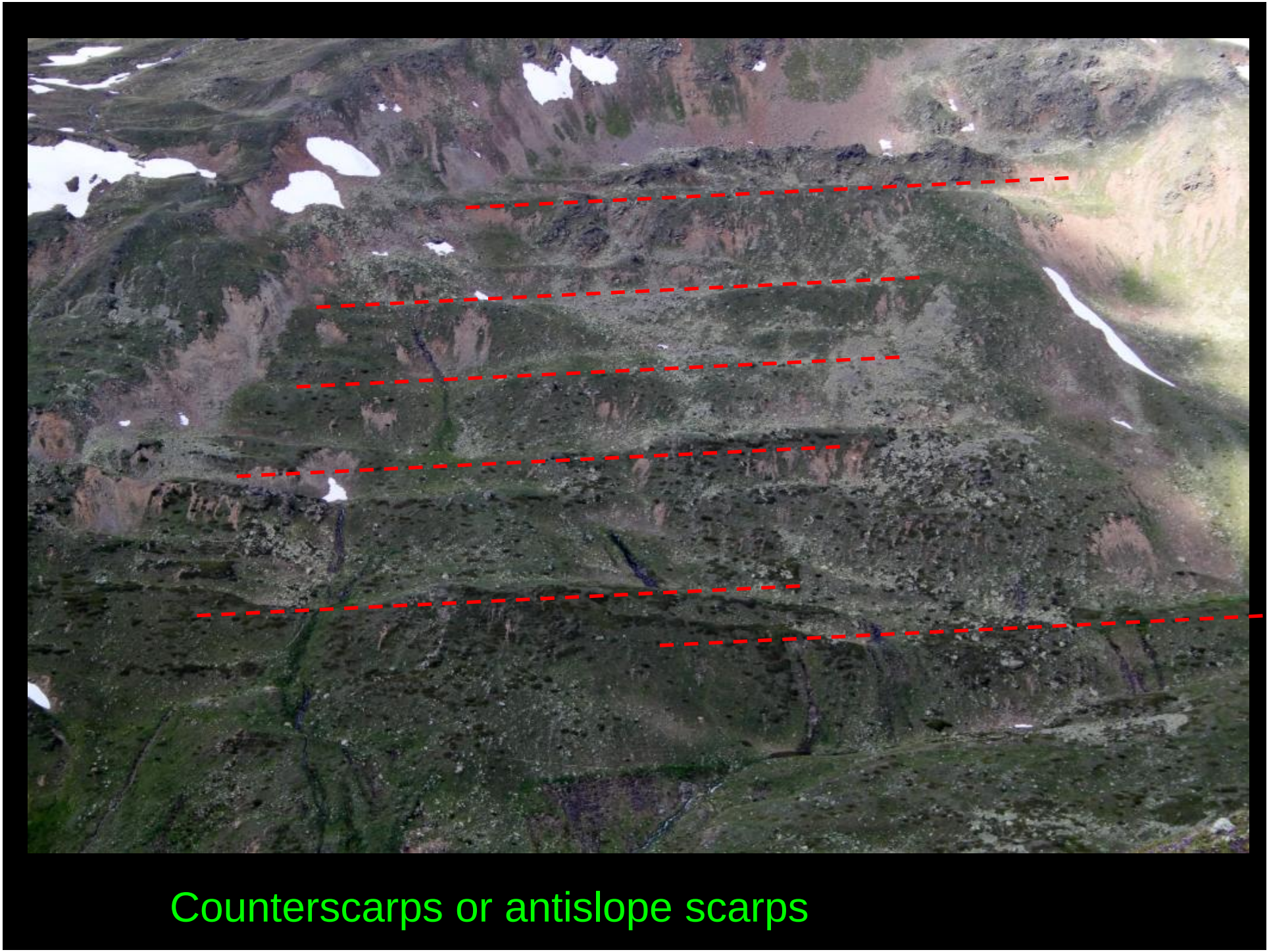
Bulging &
large landslides

(Agliardi et al. 2001)

