

Prof. A. Corsini (UNIMORE)

CARATTERISTICHE CINEMATICHE E DI PERICOLOSITA' DELLE DIVERSE TIPOLOGIE DI FRANE



UNIMORE
UNIVERSITÀ DEGLI STUDI DI
MODENA E REGGIO EMILIA









Impostazioni mappa Aiuto Coordinate Colora IT Storia Condividi / Stampa

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4 set di dati abilitati sulla mappa

Naviga da tastiera



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Navigation and utility icons including a search icon, a home icon, a compass icon, a location pin icon, a street view icon, and a person icon.

Naviga da tastiera

3 set di dati abilitati sulla mappa



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3 set di dati abilitati sulla mappa

Naviga da tastiera



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3 set di dati abilitati sulla mappa

Naviga da tastiera



Impostazioni mappa Aiuto Coordinate Colora IT Storia Condividi / Stampa

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- Location
- Layers
- Layers
- Map
- Compass
- Person

2 set di dati abilitati sulla mappa

Naviga da tastiera

WHY DO WE CARE ABOUT LANDSLIDES ?

Relevance of Landslides Risk

By one estimate*, landslides triggered by heavy rain kill roughly 4,600 people each year.

**Nature* (2012, August 8) Death toll from landslides vastly underestimated.

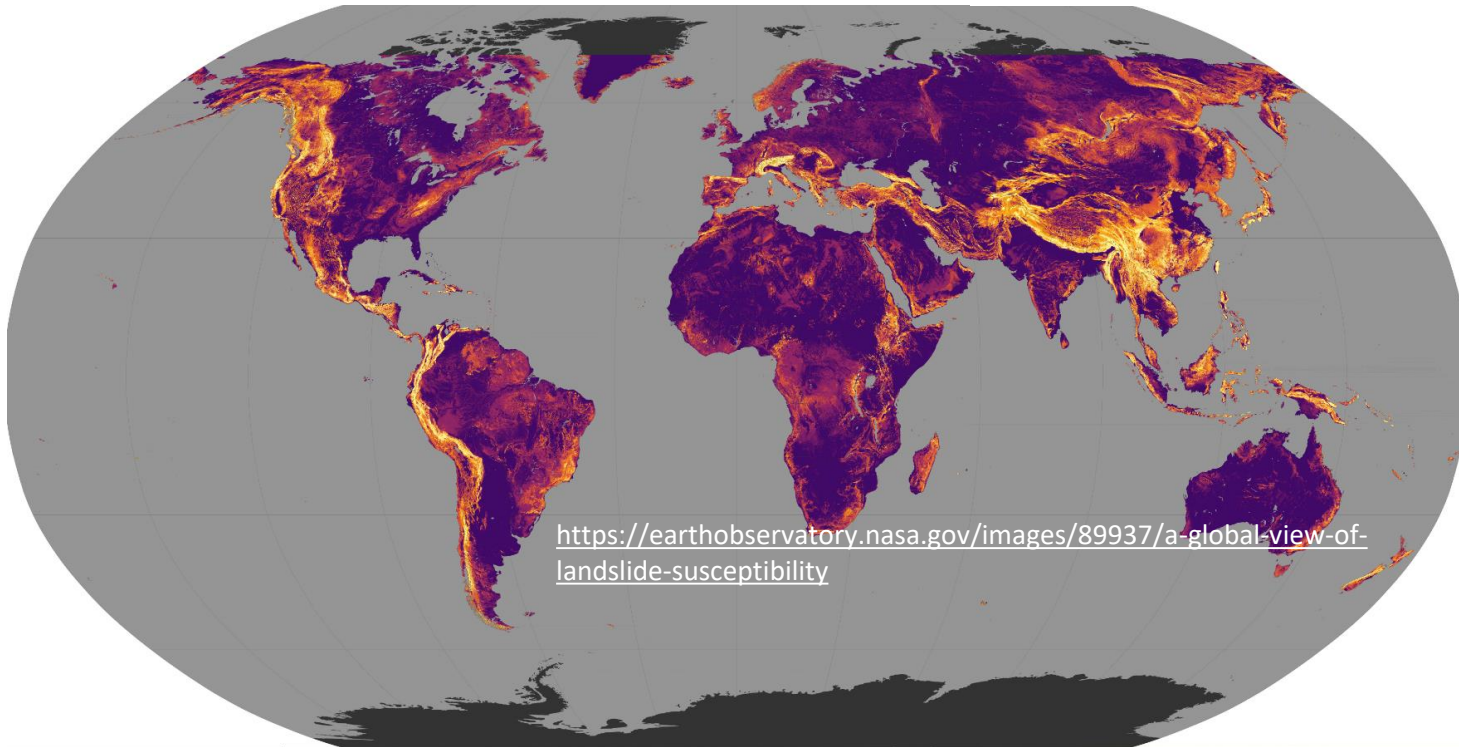
PRESS RELEASE

World Landslides Forum: Each year, landslides cause damage to 6 billion Euros

Rome, 3 / 7 October - FAO - Via delle Terme di Caracalla, 273

Rome, 3 October

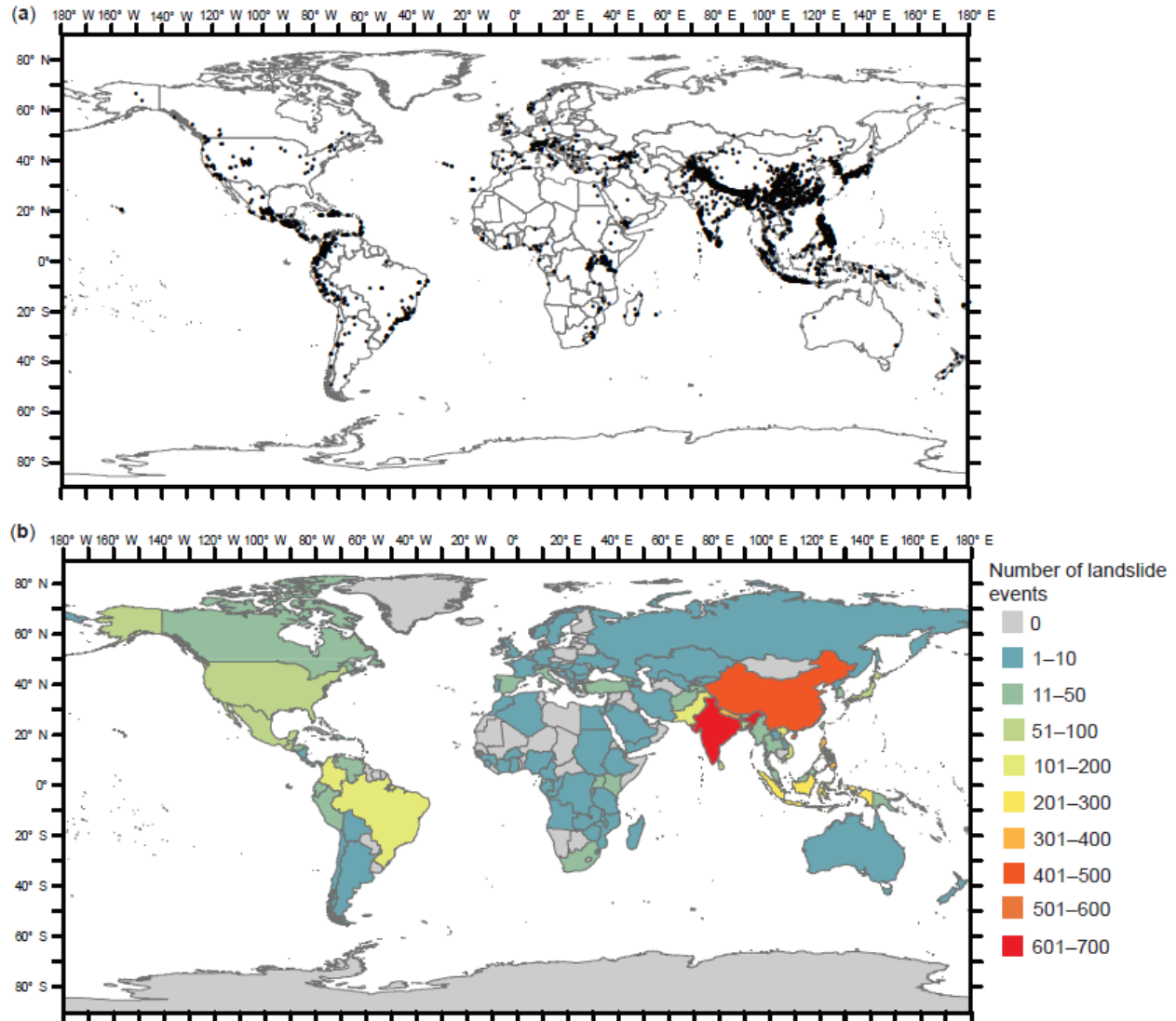
Over 6 billion euro a year for damage caused by landslides in the industrialized countries of the world. This is the outcome of the results presented at the **Second Global Forum on Landslides** held at the FAO headquarters in Rome, organized by the Global Promotion Committee of the International Programme on Landslides (IPL), and in which sees the **ISPRA** (Italian Institute for Protection and Environmental Research) at the forefront of the institutions involved.



Relevance of Landslides Risk

Nat. Hazards Earth Syst. Sci., 18, 2161–2181, 2018
<https://doi.org/10.5194/nhess-18-2161-2018>
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M. J. Froude and D. N. Petley: Global fatal landslide occurrence from 2004 to 2016



