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
Naviga da tastiera
4 set di dati abilitati sulla mappa


Impostazioni mappa
Aiuto
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Condividi / Stampa
Naviga da tastiera
3 set di dati abilitati sulla mappa


Impostazioni mappa
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Impostazioni mappa
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2 set di dati abilitati sulla mappa

# 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.

**PRESS RELEASE*

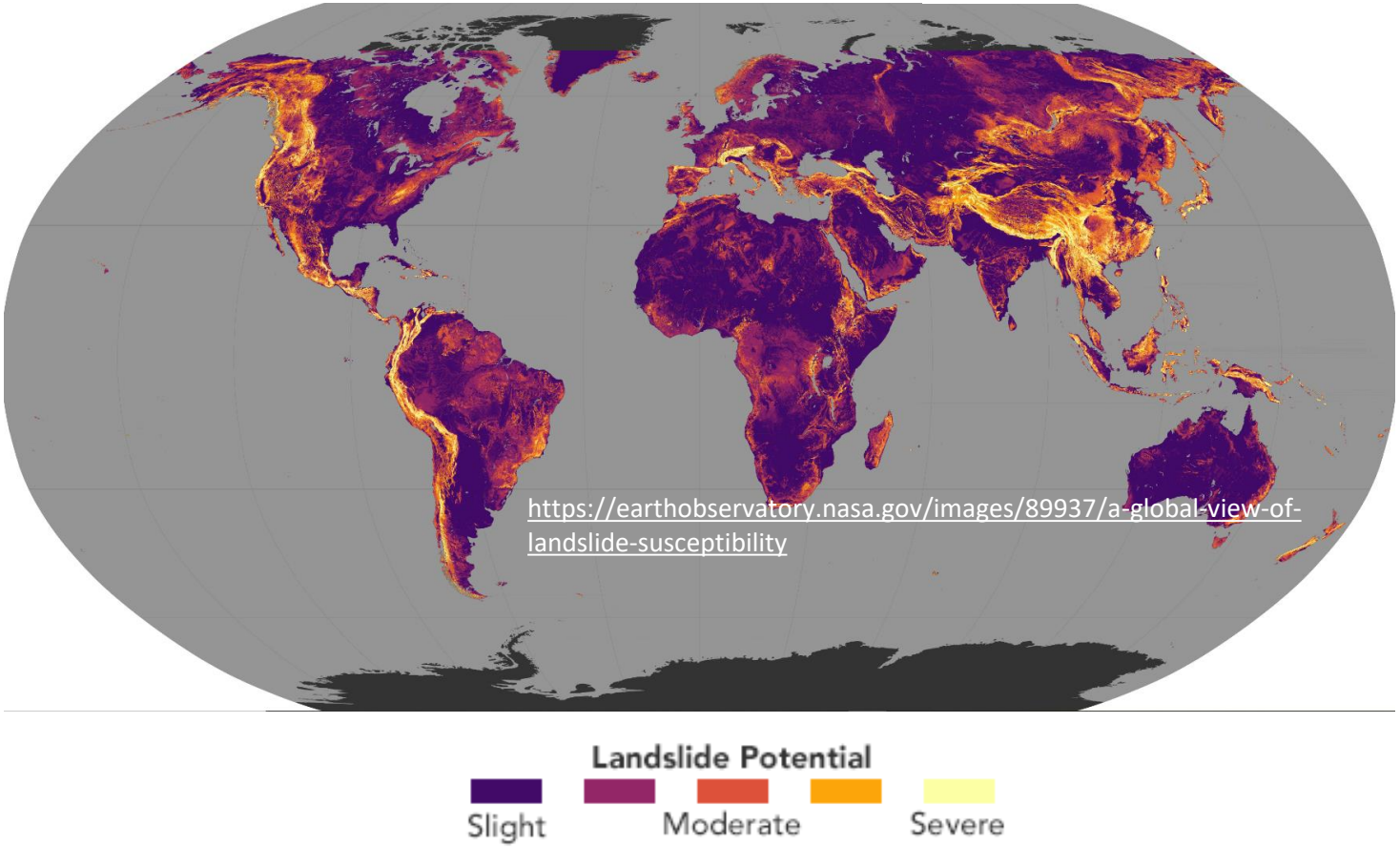
**World Landslides Forum: Each year, landslides cause damage to 6 billion Euros**

**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.

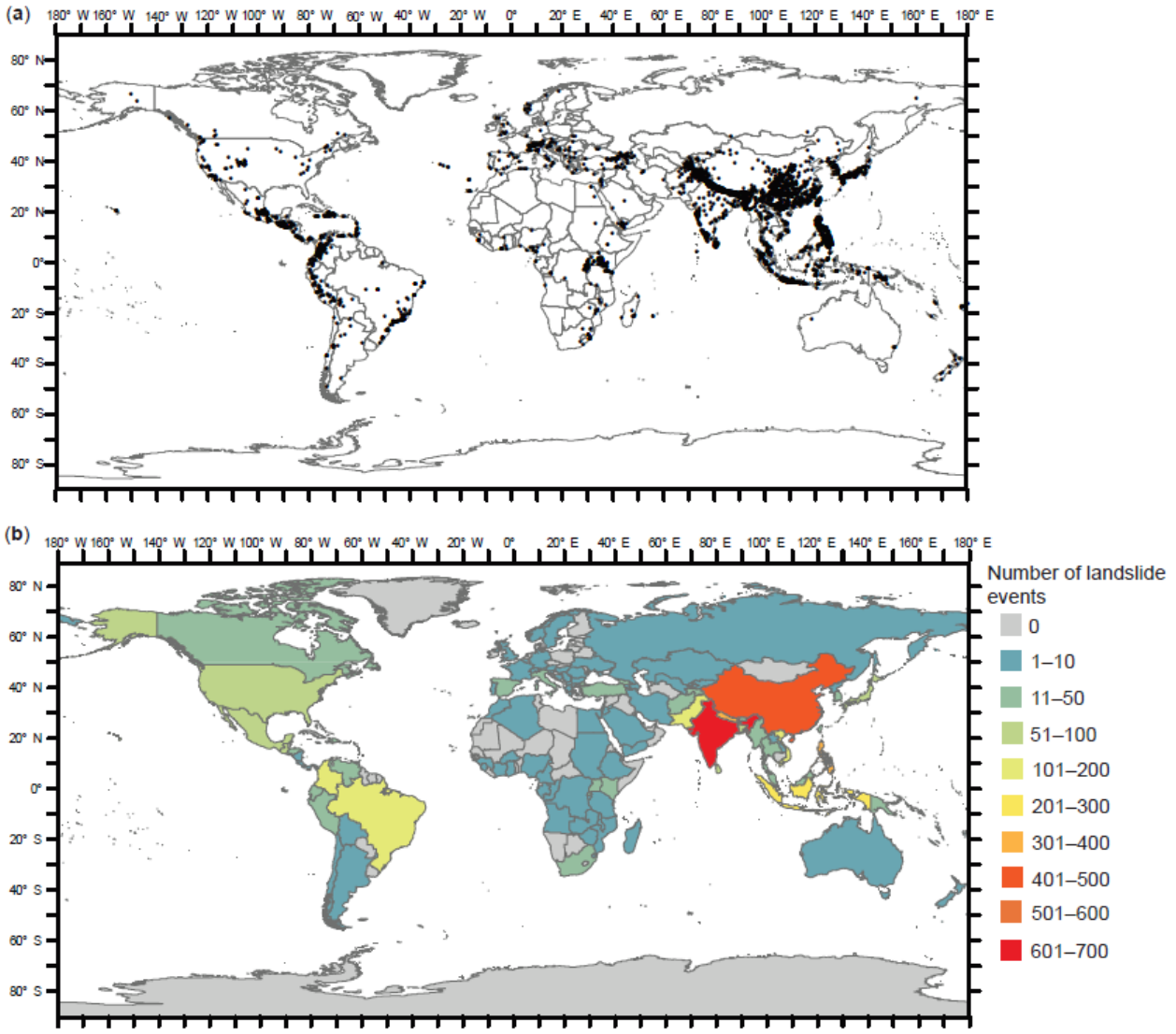
*Nature* (2012, August 8) Death toll from landslides vastly underestimated.