Double ridges

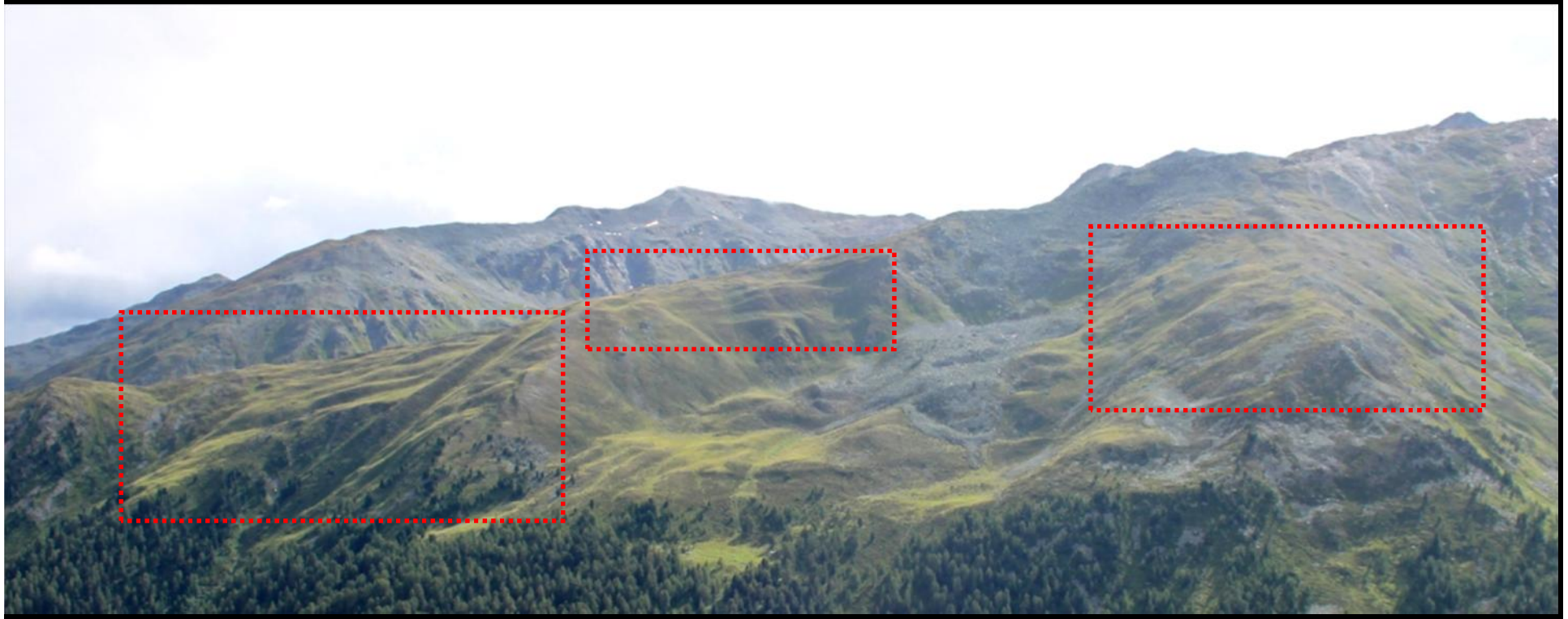


Scarps and trench

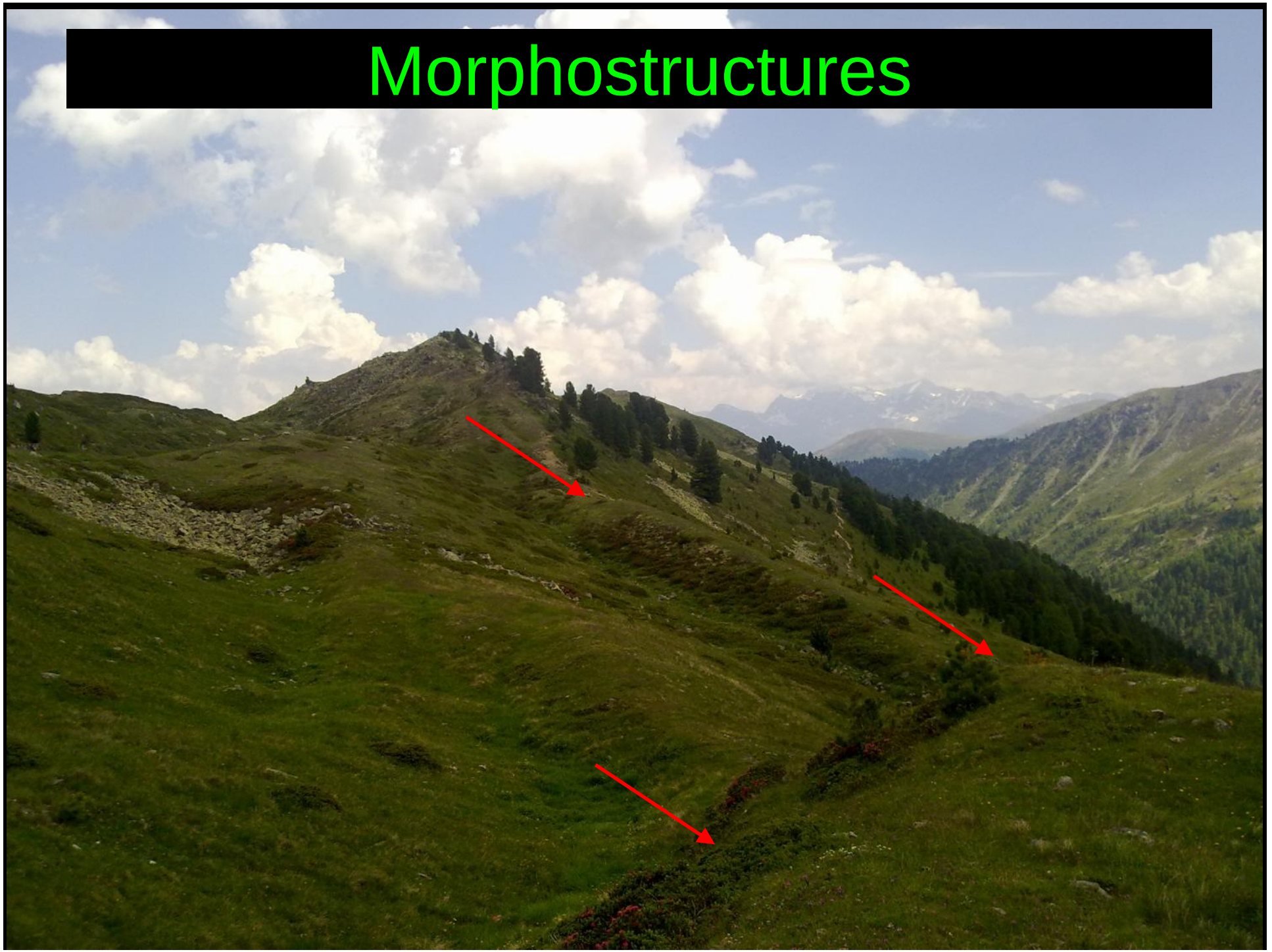


Counterscarps or antislope scarps

Morphostructures

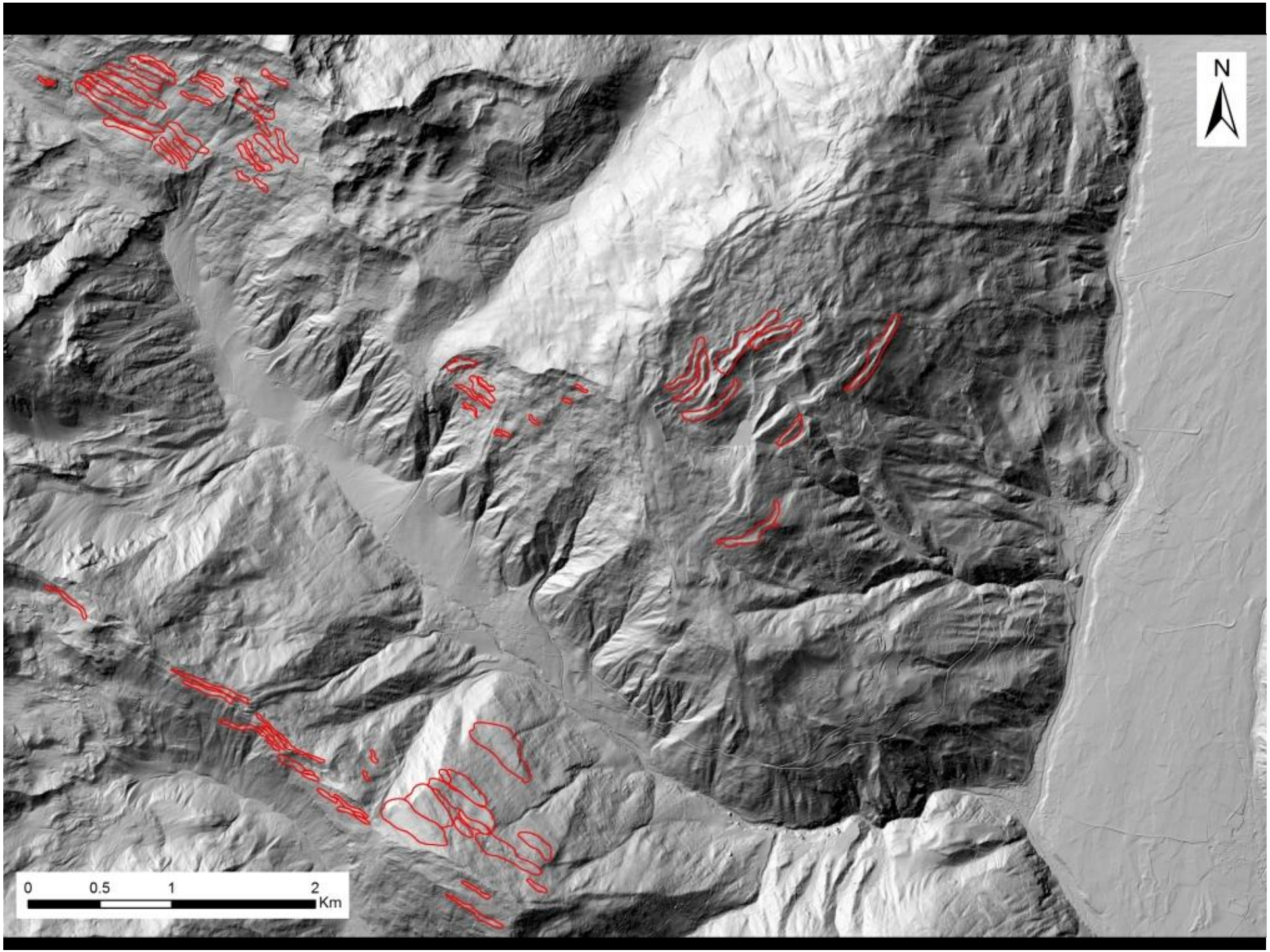


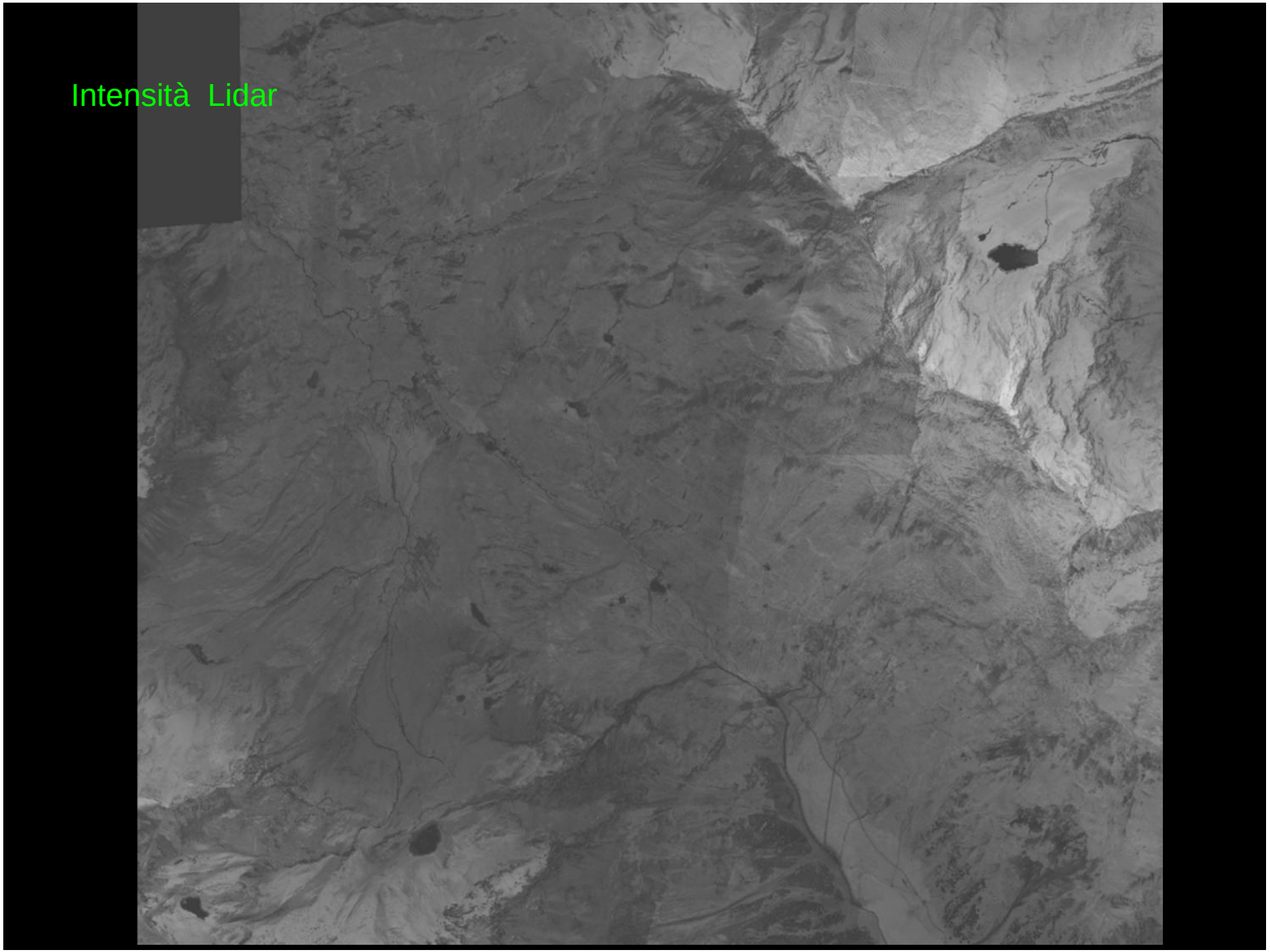
Morphostructures



- The counterscarps, in the study area, present some specific characteristics: they are wide (20 – 70 m), long (100 – 700 m), with a mean surface of 11438 m2 and an average direction perpendicular to the maximum slope.