Relevance of Landslides Risk



Pan-European Landslide Susceptibility Mapping: ELSUS Version 2

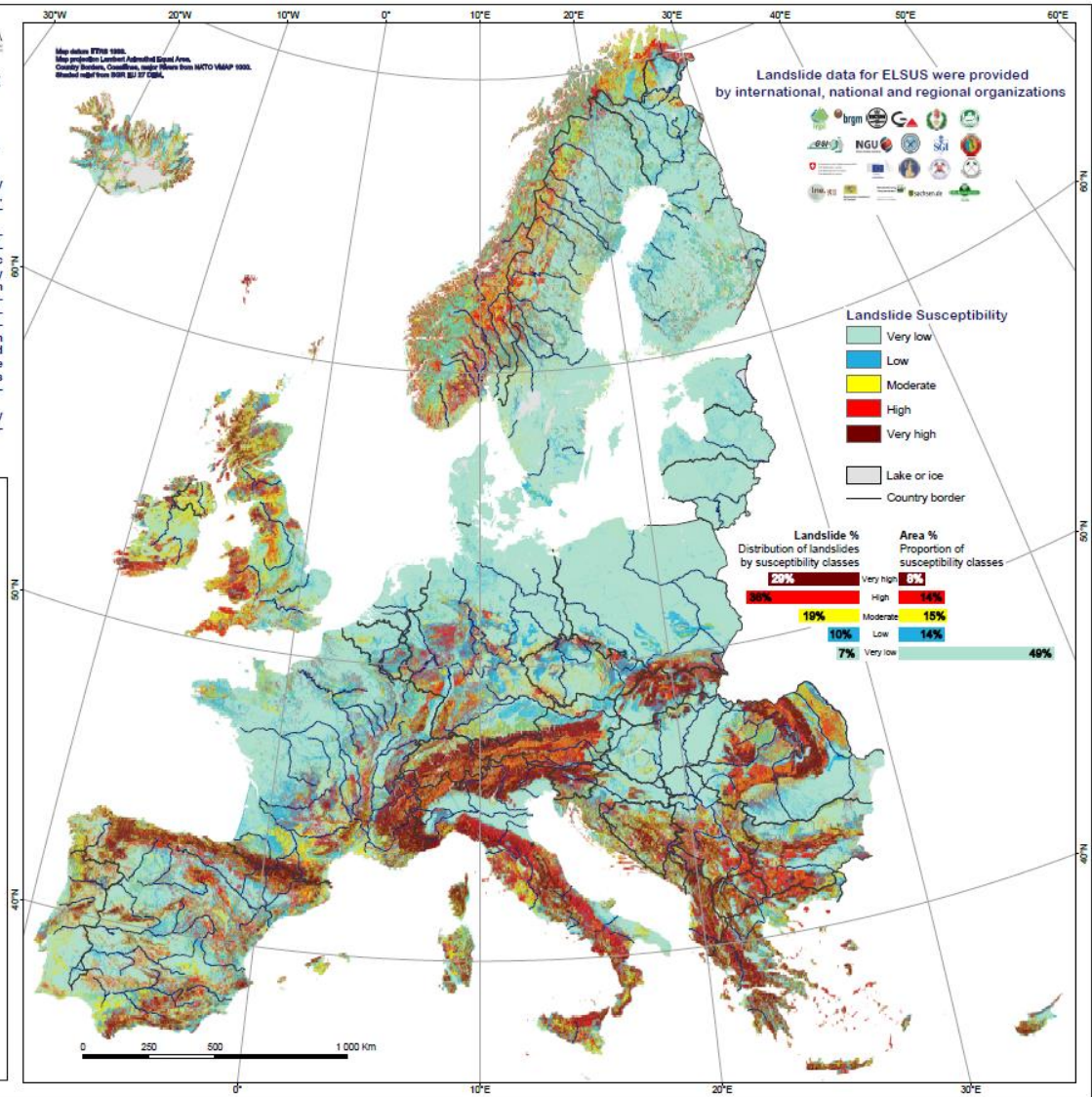
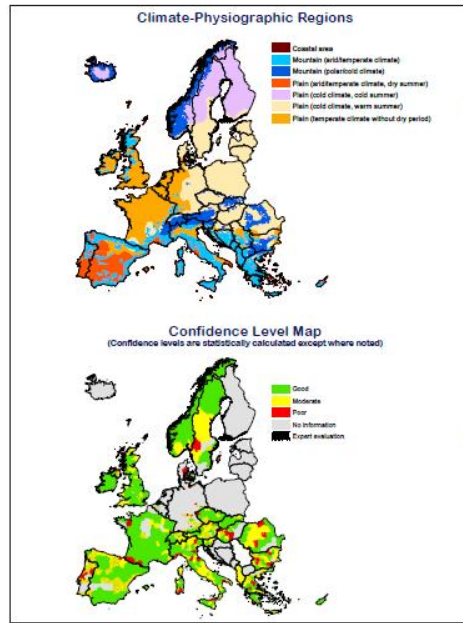
M. Wilde^{1,2}, A. Günther¹, P. Reichenbach³, J.-P. Malet⁴, J. Hervás⁵

¹ Federal Institute for Geosciences and Natural Resources, Germany; ² University of Salzburg, Austria; ³ University of Turin, Italy; ⁴ University of Strasbourg, France; ⁵ University of Valencia, Spain

The European Landslide Susceptibility Map (ELSUS V2) shows the spatial probability (susceptibility) of landslide occurrence for 28 European Member States plus Iceland, Norway, Switzerland, Bosnia, Montenegro, Serbia, Kosovo, FYR Macedonia and Albania on a 200 meter grid.

The map was prepared through a semi-quantitative, combined heuristic-statistic approach using pan-European datasets on slope gradient, engineering soil/bedrock lithology and land cover. The susceptibility evaluation uses a climate-physiographic terrain zonation representing specific landslide regions over Europe. Susceptibility evaluation and map classification were performed individually for each model region and results were mosaicked into a synoptic map. Models were calibrated and validated with a pan-European dataset that incorporates more than 140,000 landslide locations. The highest and lowest susceptibility classes for each model region always contain 50 % and 3 % of the landslides, respectively. This implies that local classification errors are observable, but the relative class graduations can be considered valid throughout the map. The reliability of the map was evaluated on an administrative level (EUROSTAT NUTS 3 regions). The map should be used with attention in areas where the confidence cannot be assessed (35 % of the total area), or where the reliability was evaluated as poor (16 % of the remaining area).

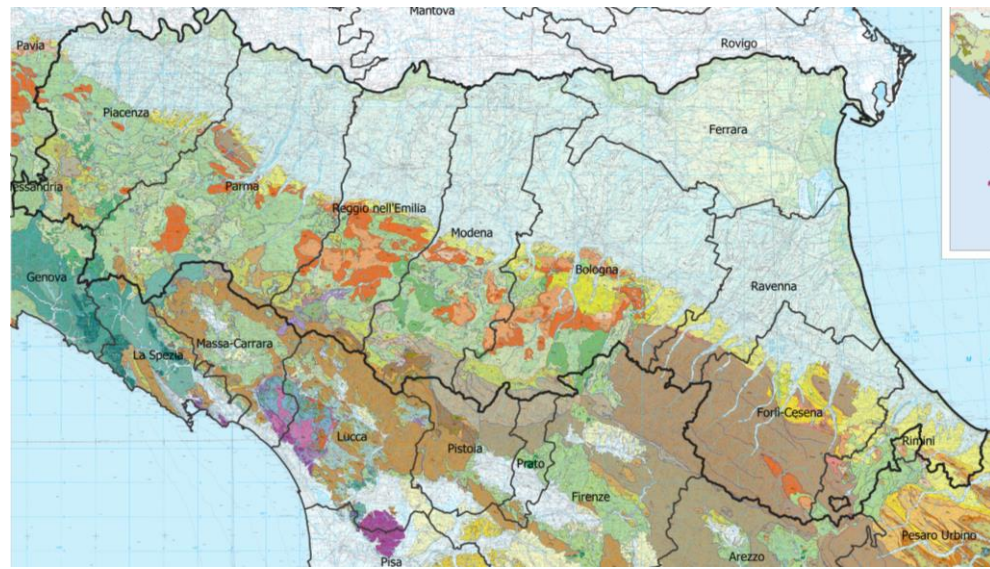
The map is produced at a 1:5 Mil. scale. Considering the input data resolution, it may be viewed at scales up to 1:200,000. In any case, the map can only be used at overview scales and it cannot be consulted to evaluate local landslide susceptibility.



