ALMA MATER STUDIORUM
UNIVERSITÀ DI BOLOGNA

Regione Emilia-Romagna

A multi-temporal inventory for constraining earthflow source-to-sink pathways in the Sillaro River basin, Northern Apennines

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EGU2020-10391
EGU General Assembly 2020

EGU European Geosciences Union

Introduction

Evaluation of landslide sediment supply to river systems is fundamental for modelling landscape evolution and for tackling applied issues on river sediment management.

In the Tuscan-Emilian Apennines the predominance of clay-rich lithologies originates earthflows, that in these settings are the dominant agents of hillslope sediment transfer.

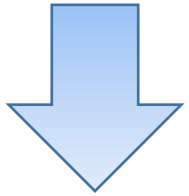
While the study and monitoring of individual earthflows are widespread, limited quantitative information are available about the contribution of these processes to the sediment budget at the basin-scale.

The compilation of earthflow inventories at the basin-scale is important to understand how they affect the landscape evolution.

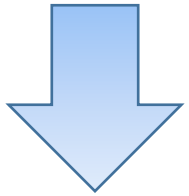
Objectives

Through the compilation of a multi-temporal earthflow inventory (1954-2018), we aim to:

i. characterize earthflow source-to-sink sedimentary pathways, with special reference to sediment delivery to ephemeral and perennial streams;



ii. explore possible litho-topographic controls on earthflow size, frequency and recurrence;



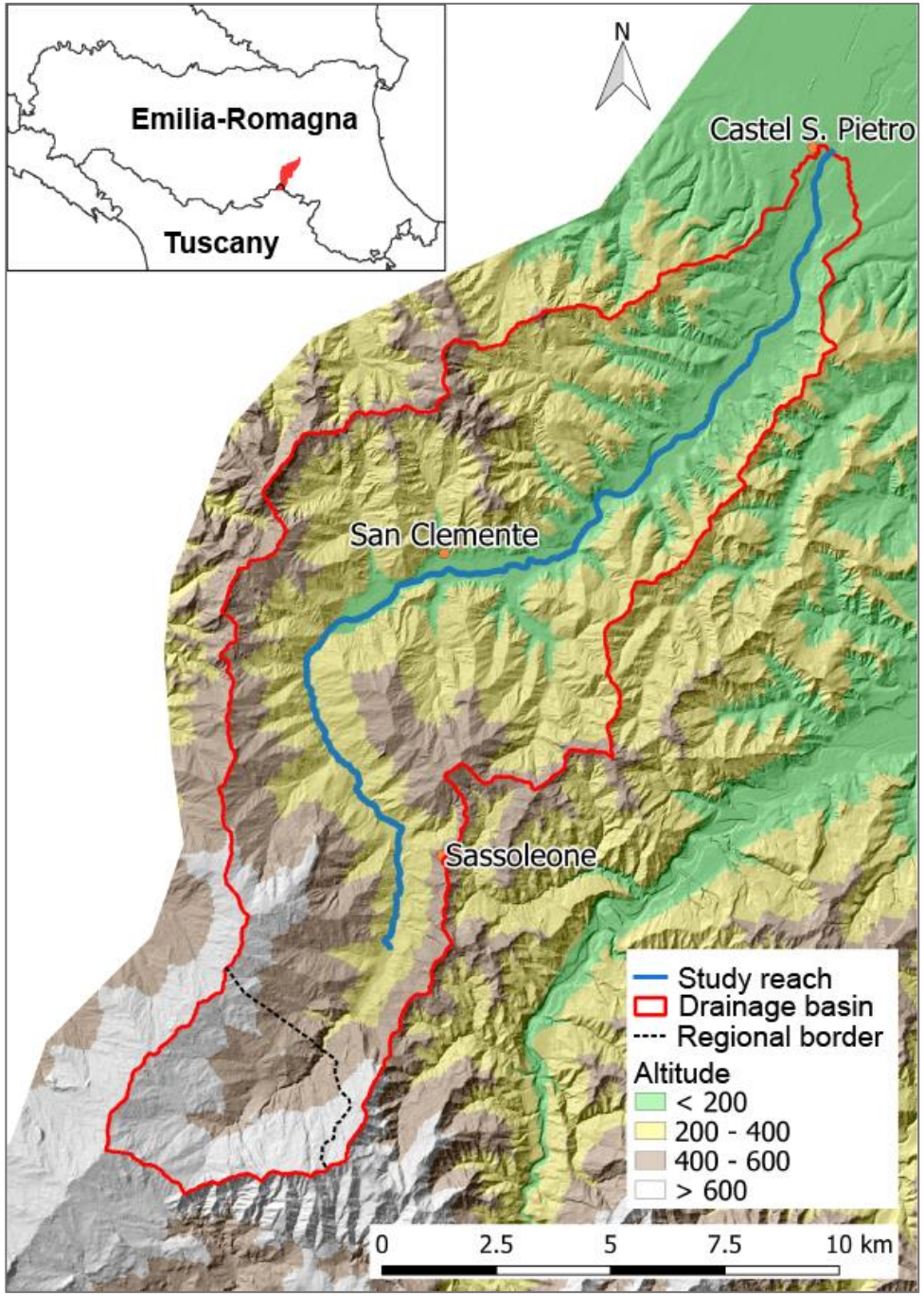
iii. test how relevant information could complement the existing inventory of the Emilia-Romagna Region, for evaluating earthflow hazard and risk potential.