- Their morphometry is characterized by a half concave profile that changes to convex through an intermediate low gradient area.

- The middle sectors of the counterscarps are the only “flat areas” (gradient < 9°) in the DSGSD and can be easily recognized through a slope classification.

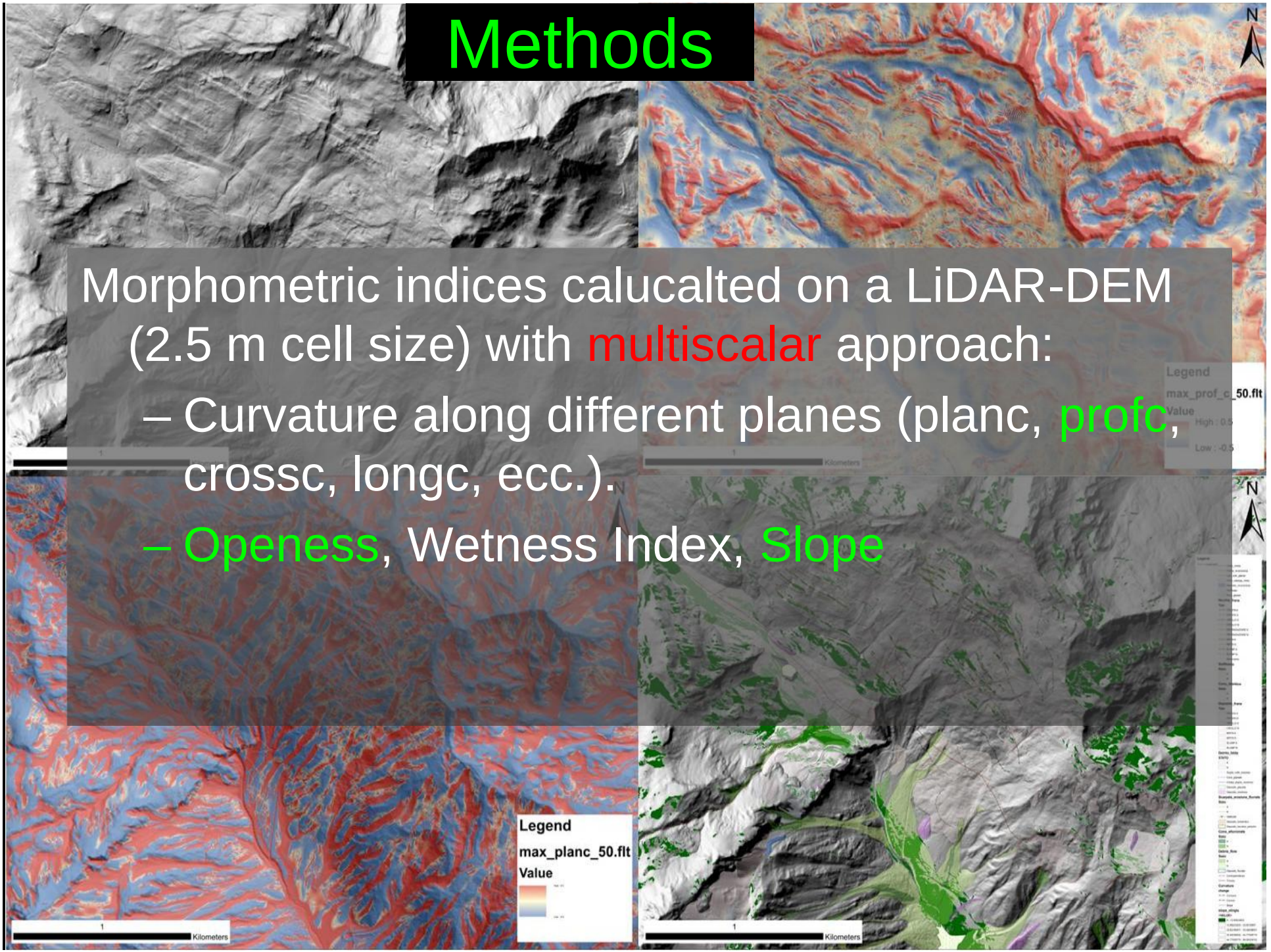

N
0
0.5
1
2
Km


Intensità Lidar

Methods

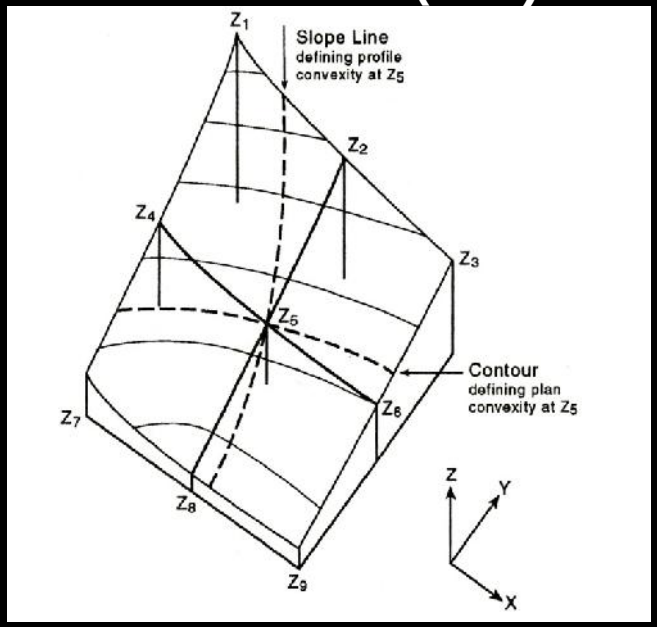
Morphometric indices calucalted on a LiDAR-DEM (2.5 m cell size) with multiscalar approach:

- Curvature along different planes (planc, profc, crossc, longc, ecc.).
- Openess, Wetness Index, Slope



Calcolo delle derivate morfometriche

da Evans (1998)



La superficie continua di un DEM può essere approssimata e rappresentata analiticamente da una funzione polinomiale di secondo grado

$$z = ax^2 + by^2 + cxy + dx + ey + f$$

Evans (1972, 1980); Wood (1996)

slope: pendenza
$= arctan(d^2+e^2)^{0.5}$

aspect: esposizione
$= arctan(d/e)$

profile convexity (*profc*): il grado di variazione della convessità calcolata intersecando il piano dell'asse z e la direzione dell'aspect;
$= (ad^2+ae^2+cde)/(d^2+e^2)(1+d^2+e^2)^{1.5}$

plan convexity (*planc*): il grado di variazione della convessità calcolata intersecando il piano xy
$= (bd^2+ae^2-cde)/(d^2+e^2)^{1.5}$

longitudinal curvature (*longc*): il grado di variazione della curvatura calcolata intersecando il piano normale alla pendenza e alla direzione dell'*aspect*;
$= (ad^2+be^2+cde)/(d^2+e^2)$

cross-sectional curvature (*crosc*): il grado di variazione della curvatura calcolata nell'intersezione tra il piano di massima pendenza e il piano perpendicolare all'*aspect*;
$= (bd^2+ae^2-cde)/(d^2+e^2)$

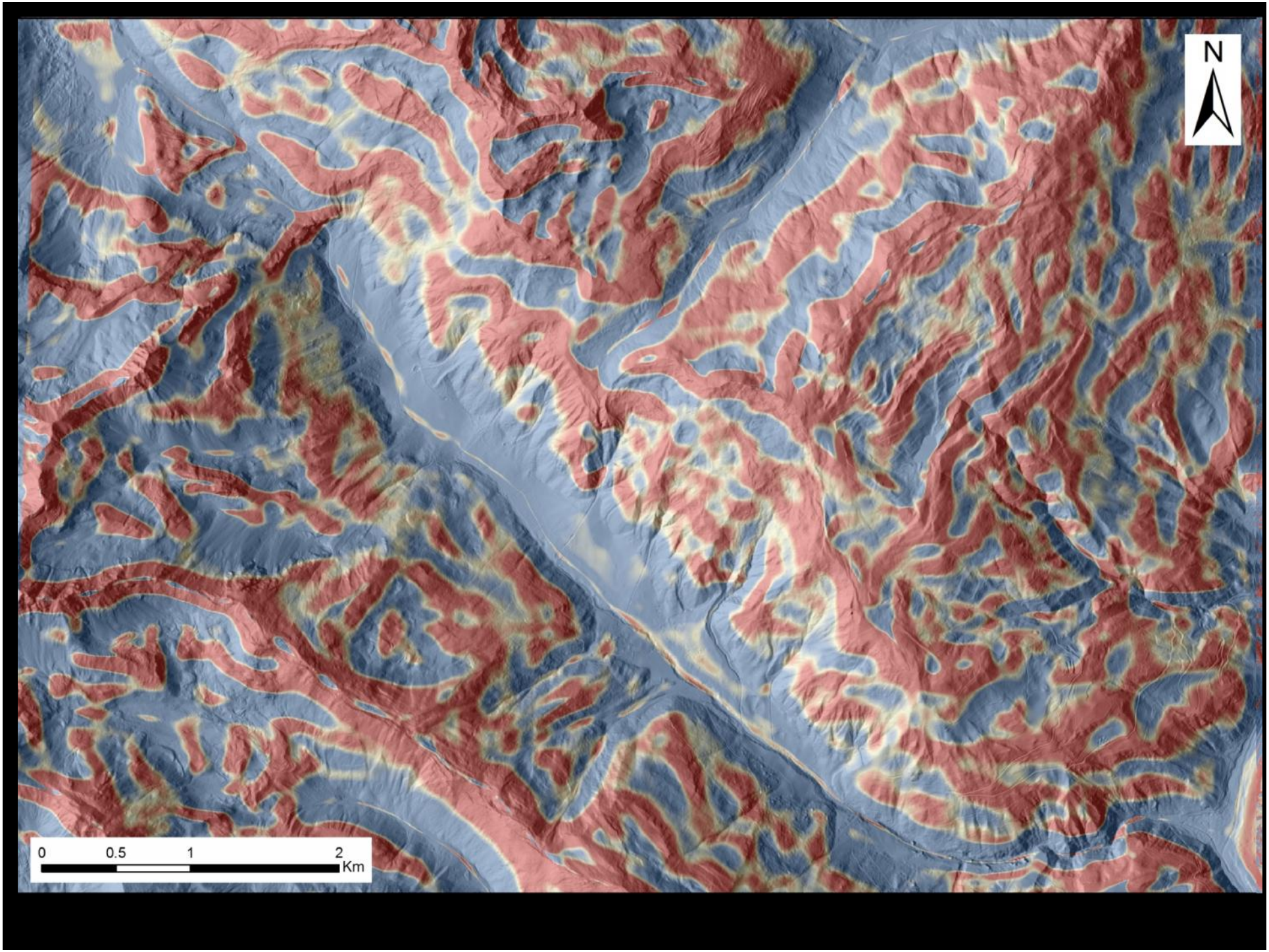
minimum curvature (*minc*): il valore minimo di curvatura calcolato in ogni piano;
$= (-a-b)-((a-b)^2+c^2)^{0.5}$

maximum curvature (*maxc*): il valore massimo di curvatura calcolato in ogni piano
$= (-a-b)+((a-b)^2+c^2)^{0.5}$