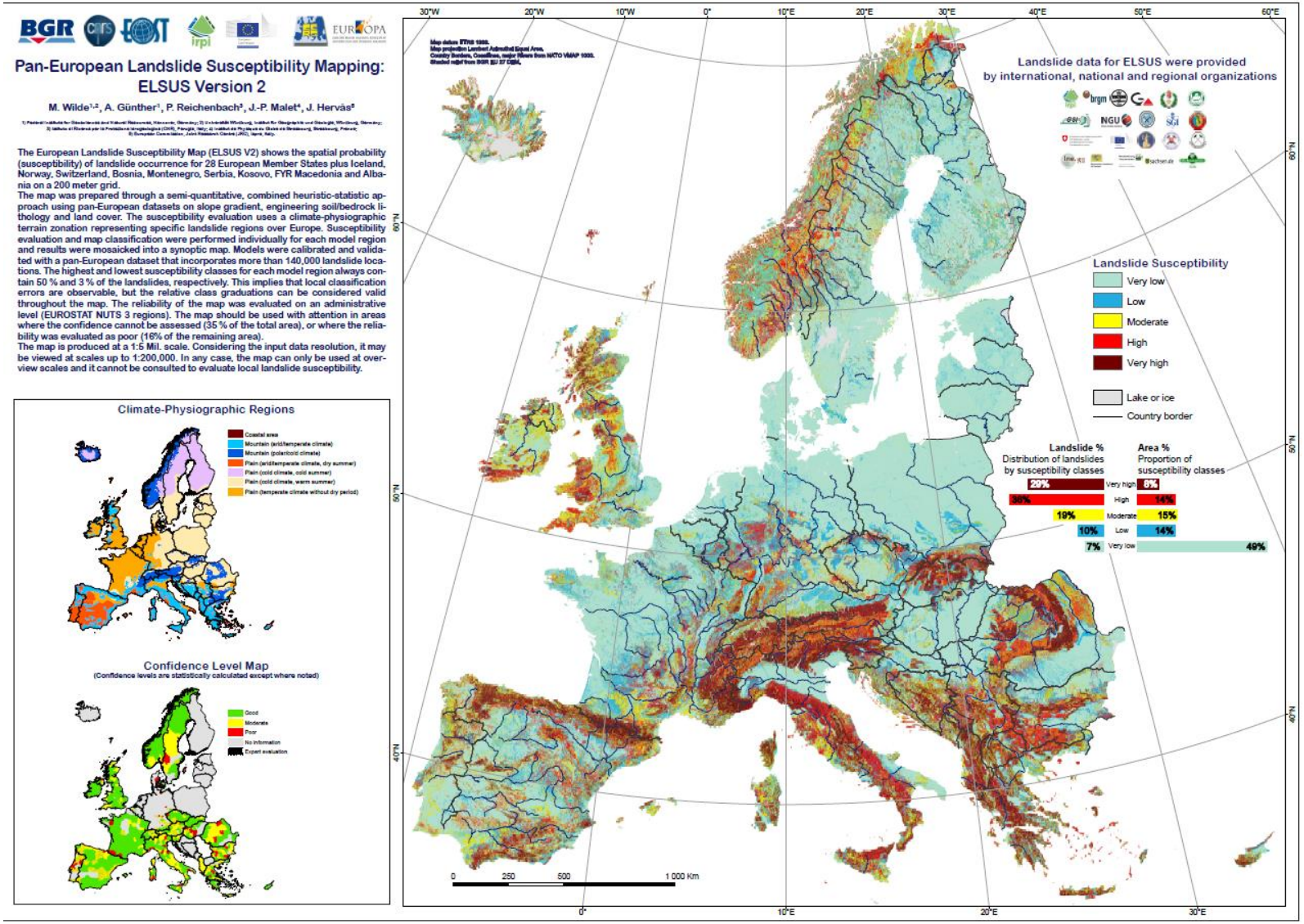
# Relevance of Landslides Risk

Nat. Hazards Earth Syst. Sci., 18, 2161–2181, 2018
https://doi.org/10.5194/nhess-18-2161-2018