Cause

PREDISPONENTI

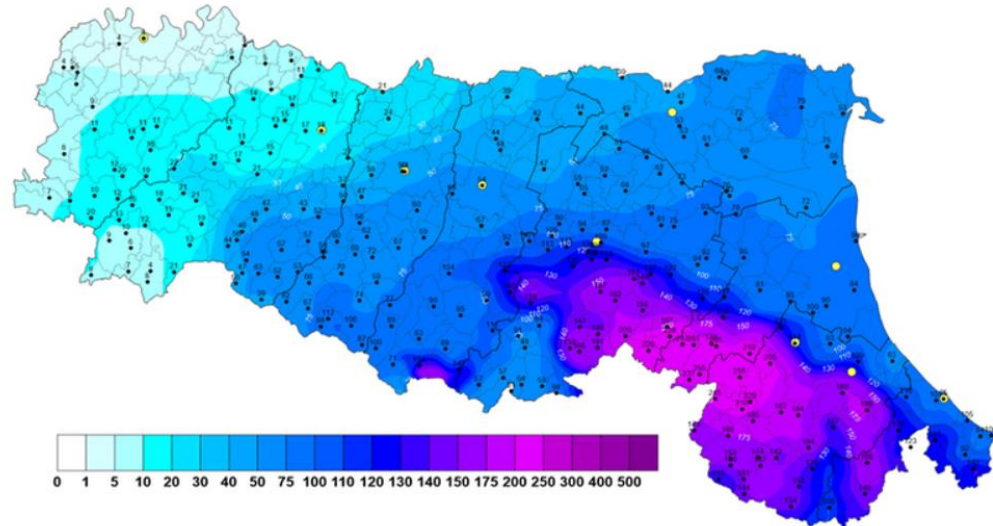
- **cause geologiche** – composizione delle rocce, tessitura e struttura, stratificazione e giacitura, alterazione, storia tettonica dell'area, stato tensionale, neotettonica, sismicità;
- **cause morfologiche** - morfometria e acclività dei versanti e degli alvei, frane antiche;
- **cause idrogeologiche** - idrografia, sorgenti, condizioni di drenaggio, condizioni statiche e dinamiche delle acque del sottosuolo, sovrappressioni interstiziali, caratteristiche delle falde acquifere;



In figura le precipitazioni cumulate nel periodo 16-17 maggio 2023

INNESCANTI

- **Cause meteo- idrogeologiche**
precipitazioni, pressione dell'acqua In falda, piene, erosione e scalzamento al piede di versanti;
- **Cause sismiche**
gravità, terremoti;
- **Cause antropiche**
scavi, vibrazioni



Tipologie

<https://www.usgs.gov/media/images/types-landslides>

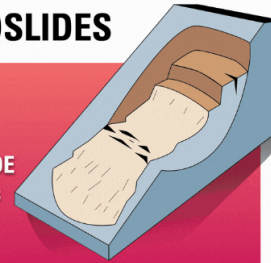
<https://blogs.agu.org/landslideblog/>

TYPES OF LANDSLIDES

1.

ROTATIONAL LANDSLIDE

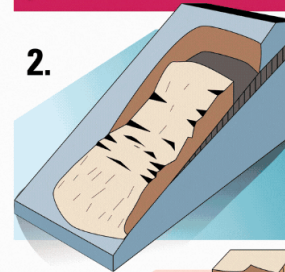
Ground rotates and slides along a curved failure plane.



2.

TRANSLATIONAL LANDSLIDE

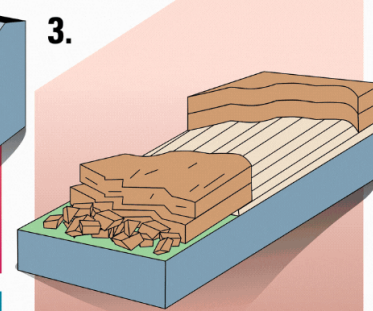
Ground slides with little rotation along a flat plane parallel to the surface.



3.

BLOCK SLIDE

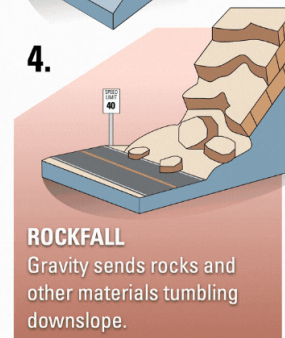
A type of translational landslide made of mostly one block of surface material that moves downslope.



4.

ROCKFALL

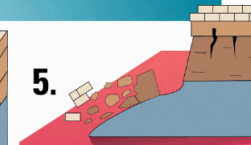
Gravity sends rocks and other materials tumbling downslope.



5.

TOPPLE

Pieces of a cliff or rock face fall forward as large blocks.



6.

EARTHFLOW

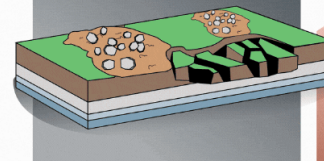
Form on moderate slopes when fine-grained material liquefies and runs out in hourglass shape.



7.

LATERAL SPREAD

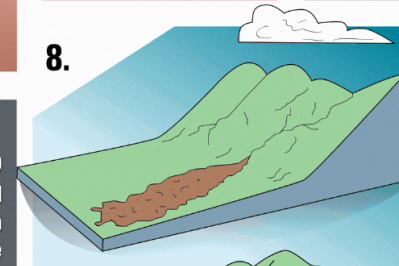
When surface material extends or spreads on gentle slopes. This type of ground deformation is often associated with earthquake shaking.



8.

DEBRIS FLOW

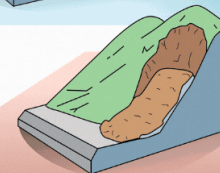
Rapidly moving mix of water, mud, trees, and other materials that flows downvalley and can travel great distances.



9.

DEBRIS AVALANCHE

An extremely large and fast moving debris flow.



10.

CREEP

Soil and surface material that slowly moves down a slope.