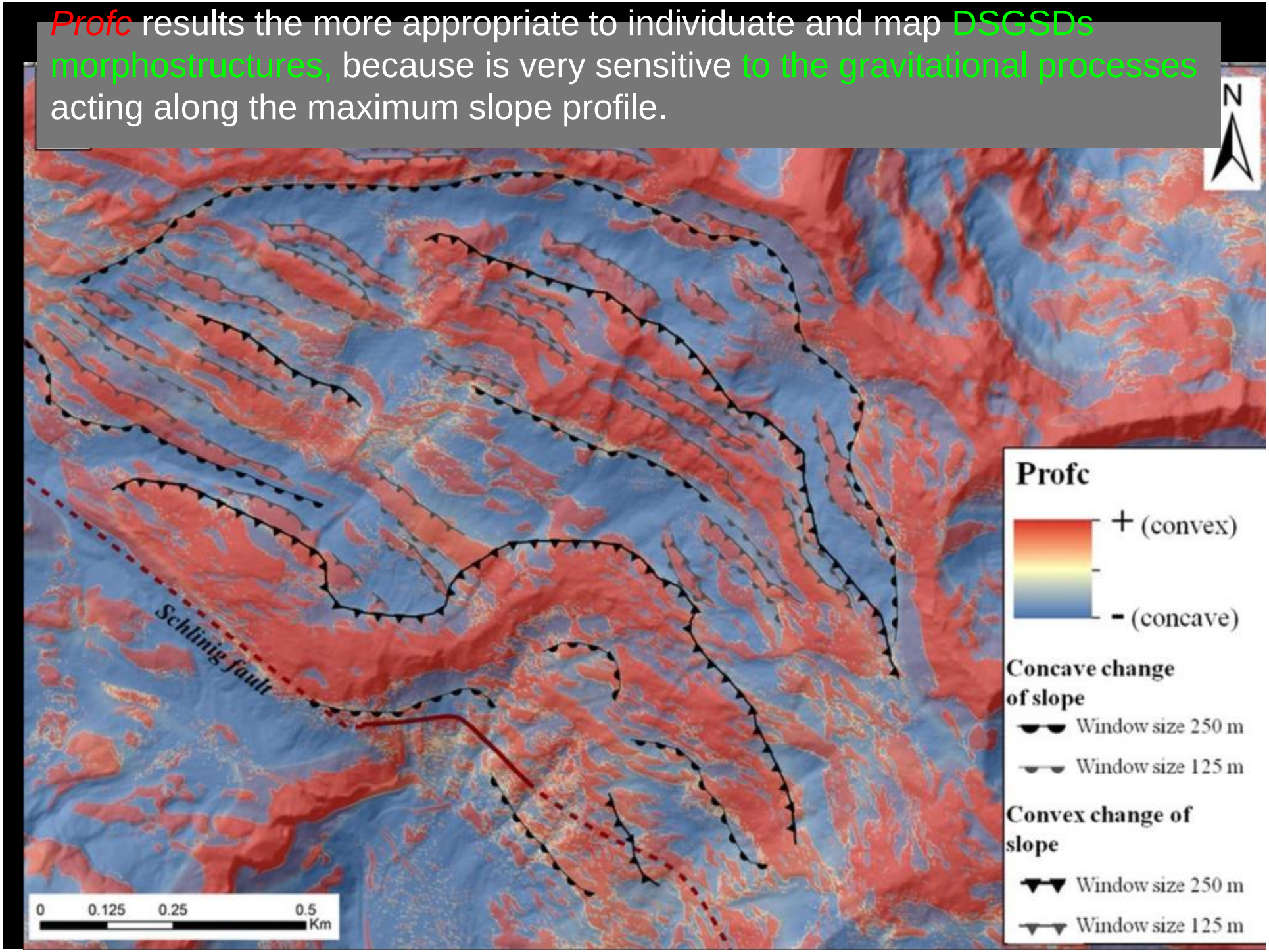
Multiscalar Approach

- The multi scalar approach of Wood (1996), varying the *kernel* window size of the analysis results very appropriate.

- This morphometric variable, calculated with a *kernel* window size of 125 m, results the more appropriate to identify the specific landforms related to DSGSDs. *Profc*, calculated with a window size of 250 m, is useful to map the DSGSDs main sectors (double ridge and concave upslope area, bulging, etc.) and avoid the misinterpretation of DTM errors.

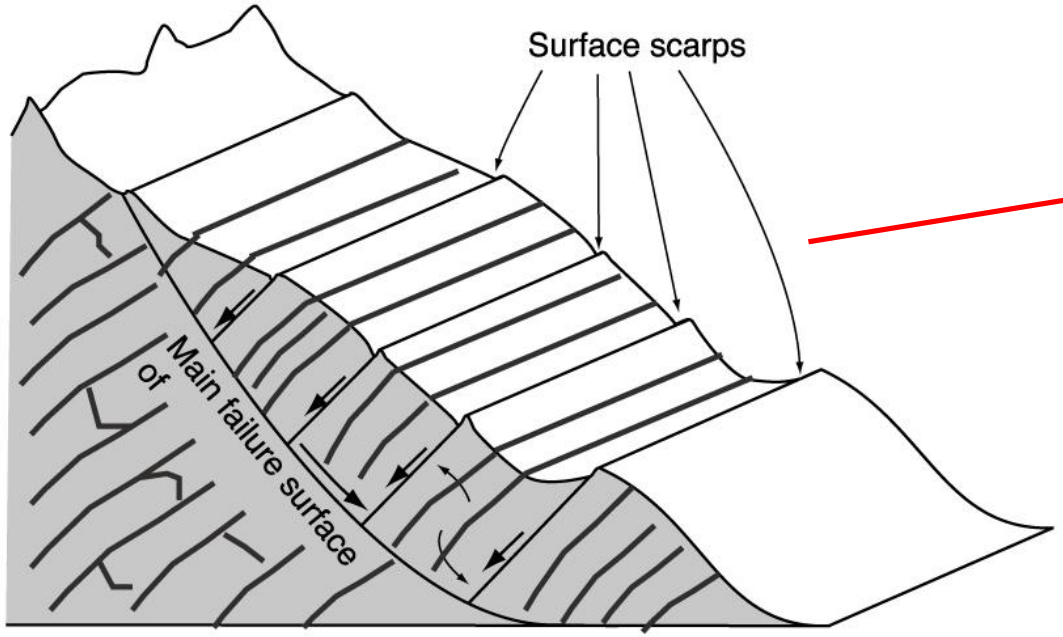

N
0
0.5
1
2
Km

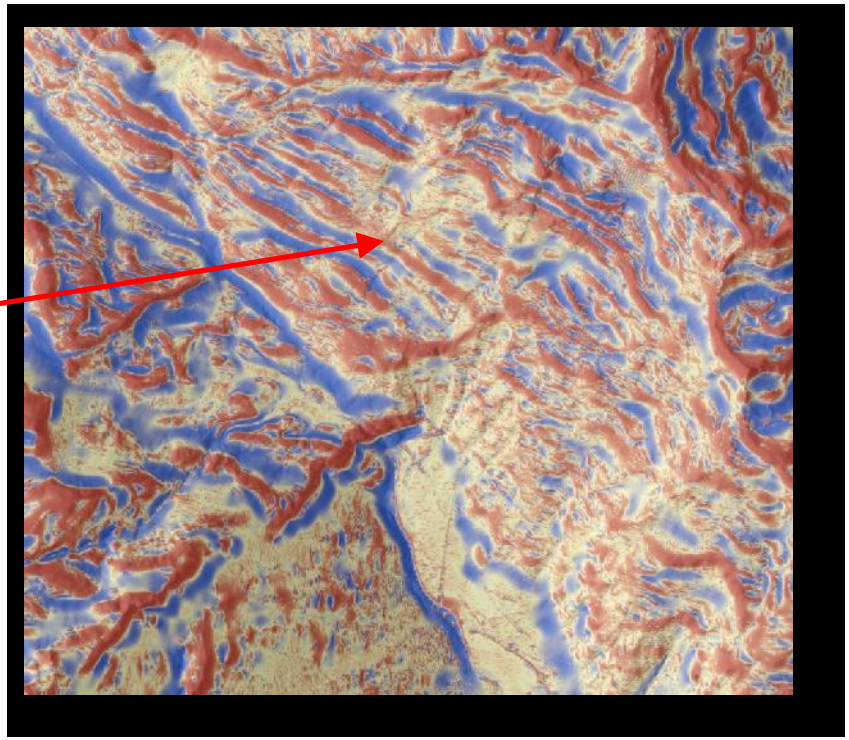
Profc results the more appropriate to individuate and map DSGSDs morphostructures, because is very sensitive to the gravitational processes acting along the maximum slope profile.