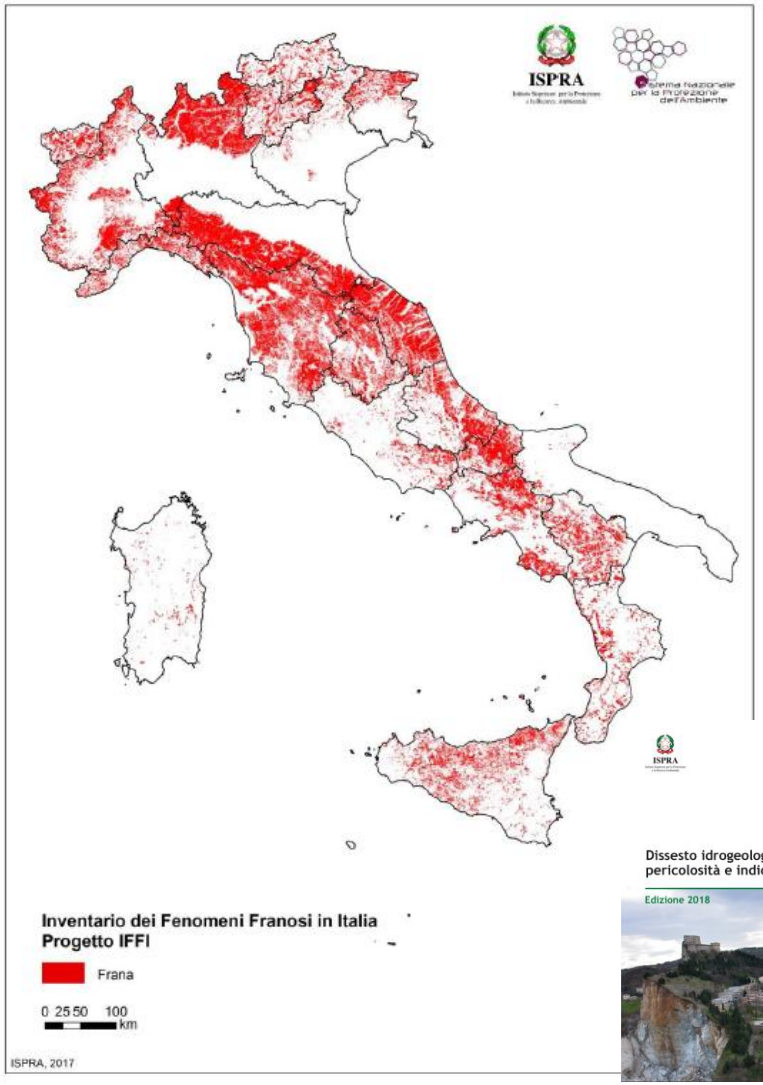

## M. J. Froude and D. N. Petley: Global fatal landslide occurrence from 2004 to 2016



# Relevance of Landslides Risk



# Relevance of Landslides Risk







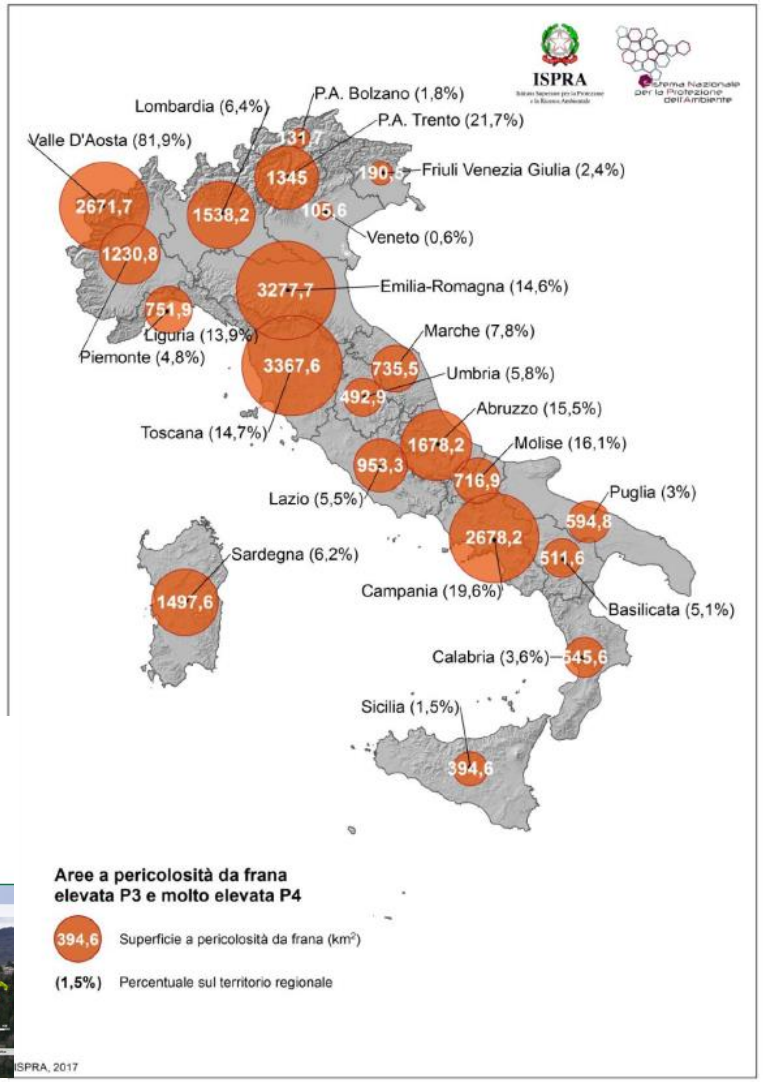



**Figura 1.12** – *Distribuzione delle frane sul territorio nazionale (Inventario dei Fenomeni Franosi in Italia - Progetto IFFI)*

**Figura 1.16** – *Aree a pericolosità da frana elevata P3 e molto elevata P4 PAI su base regionale – Mosaicatura 2017*

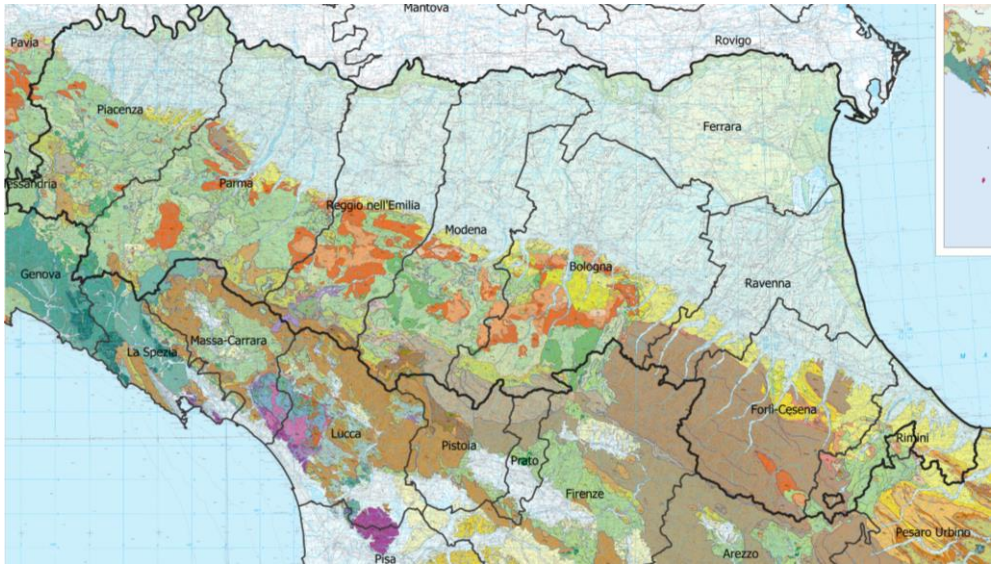
# Cause

## 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, sovrapressioni interstiziali, caratteristiche delle falde acquifere;