CARATTERISTICHE CINEMATICHE E DI PERICOLOSITA

Cetaceans



blue whale
(*Balaenoptera musculus*)
length up to 29.5 m (97 ft)



humpback whale
(*Megaptera novaeangliae*)
average length 14 m (46 ft)



gray whale
(*Eschrichtius robustus*)
length up to 15 m (49 ft)



fin whale
(*Balaenoptera physalus*)
length up to 27 m (89 ft)



narwhal
(*Monodon monoceros*)
average length 4 m (13 ft)



beluga
(*Delphinapterus leucas*)
length up to 4 m (13 ft)



sperm whale
(*Physeter macrocephalus*)
length up to 24 m (79 ft)



sei whale
(*Balaenoptera borealis*)
length up to 15 m (49 ft)



bowhead, or Greenland right whale
(*Balaena mysticetus*)
length up to 20 m (66 ft)



minke whale
(*Balaenoptera acutorostrata*)
length up to 10 m (33 ft)



dolphins



northern right whale
(*Eubalaena glacialis*)
length up to 18 m (59 ft)



Baird's beaked, or giant bottlenose, whale
(*Berardius bairdii*)
length up to 13 m (43 ft)

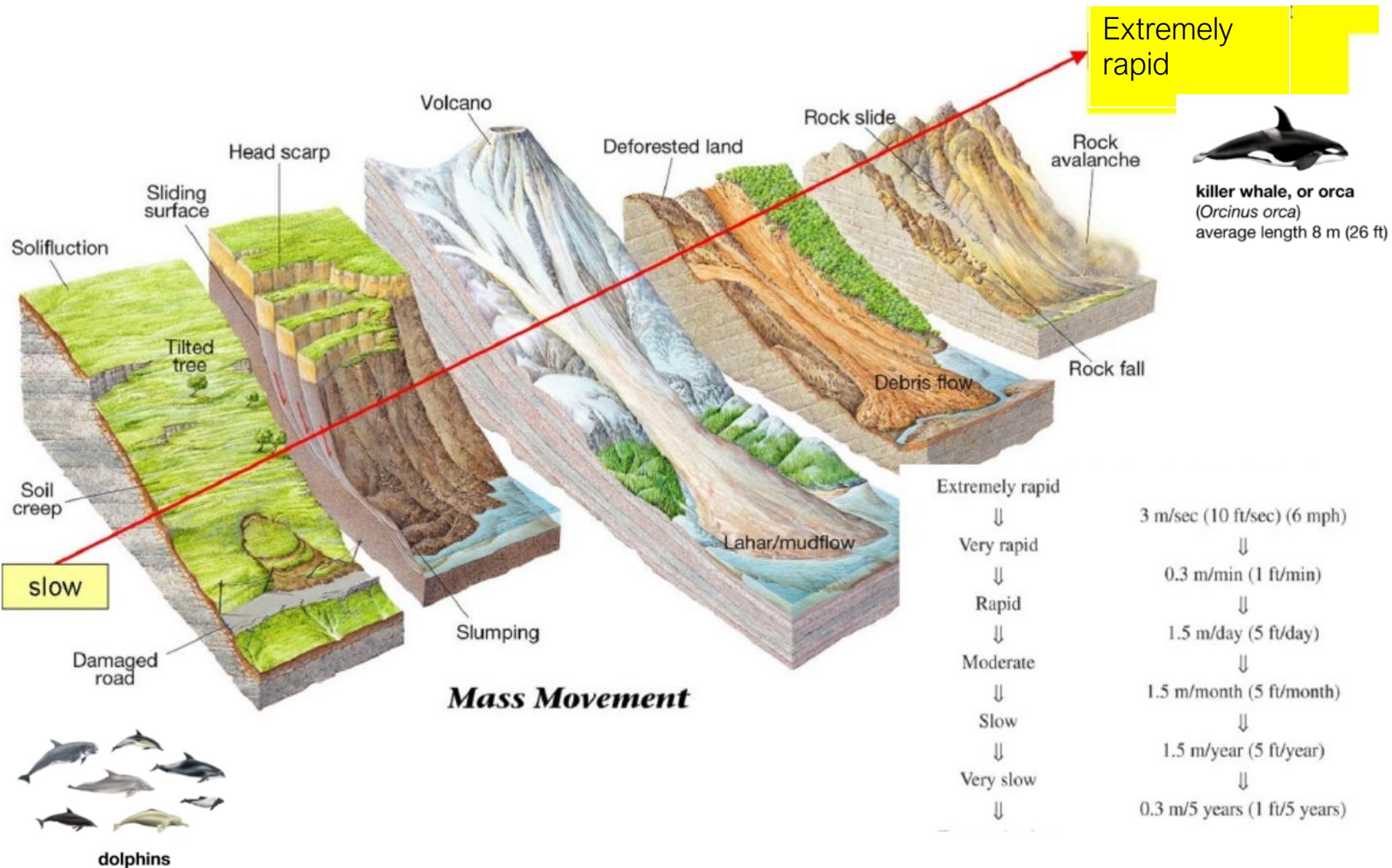


killer whale, or orca
(*Orcinus orca*)
average length 8 m (26 ft)