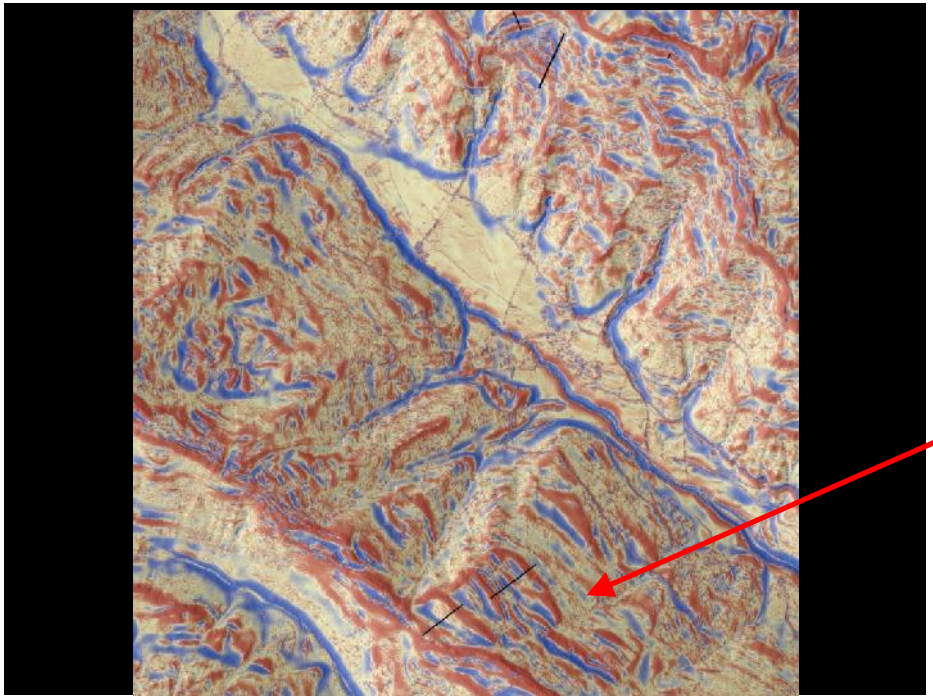


A

Persaud & Pfiffner (2004) modified

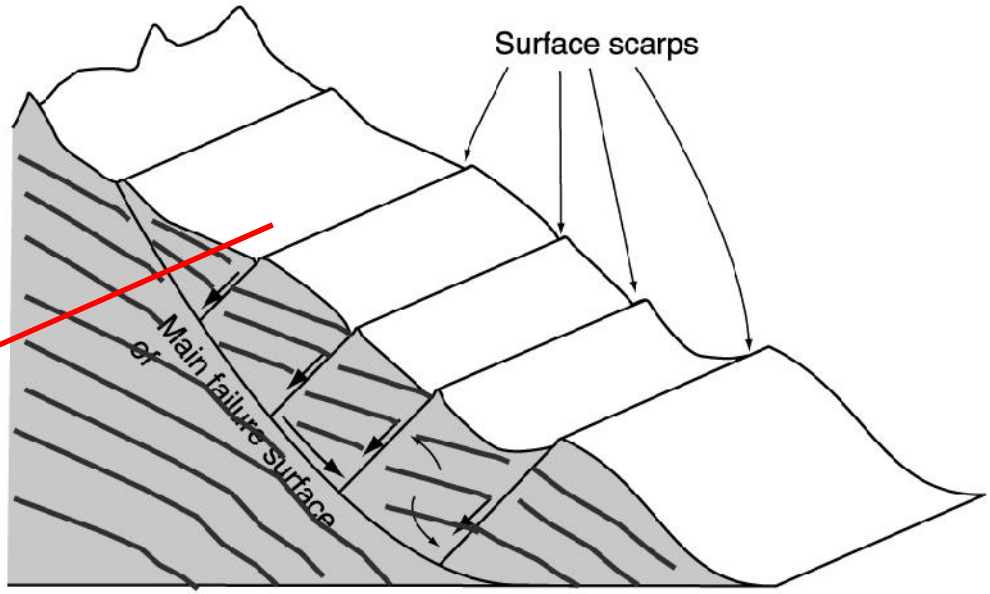






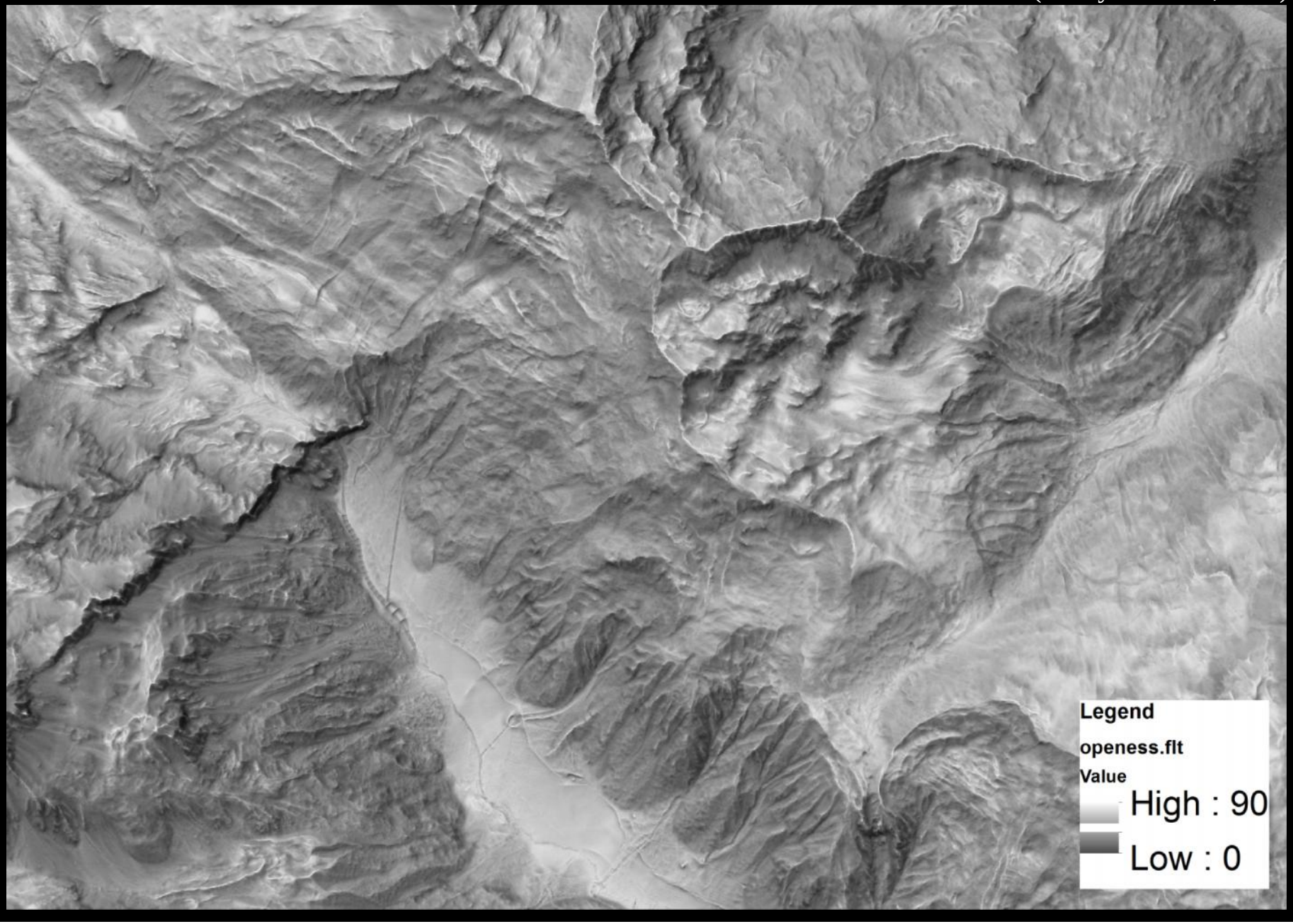
B

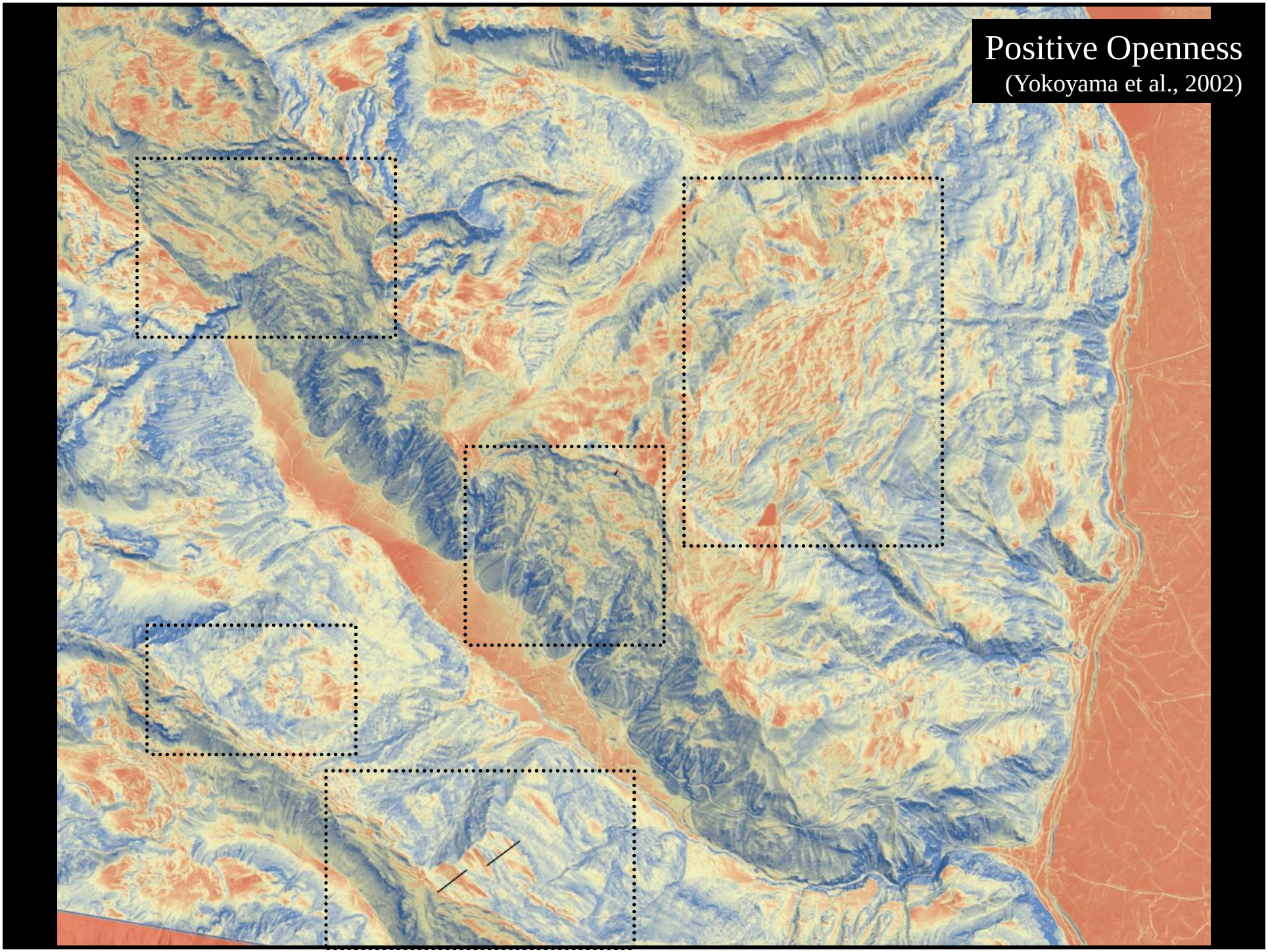
Persaud & Pfiffner (2004) modified

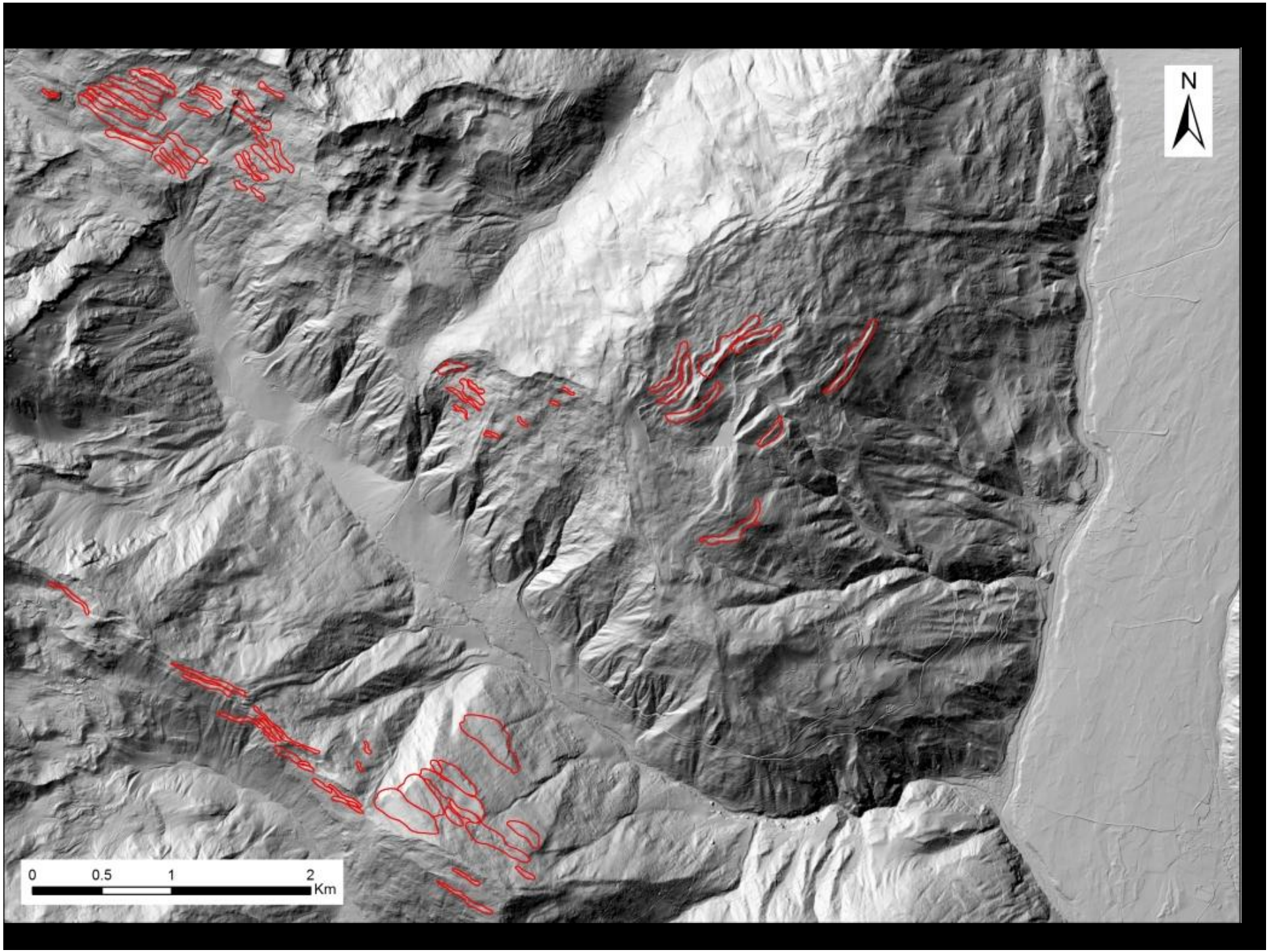


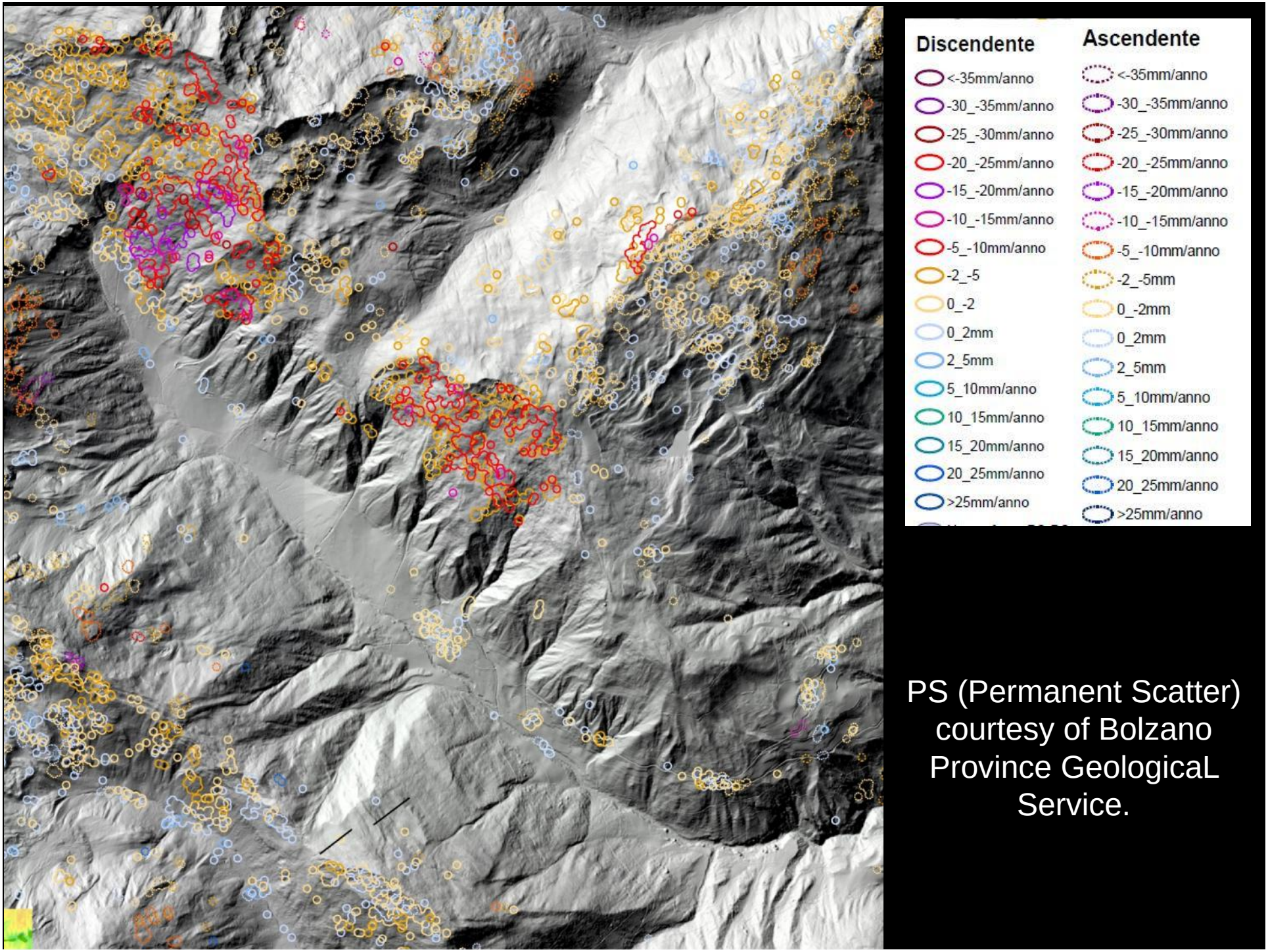
Positive Openness

(Yokoyama et al., 2002)

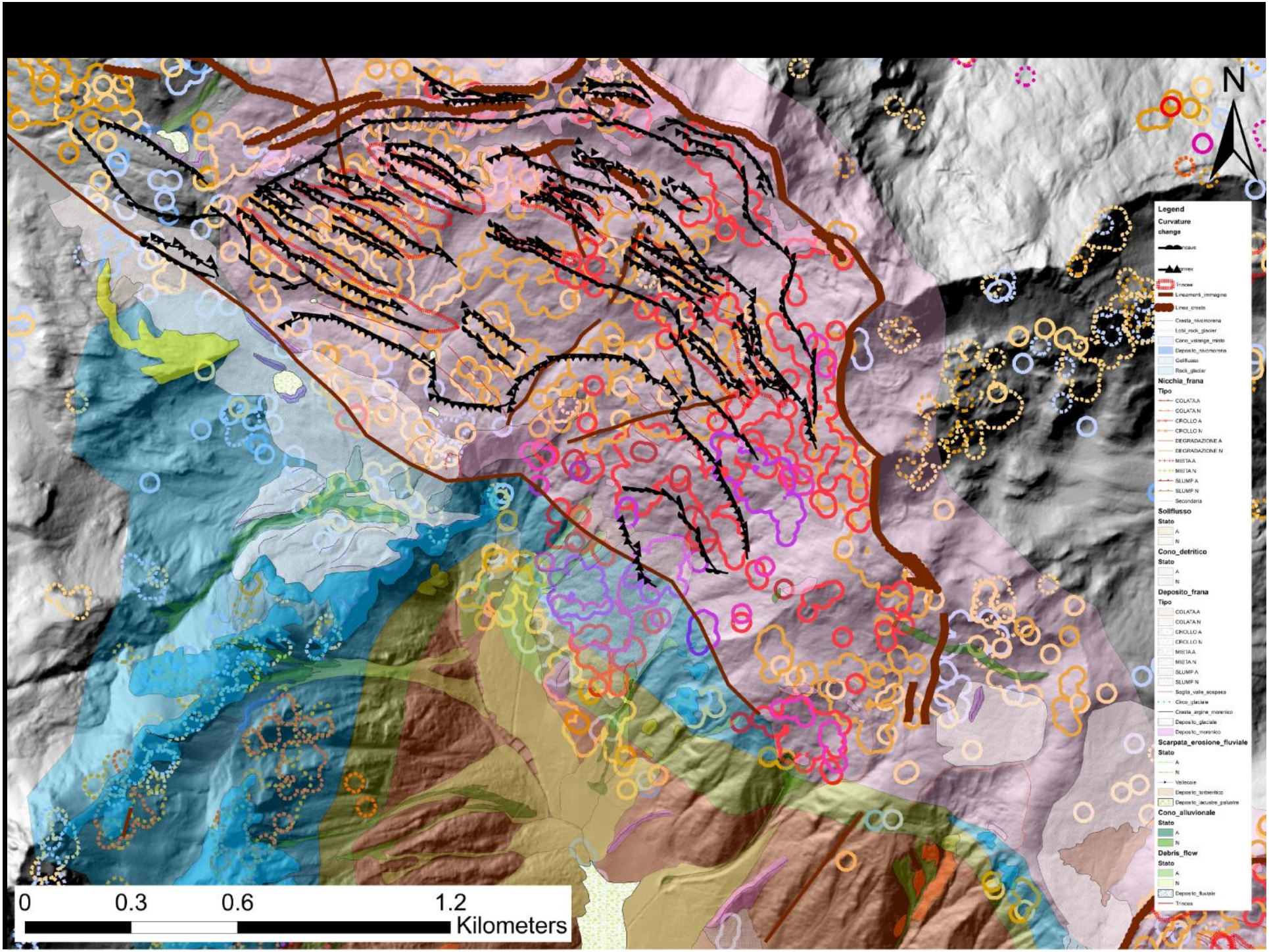



Positive Openness
(Yokoyama et al., 2002)


N
0
0.5
1
2
Km



PS (Permanent Scatter) courtesy of Bolzano Province GeologicaL Service.