The Sillaro Basin

- **Study basin:** located in the Northern Apennines, Italy

- **Study basin area:** ~ 138 km^2

- **Channel type:** wandering (single & multi- thread channel reaches)



The Sillaro Basin

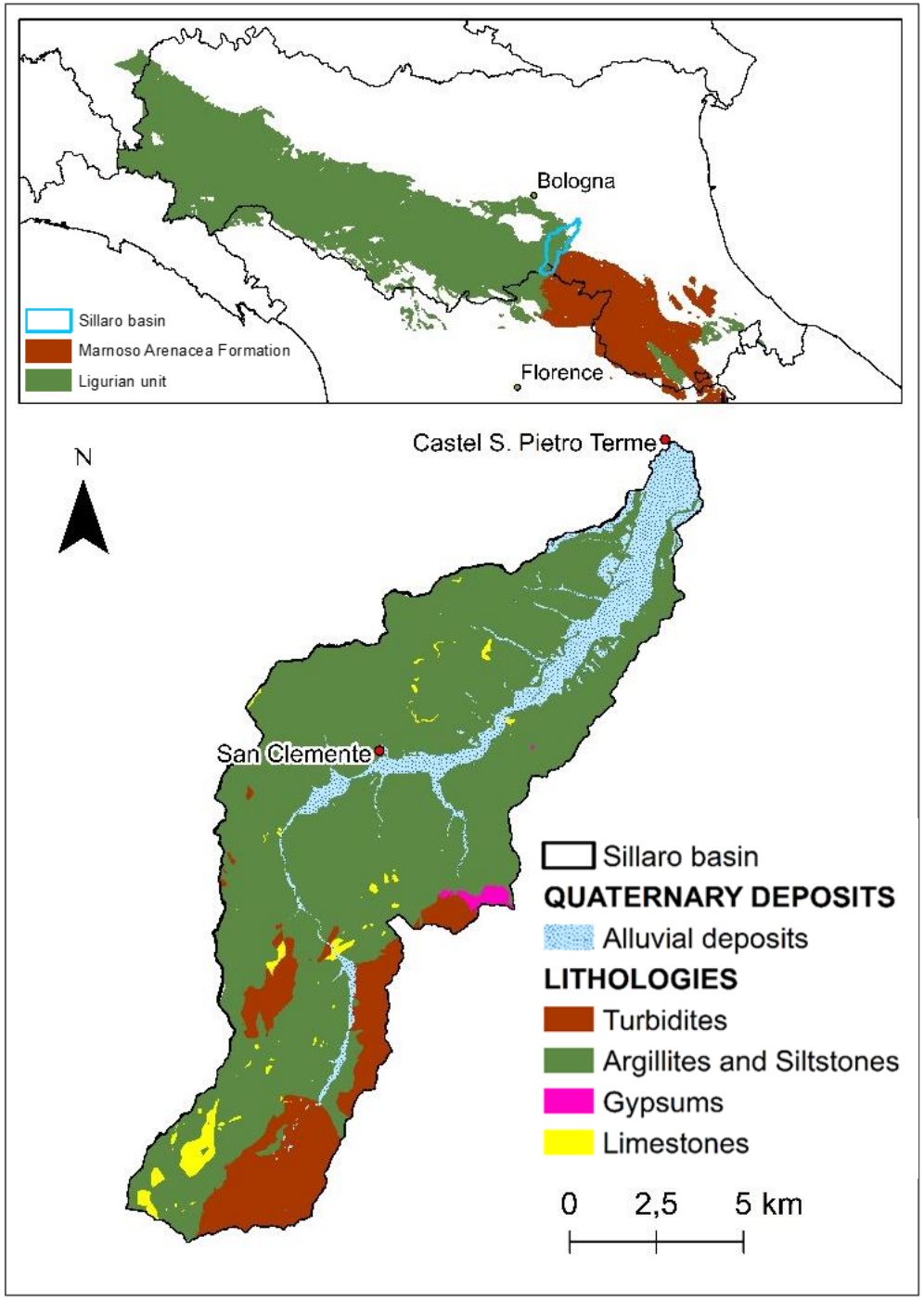
- **Study basin:** located in the Northern Apennines, Italy

- **Study basin area:** ~ 138 km^2

- **Channel type:** wandering (single & multi- thread channel reaches)