porpoise

Landslides velocity





dolphins



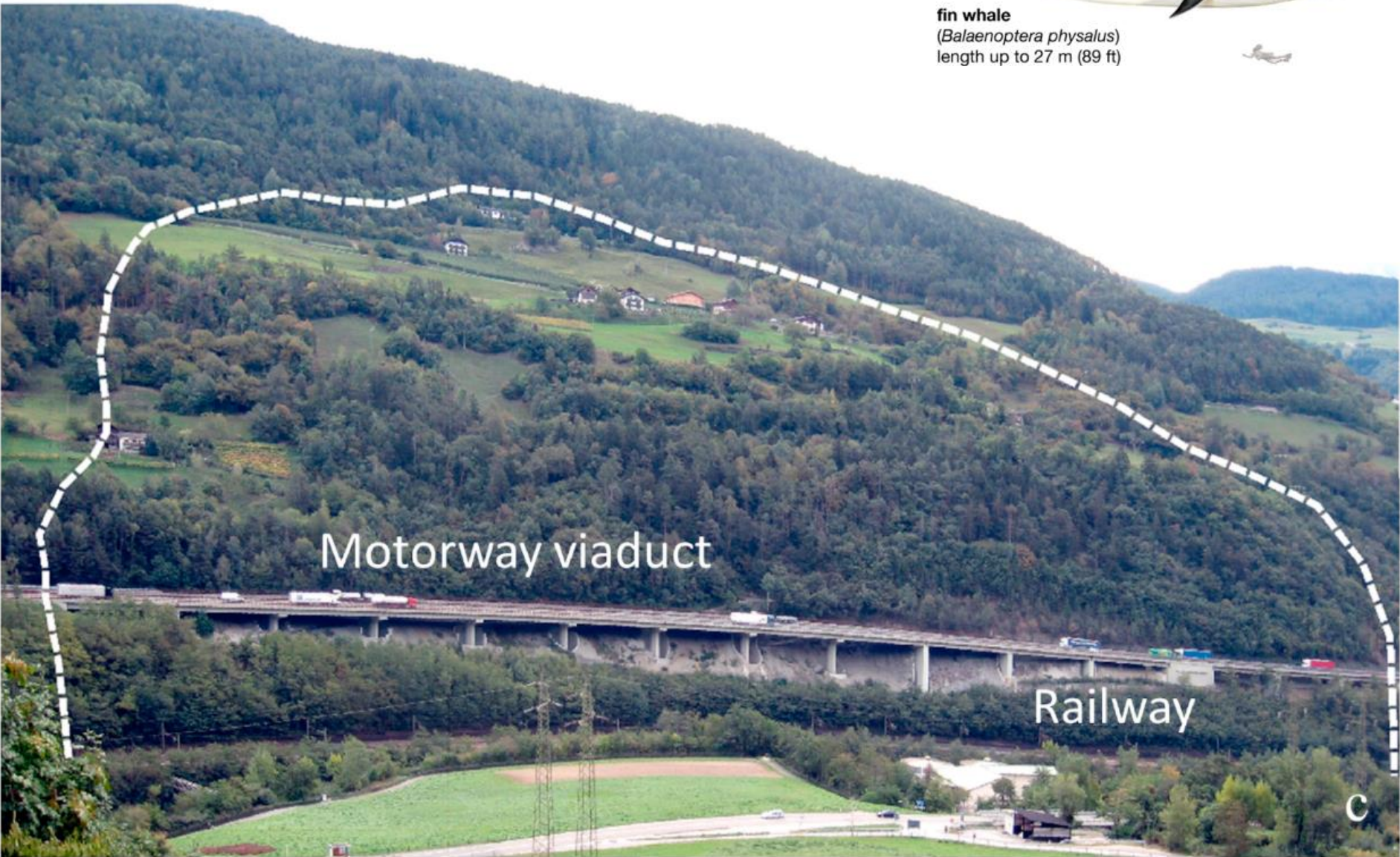


killer whale, or orca
(*Orcinus orca*)
average length 8 m (26 ft)





fin whale
(*Balaenoptera physalus*)
length up to 27 m (89 ft)



Motorway viaduct

Railway

C



blue whale
(*Balaenoptera musculus*)
length up to 29.5 m (97 ft)



Landslides velocity

Class	Description	Velocity	Kinematics (Type of movement)					Damage potential
			Fall	Topple	Slide	Flow	Spread	
7	extremely rapid							very great damage potential, many dead, evacuation not possible, great property damages
6	very rapid	5x10 ³ mm/s 5 m/s						great damage potential, some dead, evacuation partly possible, great property damages
5	rapid	5x10 ¹ mm/s 3 m/min						damage potential existing, no dead because of possible evacuation, great property damages
4	moderate	5x10 ⁻¹ mm/s 1.8 m/h						damages on buildings and infrastructure
3	slow	5x10 ⁻³ mm/s 158 m/a						damages on buildings and infrastructure, redevelopment according to velocities partly possible
2	very slow	5x10 ⁻⁵ mm/s 1.6 m/a						differential movements cause damages on buildings, some structures can not be influenced by movement
1	extremely slow	5x10 ⁻⁷ mm/s 16 mm/a						without instrumentation movement can not be detected, development possible with precaution

Geometrical severity of landslides thickness (i.e. depth)

Landslide depth

- Low: (Depth < 2 m) “shallow”
 - Medium: (Depth < 15 m)
 - High: (Depth > 15 m)
 - Very high: (Depth > 50 m)
 - Extremely high: (Depth > 100 m)
- } “deep-seated”



Debris flows & Mudflows

https://www.facebook.com/telebelluno/videos/le-colate-detritiche-debris-flow-riprese-in-svizzera-e-alto-adige-alcuni-video-c/1456545407760686/?locale=it_IT

<https://twitter.com/i/status/1684963412986785793>

<https://youtu.be/ZC6YOFnMSAc>

<https://twitter.com/i/status/1685246420713181185>

<https://youtu.be/5SX3yISz93c>

Rockfalls

https://youtu.be/_jU30W6vkg

<https://youtu.be/AEMT9zdPU9c>

<https://twitter.com/i/status/1668109229121470464>

<https://twitter.com/i/status/1650487390593511431>

Rockslides and Rotational slides

<https://youtu.be/Jka0fh7r-88>

<https://twitter.com/i/status/1655573114481197061>

<https://youtu.be/2nOaNcJV-74>

<https://youtu.be/ClXtK69Cerw>

<https://youtu.be/5RV9b6ZQBSw>

<https://youtu.be/M-X2-FN9pb0>

Rock avalanches

<https://youtu.be/3WyietLB3Eg>

<https://www.youtube.com/shorts/SK38UDPhQEk?feature=share>

<https://youtu.be/SixjY6JYz8>

<https://youtu.be/eJRL3uBQ4CA>

Earthslides

<https://www.pbslearningmedia.org/resource/buac35-sci-landslide/landslide-animation/>