N
Legend
Curvature
change
Tracce
Lineamenti_immagine
Linea_cresta
Cresta_rilevmorena
Lobi_rock_glacier
Cono_valanga_misto
Deposito_rilevmorena
Gelifluso
Rock_glacier
Nicchia_frana
Tipo
COLATA A
COLATA N
CROLLO A
CROLLO N
DEGRADAZIONE A
DEGRADAZIONE N
MISTA A
MISTA N
SLUMP A
SLUMP N
Secondaria
Solifluso
Stato
A
N
Cono_detritico
Stato
A
N
Deposito_frana
Tipo
COLATA A
COLATA N
CROLLO A
CROLLO N
MISTA A
MISTA N
SLUMP A
SLUMP N
Soglia_valle_sospesa
Circo_glaciale
Cresta_argine_morenico
Deposito_glaciale
Deposito_morenico
Scarpata_erosione_fluviale
Stato
A
N
Vallecola
Deposito_torrentizio
Deposito_lacustre_palustre
Cono_alluvionale
Stato
A
N
Debris_flow
Stato
A
N
Deposito_fluviale
Tracce
0
0.3
0.6
1.2
Kilometers

Conclusion and perspectives

- The propused methodology results appropriate to map the phenomena in the area of study.

- The morhostructures topographic signature could help to identify the DGSGs process in a more objective way if applied in analogs landscapes.


Thank for your attention!