- **Dominant geology:** argillites & siltstones of the Ligurian domain

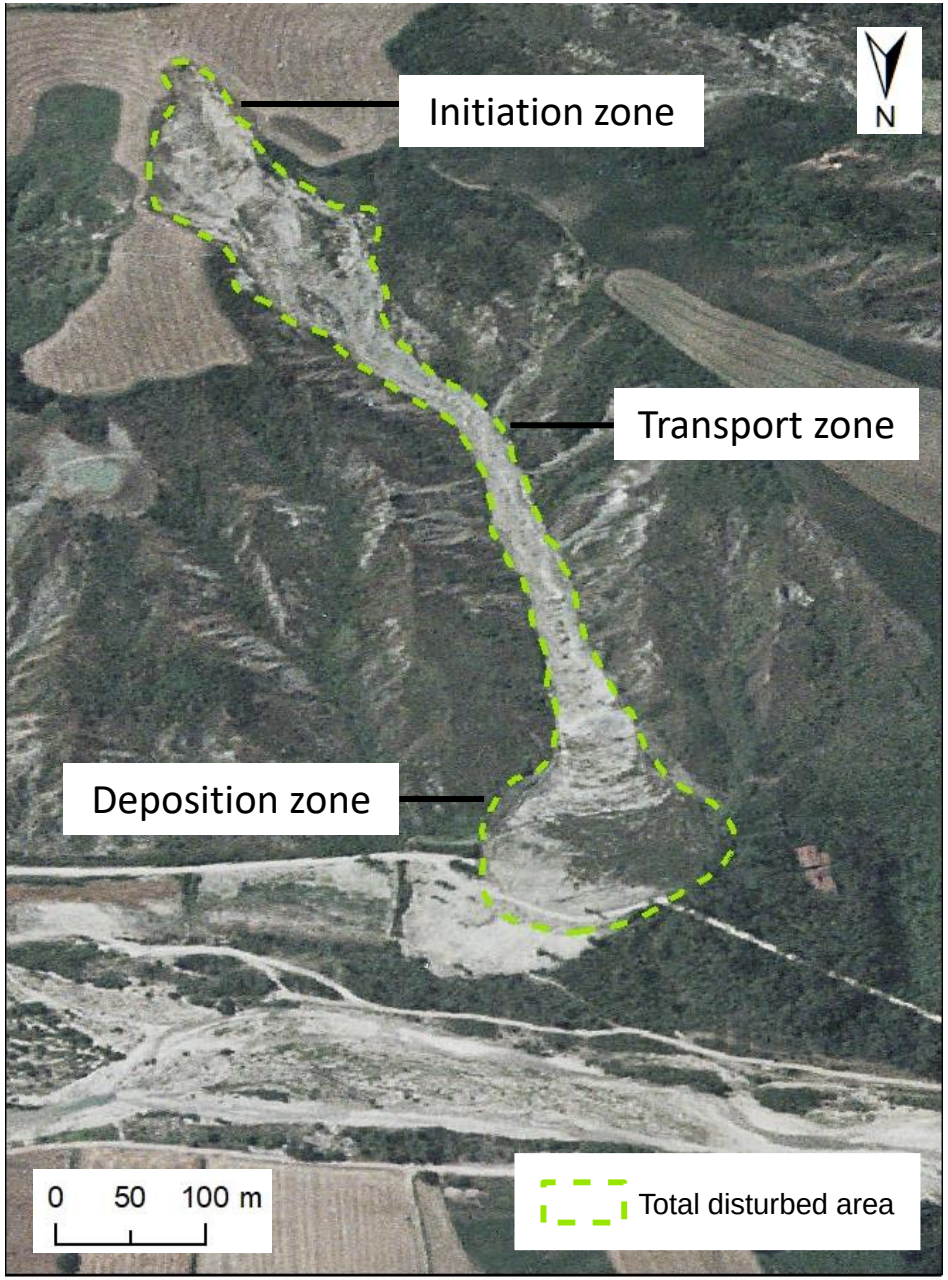
- **Dominant landslide type:** earthflows



Methods

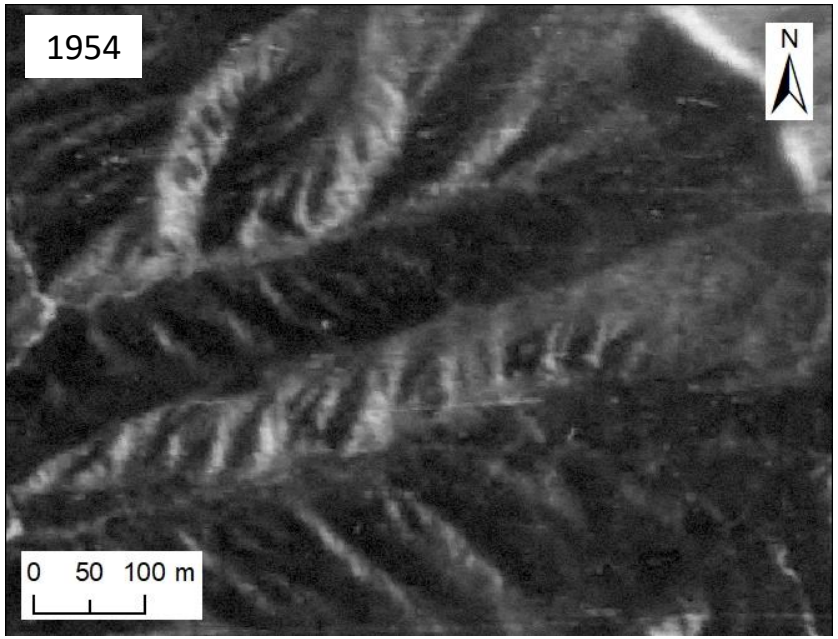
- Multi-temporal mapping of earthflows across 12 historical aerial photo sets from 1954 to 2018:
  - 1954
  - 1969
  - 1976
  - 1988
  - 1996
  - 2000
  - 2006
  - 2008
  - 2011
  - 2014
  - 2016
  - 2018