https://youtu.be/p70sOgxfa_g

<https://youtu.be/eJRL3uBQ4CA?t=1066>

Earthflows

<https://youtu.be/eJRL3uBQ4CA?t=275>

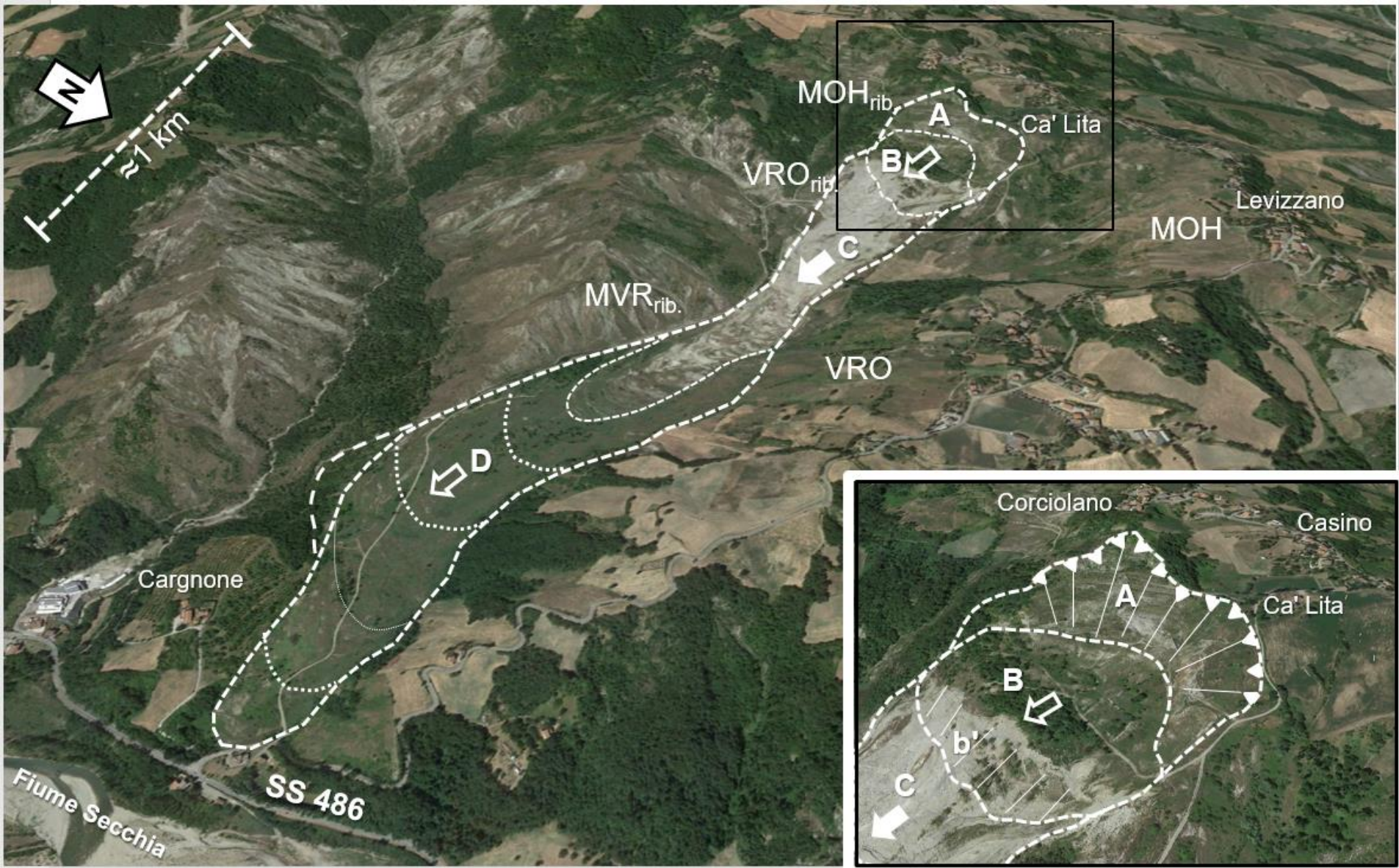
<https://youtu.be/eJRL3uBQ4CA?t=858>

Earthslides-earthflows

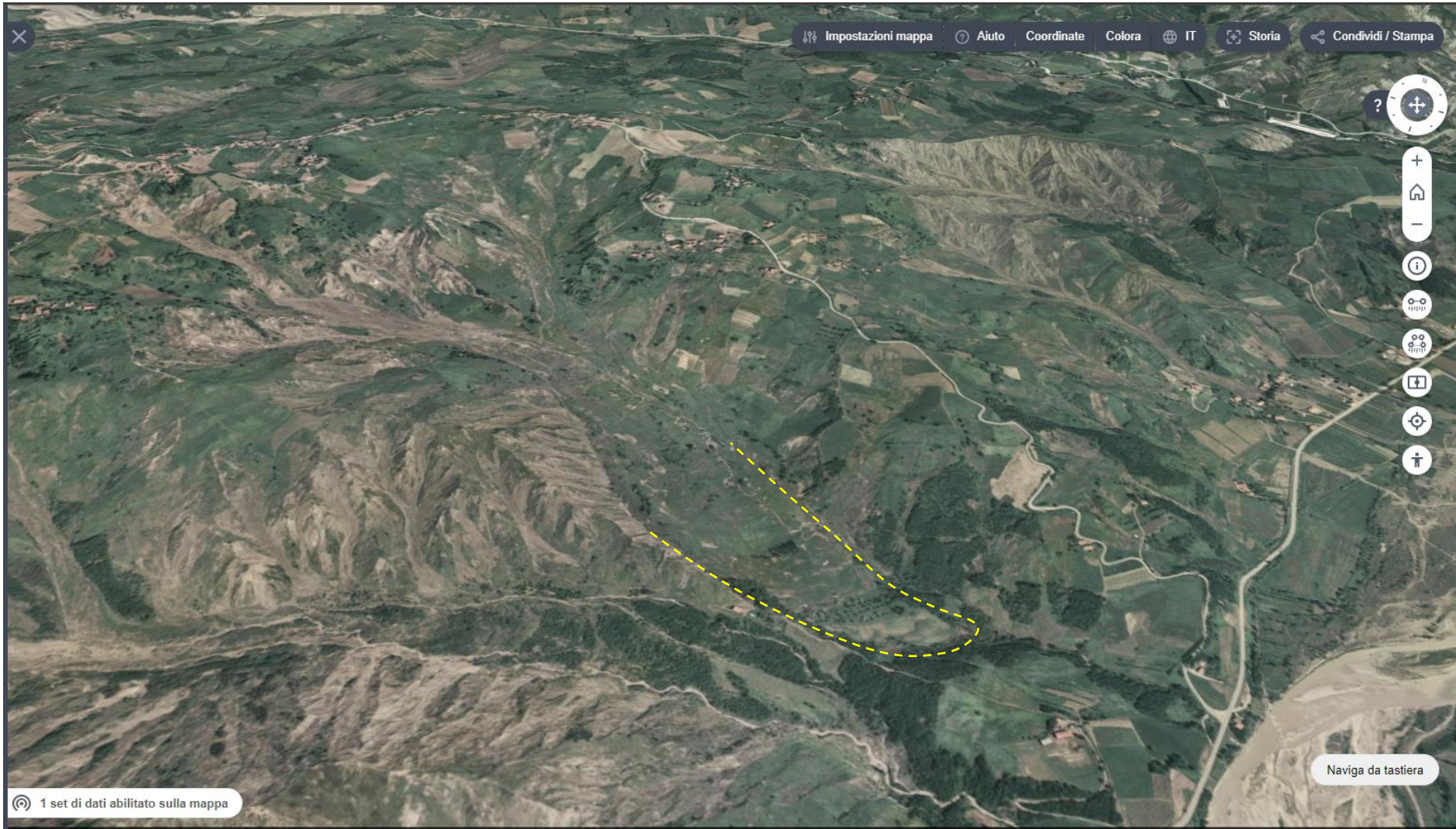


TLC200 PRO 2023/03/24 17:46:11

Earthslides-earthflows



<https://youtu.be/SdVmNV2ti0E>