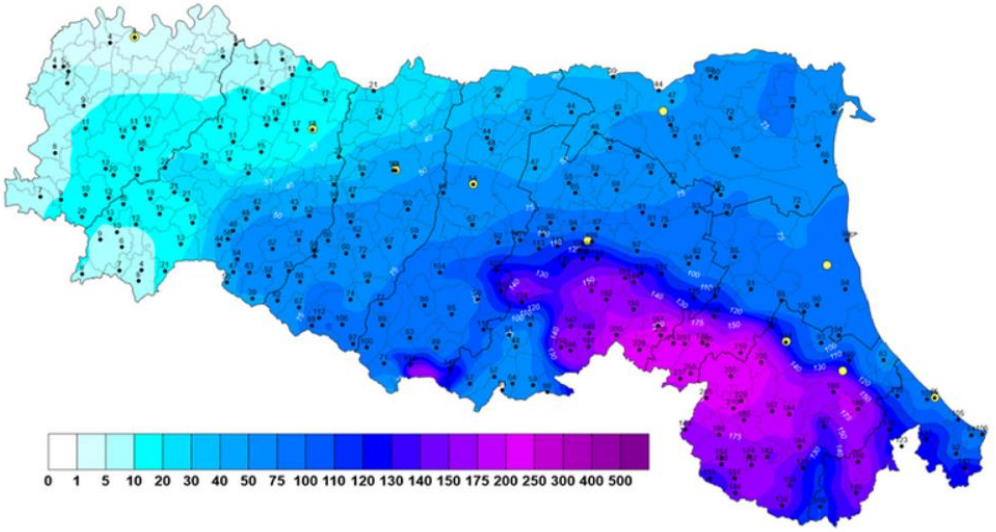

## INNESCANTI

➢**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

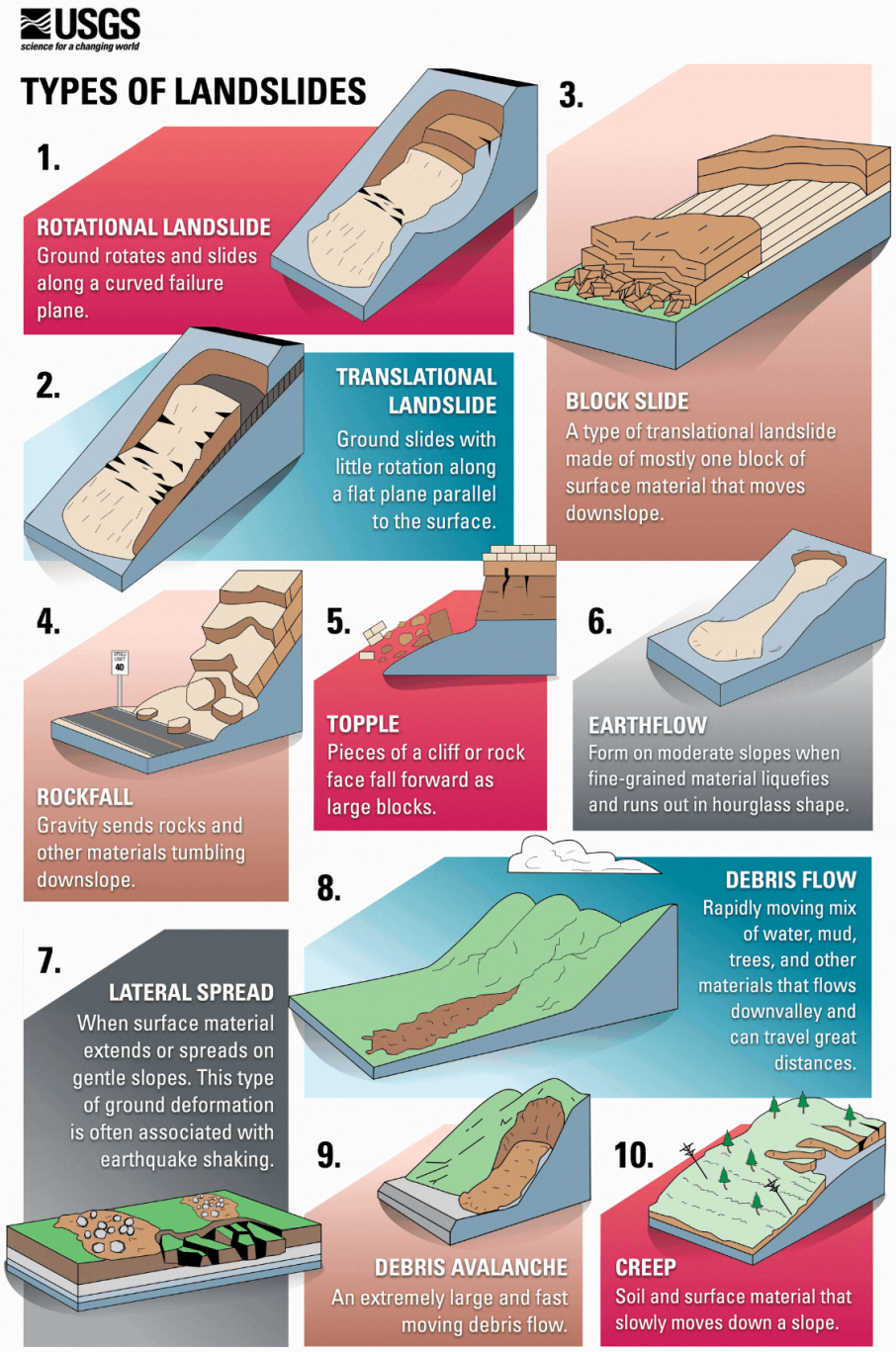
*In figura le precipitazioni cumulate nel periodo 16-17 maggio 2023*