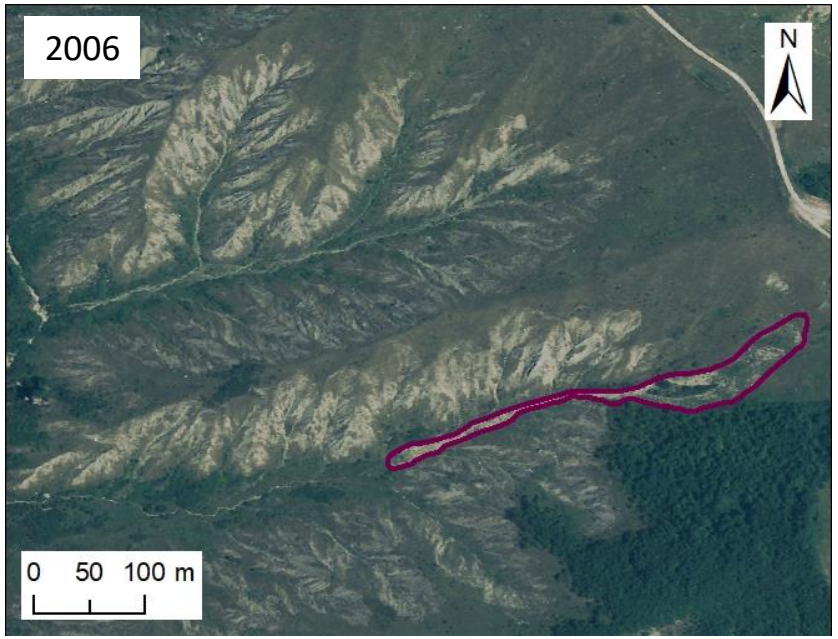
- Mapping of the '*Total disturbed area*': initiation + transport + deposition



Methods

- We mapped all earthflows visible on sequential orthophoto mosaics. In particular, we mapped all movements above a minimum width of 4 meters. Below this threshold, it was not possible to consistently identify earthflows and delineate the relevant perimeter, especially on the 1954 orthophotos, which are the coarser set.





- Implementation of a database with the following earthflow attributes:

i. Year of occurrence
ii. Recurrence
iii. Area
iv. Geology
v. Land use
vi. Source
vii. Sink

EARTHFLOW SOURCE-TO-SINK PATHWAYS

SOURCE SITES

Morphology at initiation:

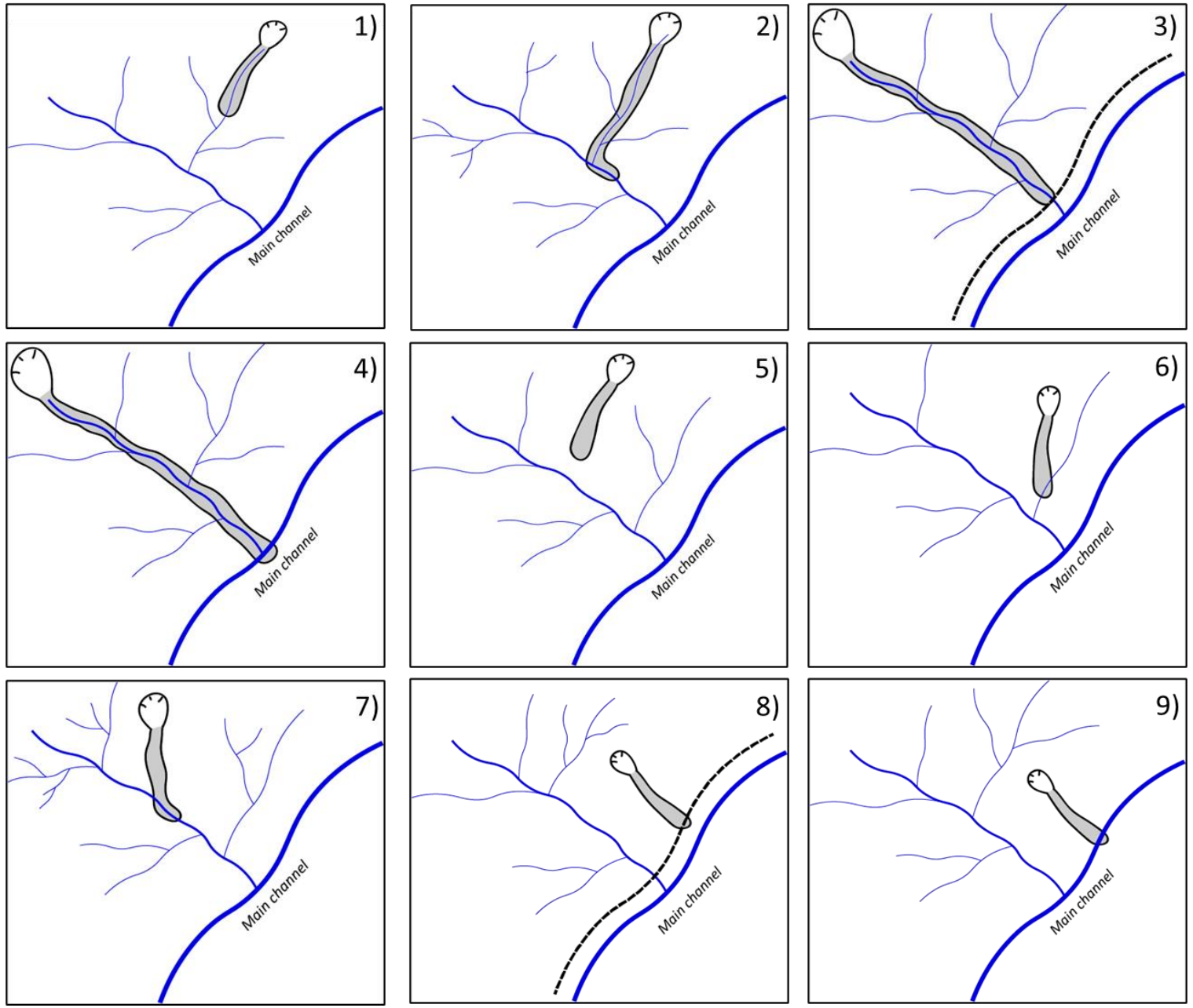
- Gully headwall
- Hillslope (open slope)