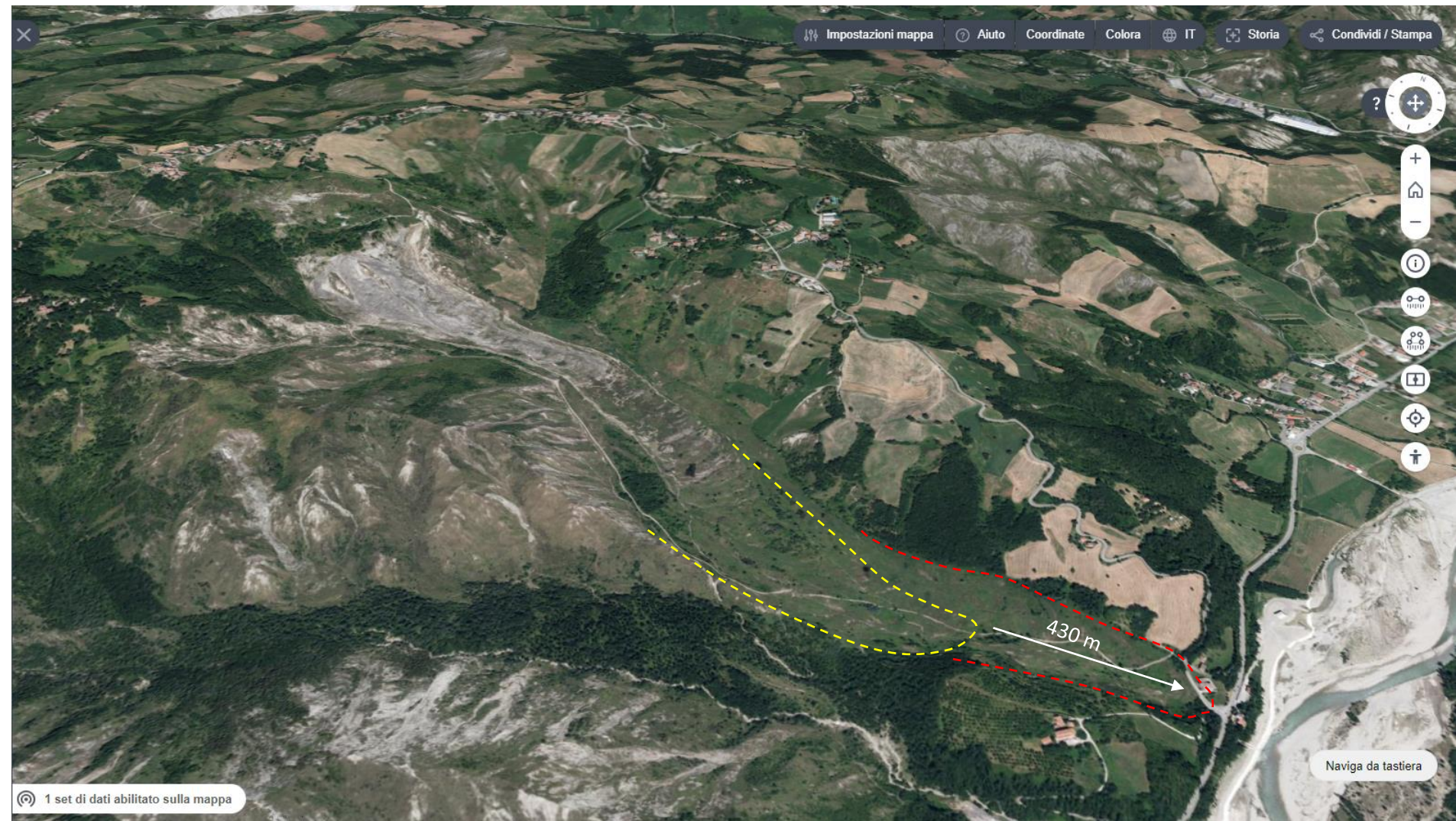


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- Street View
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- Person

1 set di dati abilitato sulla mappa

Naviga da tastiera



<https://www.rainews.it/tgr/emiliaromagna/video/2023/06/non-si-ferma-la-frana-di-baiso-5ba75eca-16fe-45c5-a965-c421af5aac6b.html>

<https://youtu.be/SdVmNV2ti0E>