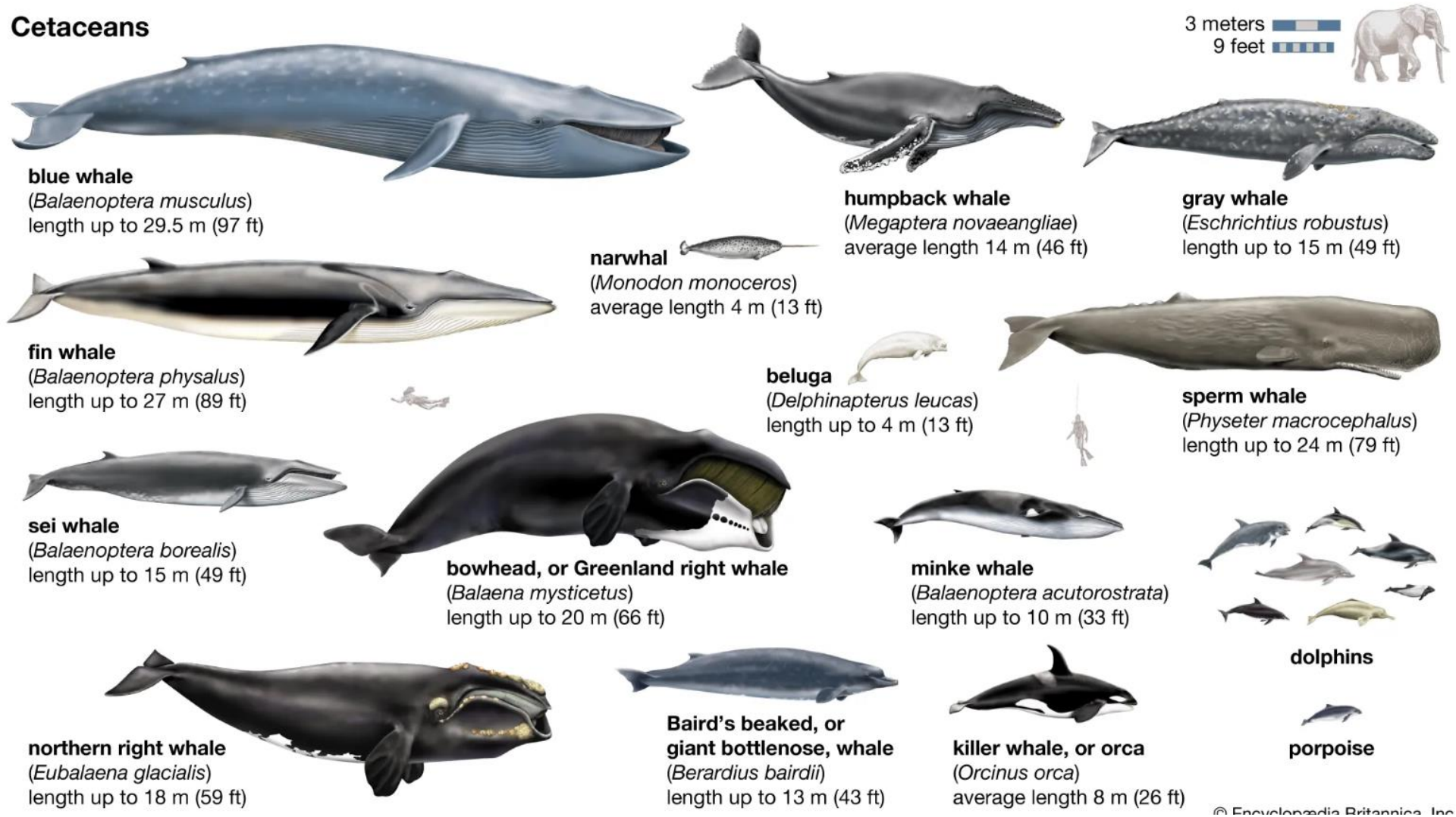
# Tipologie

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

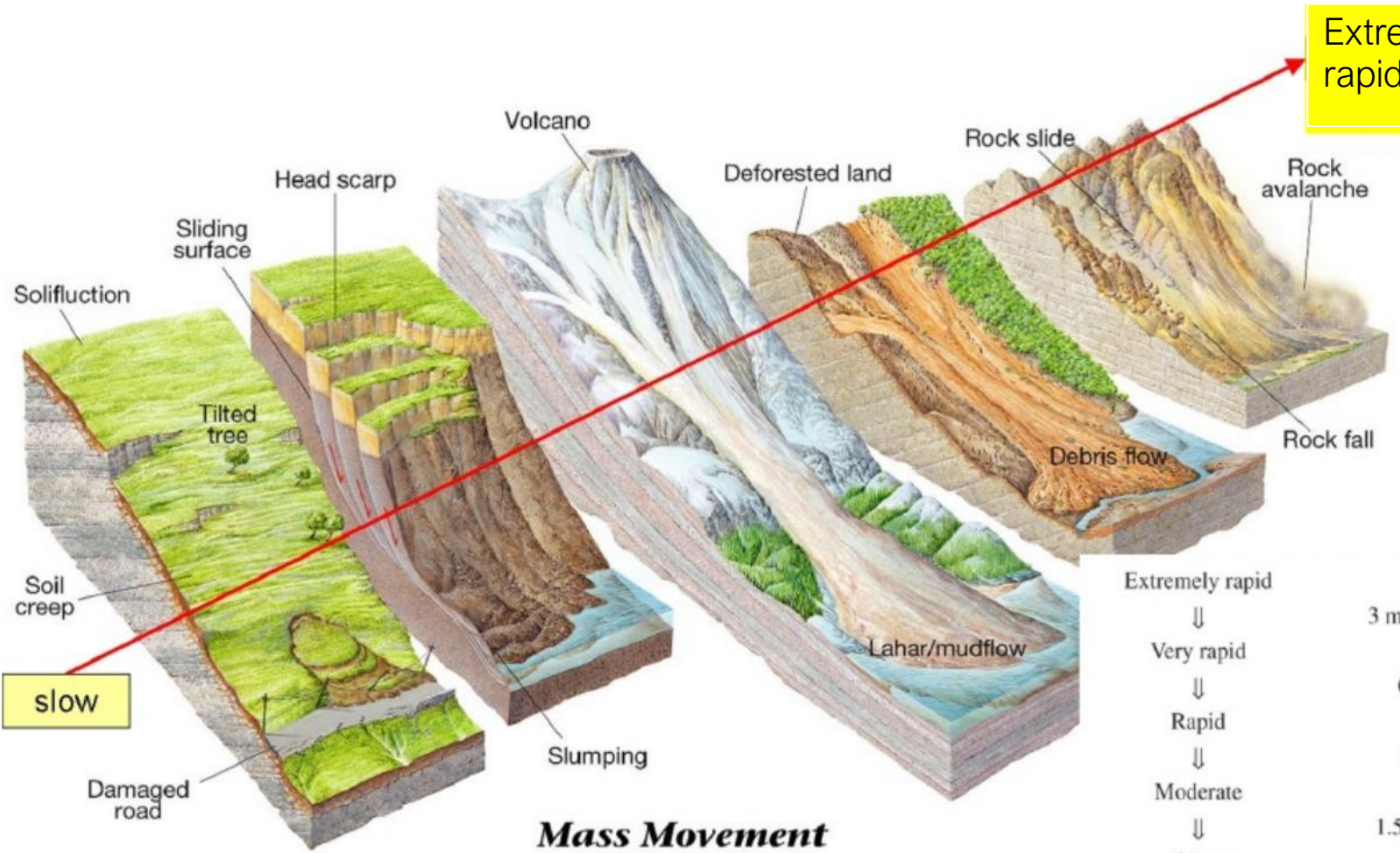
https://blogs.agu.org/landslideblog/



# CARATTERISTICHE CINEMATICHE E DI PERICOLOSITA



# Landslides velocity



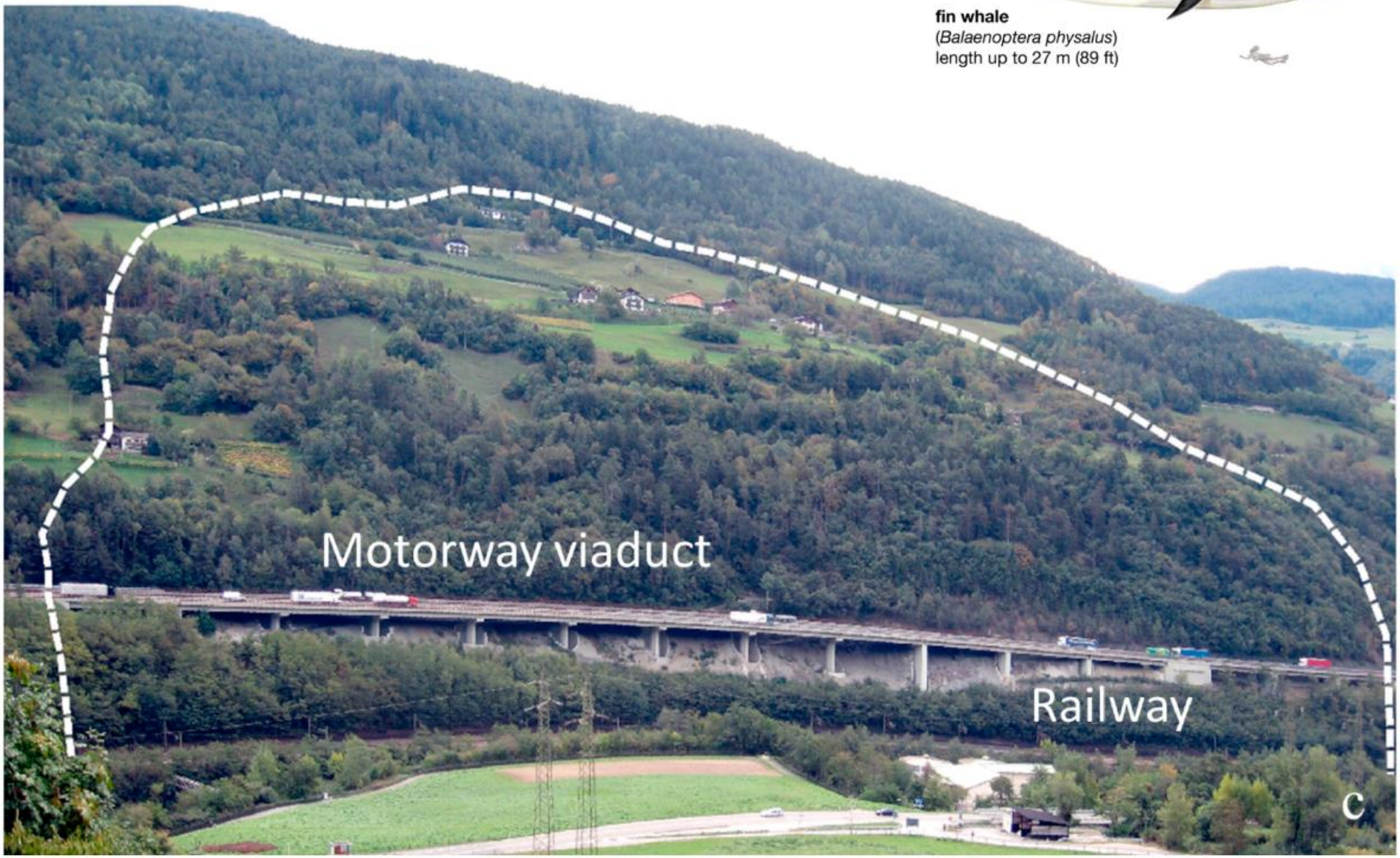

**killer whale, or orca**
(*Orcinus orca*)
average length 8 m (26 ft)

| | |
|---|---|
| Extremely rapid | |
| ⇓ | 3 m/sec (10 ft/sec) (6 mph) |
| Very rapid | ⇓ |
| ⇓ | 0.3 m/min (1 ft/min) |
| Rapid | ⇓ |
| ⇓ | 1.5 m/day (5 ft/day) |
| Moderate | ⇓ |
| ⇓ | 1.5 m/month (5 ft/month) |
| Slow | ⇓ |
| ⇓ | 1.5 m/year (5 ft/year) |
| Very slow | ⇓ |
| ⇓ | 0.3 m/5 years (1 ft/5 years) |

**dolphins**


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)