SINK SITES

Morphology at deposition:

- Gully channel (1st and 2nd order)
- Connected tributary (> 2nd order)
- Main channel
- Hillslope
- Anthropogenic barrier (eg, road)

9 combinations identified



Results

MULTI-TEMPORAL INVENTORY:

Number of earthflows = 1085

Total disturbed area = ~ 6 km^2

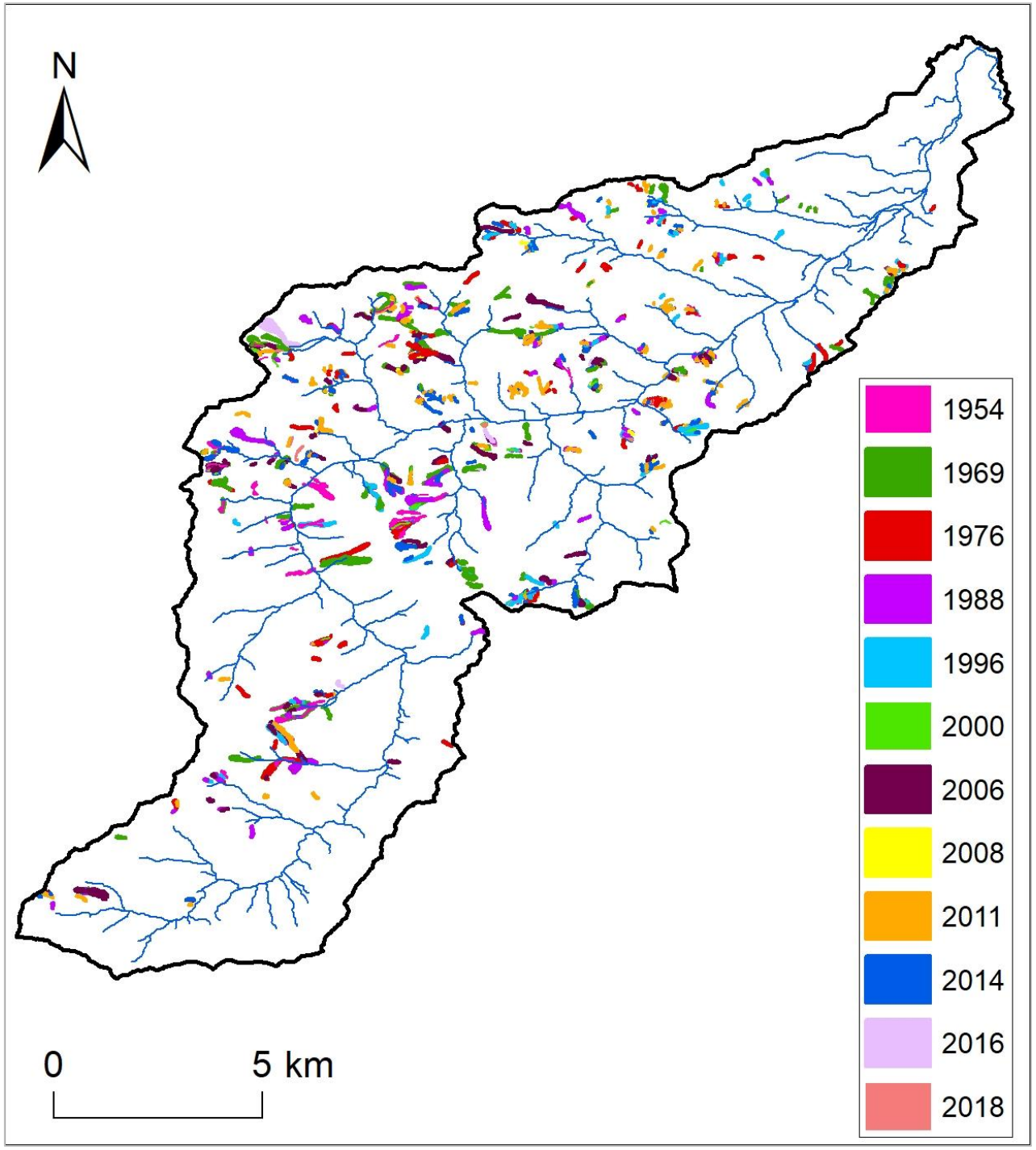
Average area = 5690 m^2

Median area = 2800 m^2

Range area: min 200 m^2
max 97610 m^2

→ 319 single movements

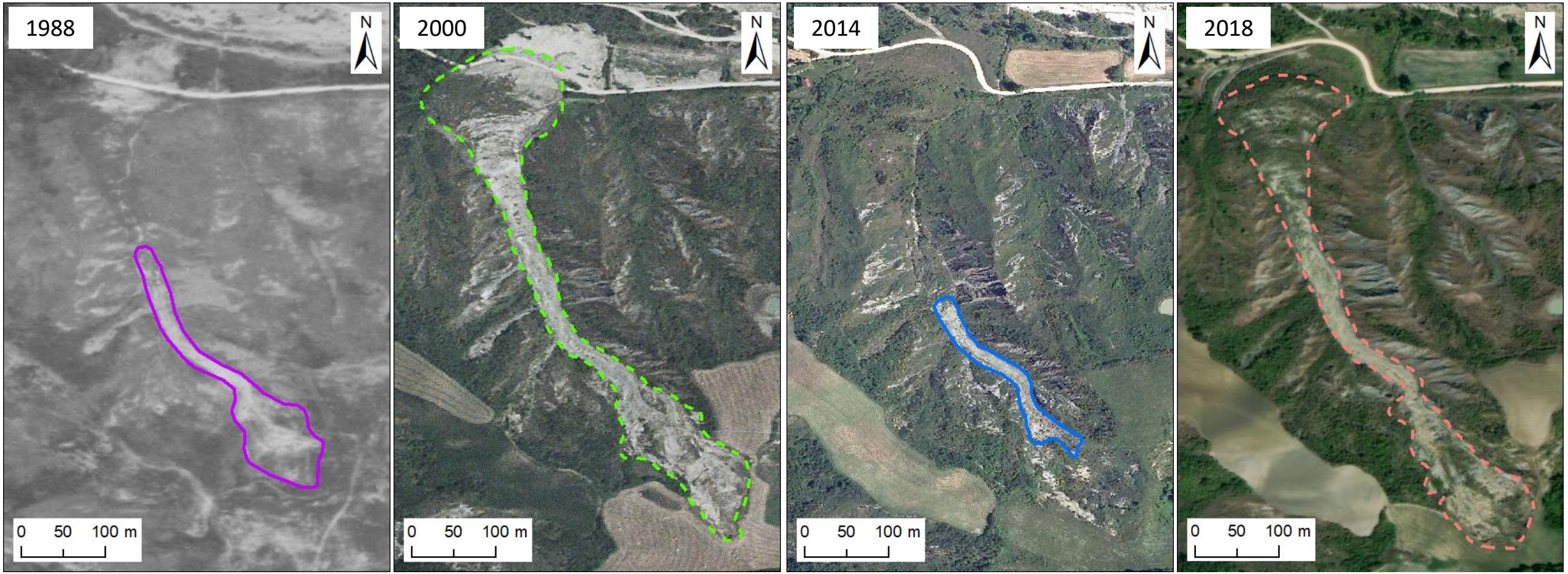
→ 766 recurring movements



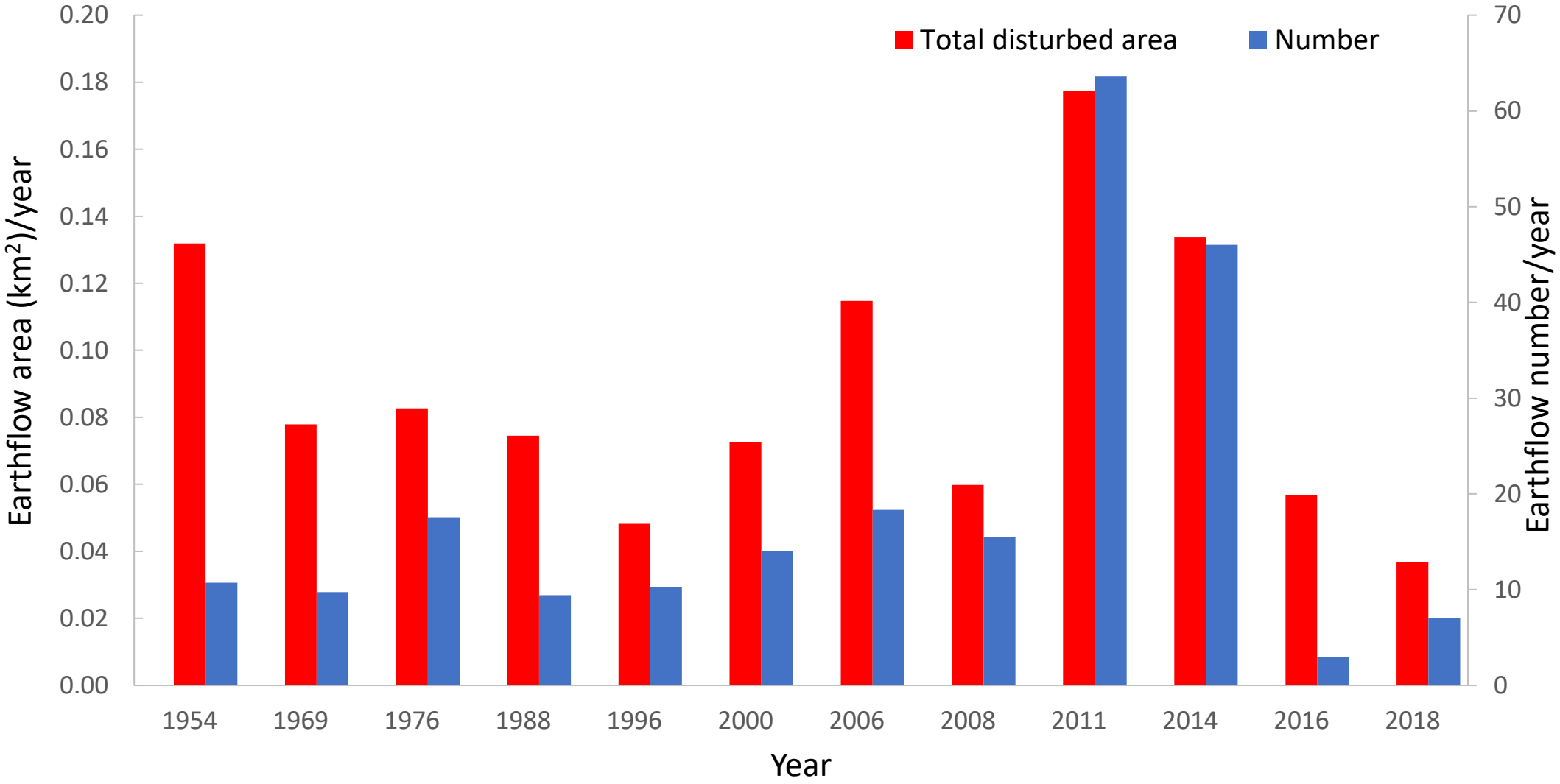
Multi-temporal aerial photo interpretation and mapping allow depicting:

(i) the pace and extent of recurring earthflows at a given site

(ii) the degree to which the flow lobe travels all the way down to the colluvial fan, or involves only part of the tributary channel.