**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 | $5 \times 10^{3}$ mm/s | | | | | | very great damage potential, many dead, evacuation not possible, great property damages |
| 6 | very rapid | 5 m/s | | | | | | great damage potential, some dead, evacuation partly possible, great property damages |
| 5 | rapid | $5 \times 10^{-1}$ mm/s<br>3 m/min | | | | | | damage potential existing, no dead because of possible evacuation, great property damages |
| 4 | moderate | $5 \times 10^{-3}$ mm/s<br>1.8 m/h | | | | | | damages on buildings and infrastructure |
| 3 | slow | $5 \times 10^{-5}$ mm/s<br>158 m/a | | | | | | damages on buildings and infrastructure, redevelopment according to velocities partly possible |
| 2 | very slow | 1.6 m/a | | | | Rock Flow | Soil Flow | differential movements cause damages on buildings, some structures can not be influenced by movement |
| 1 | extremely slow | $5 \times 10^{-7}$ mm/s<br>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/SixjlY6JYz8

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

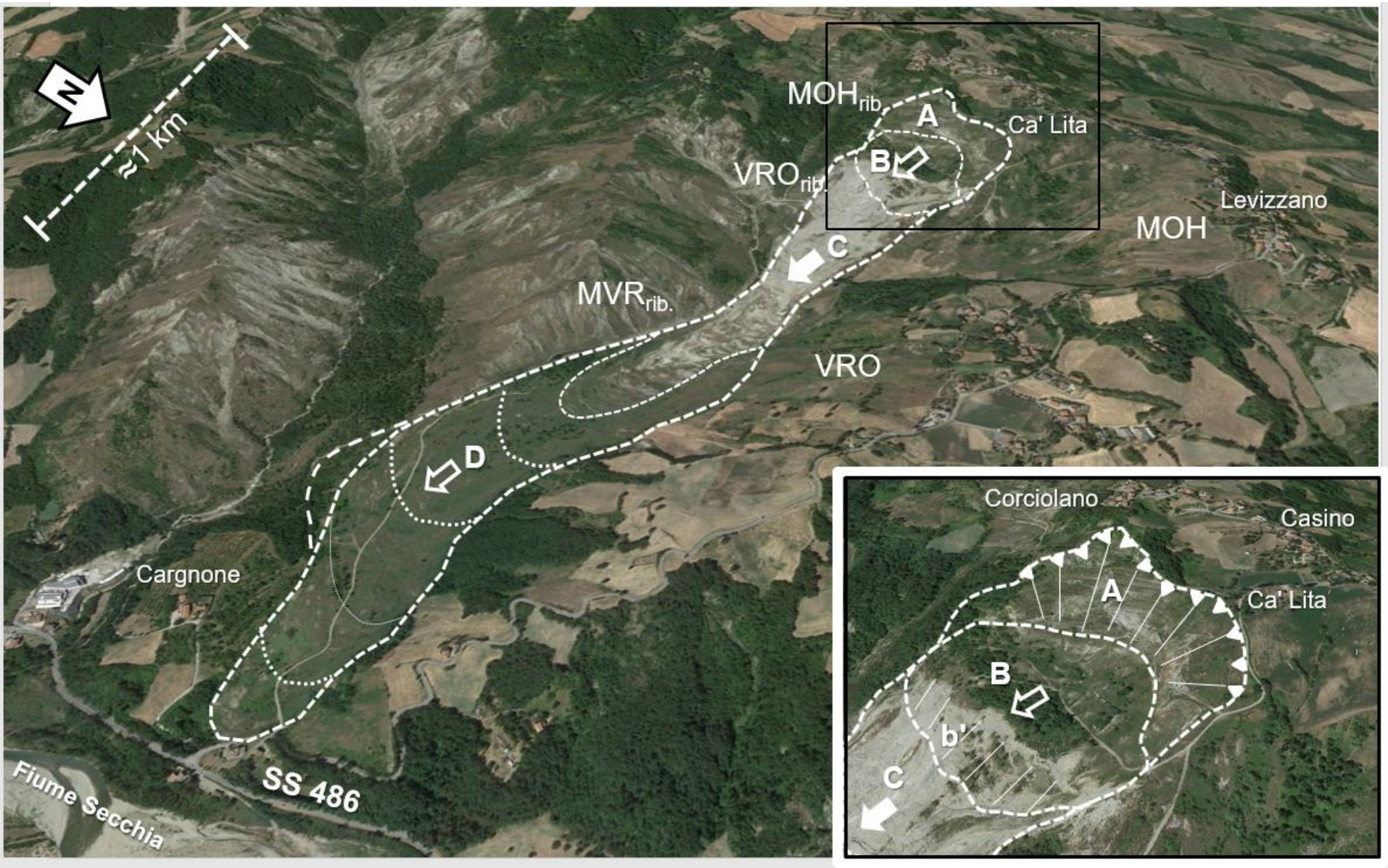
Earthflows

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

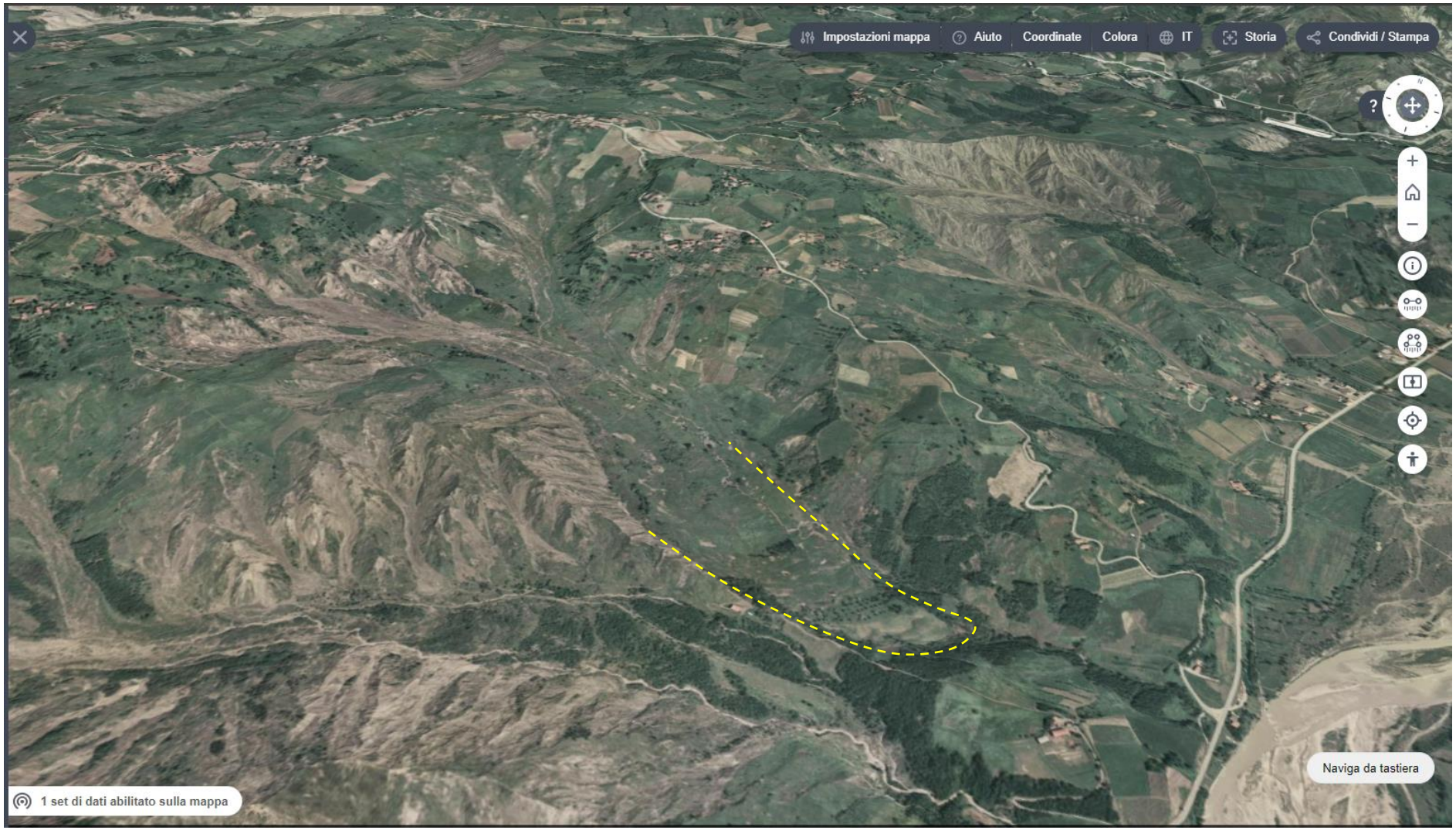
https://youtu.be/eJRL3uBQ4CA?t=858

Earthslides-earthflows

Earthslides-earthflows




https://youtu.be/SdVmNV2ti0E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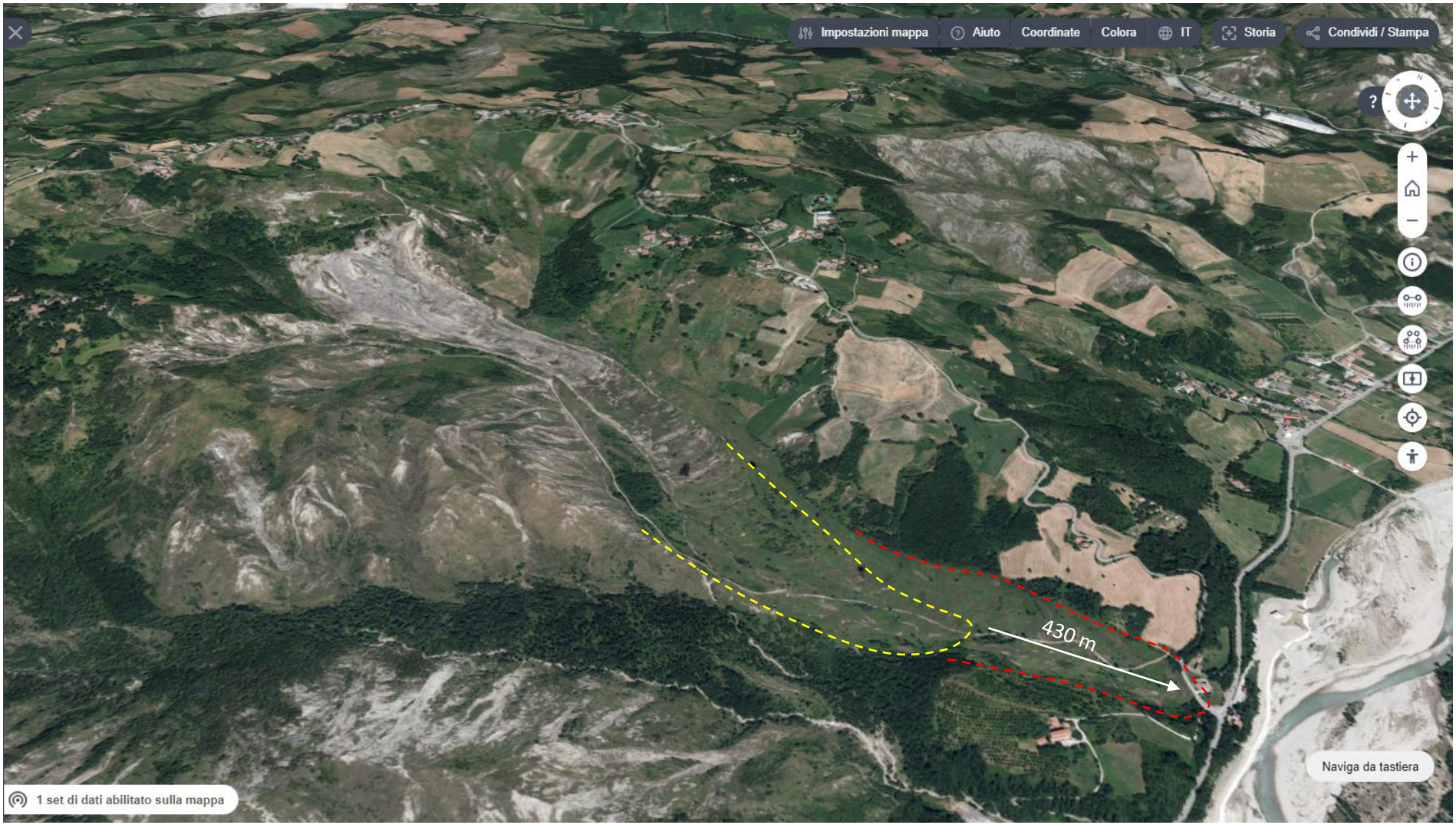
1 set di dati abilitato sulla mappa


Impostazioni mappa
Aiuto
Coordinate
Colora
IT
Storia
Condividi / Stampa
430 m
Naviga da tastiera
1 set di dati abilitato sulla mappa

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