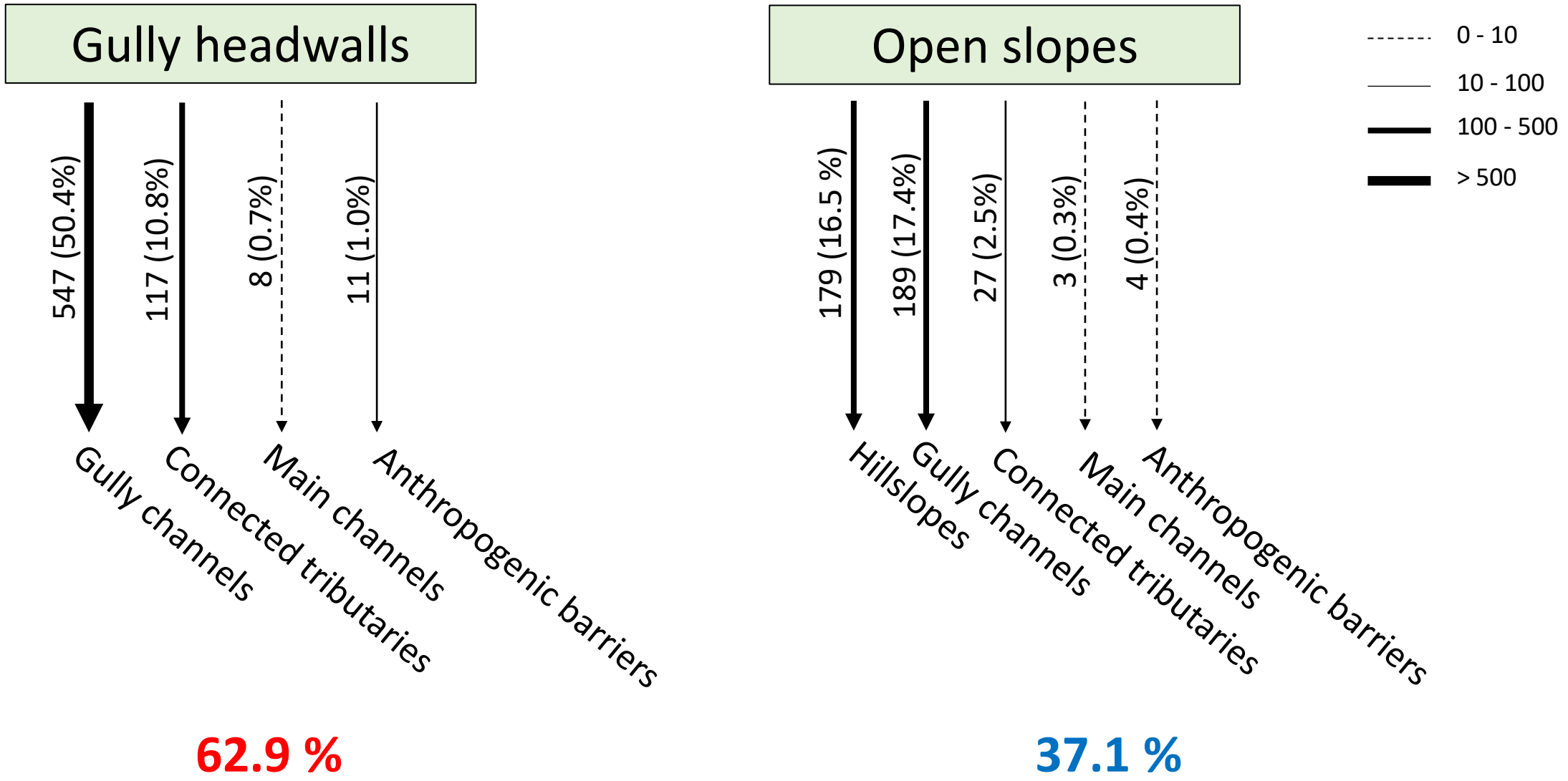


TEMPORAL DISTRIBUTION



SOURCE TO SINK PATHWAYS

Number of mapped earthflows

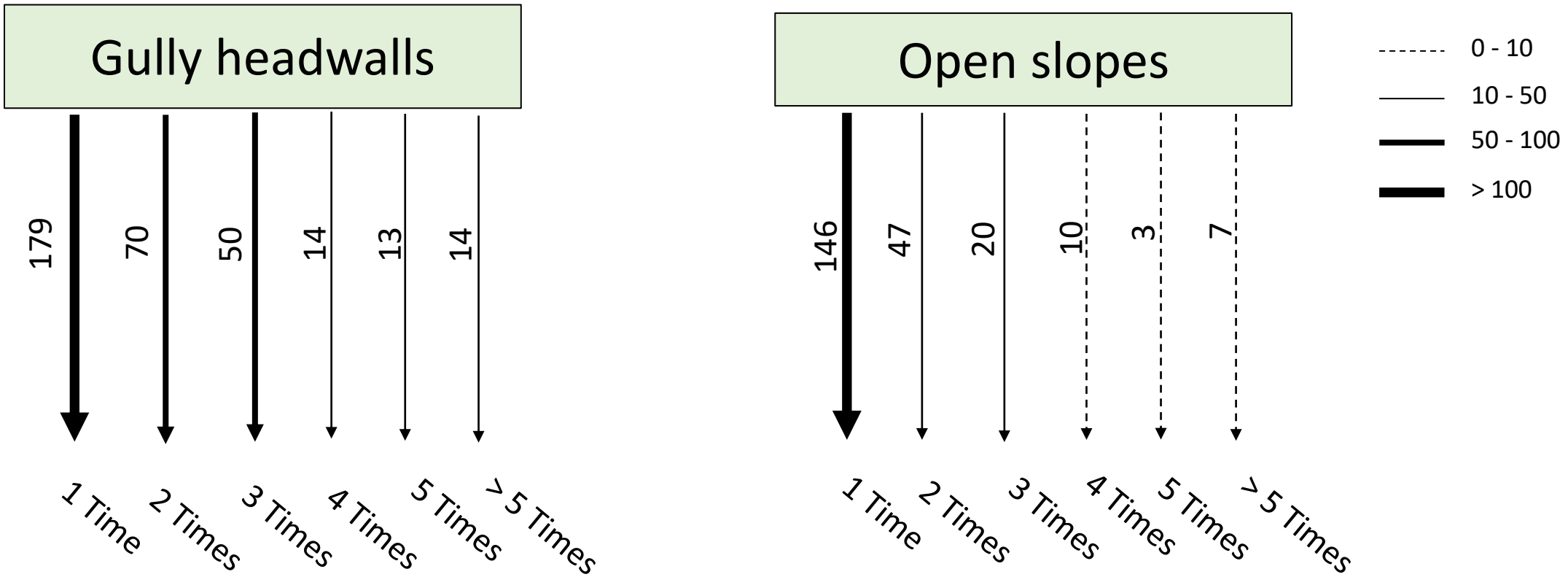


62.9 %

37.1 %

RECURRENCE

Number of earthflow sites



Comparison between the Sillaro and the Emilia-Romagna Region (RER) inventories

THE SILLARO INVENTORY

- *Spatial scale*: Sillaro river basin
- *Temporal scale*: from 1954 to 2018
- *Contents*: only active earthflows
- *Year of occurrence*: specified
- *Update*: for each of the 12 orthophotos available, performed mapping a new polygon

THE RER INVENTORY

- *Spatial scale*: Emilia-Romagna region
- *Temporal scale*: from the mid 90's until today
- *Contents*: active and dormant landslides
- *Year of occurrence*: unspecified (indicated only for the last update of some landslides)
- *Update*: mainly for landslides that caused damage, performed overwriting the old landslide mapping

We aim to contrast and integrate the Sillaro and the Emilia-Romagna Region inventories.

Some advantages:

- create a more complete inventory
- integrate data on events that caused damage
- check if there is a correlation between dormant and recurrent earthflows