Identification of regional landslide triggering thresholds in the Lombardy region using multivariate statistical analysis

Nunziarita Palazzolo [1,2], David J. Peres [2], Enrico Creaco [1] & Antonino Cancelliere [2]

(1) Department of Civil Engineering and Architecture, University of Pavia

(2) Department of Civil Engineering and Architecture, University of Catania

This presentation participates in OSPP

Outstanding Student & PhD candidate Presentation contest

Programme group: HS7

Session: HS7.5/NH1.11/NP8.8

25 May 2022, 14:02–14:08 - Room 2.44

nunziarita.palazzolo01@universitadipavia.it

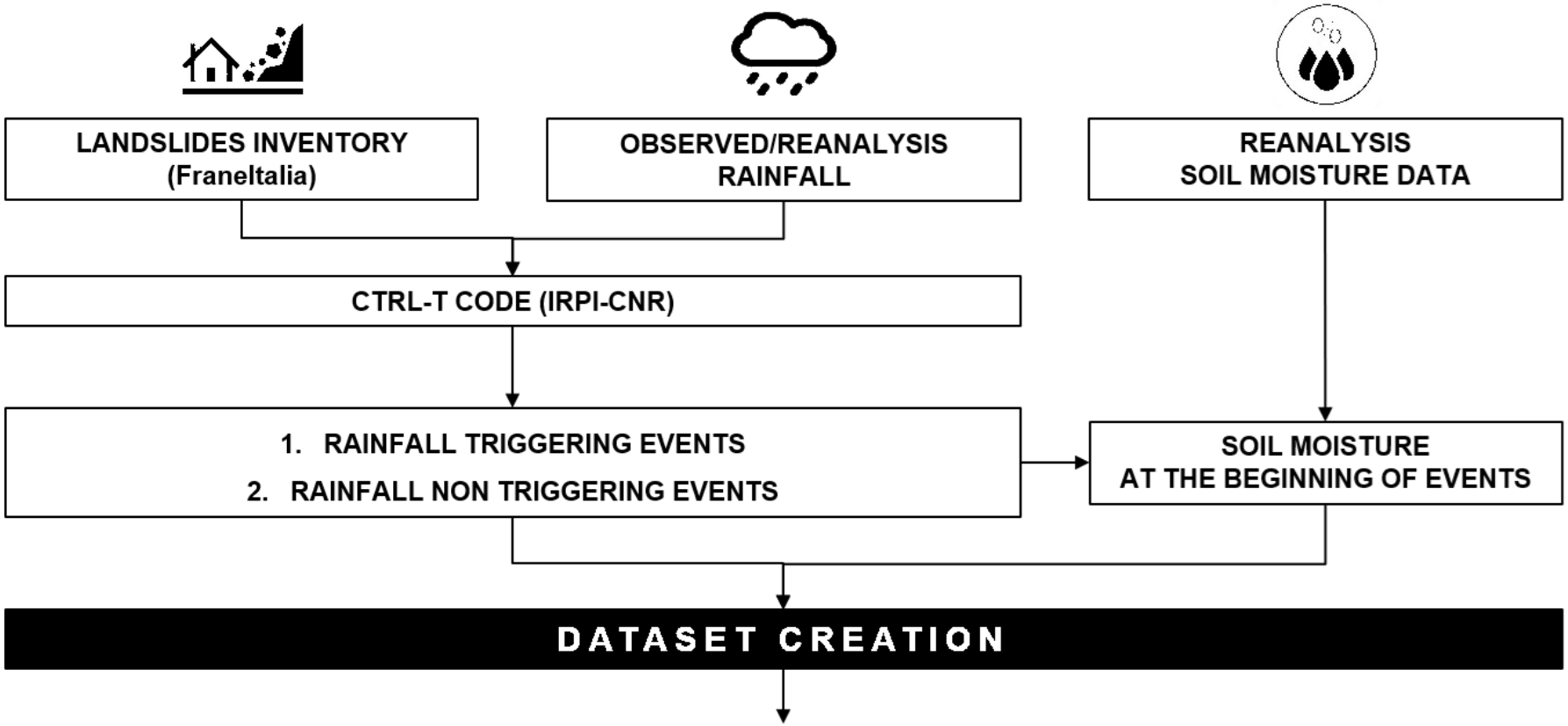
LANDSLIDES TRIGGERING THRESHOLDS

Defined by not more than two or three precipitation variables (mostly rainfall event depth and duration) following a power-law

CAN SOIL MOISTURE INFORMATION IMPROVE THE PERFORMANCE?

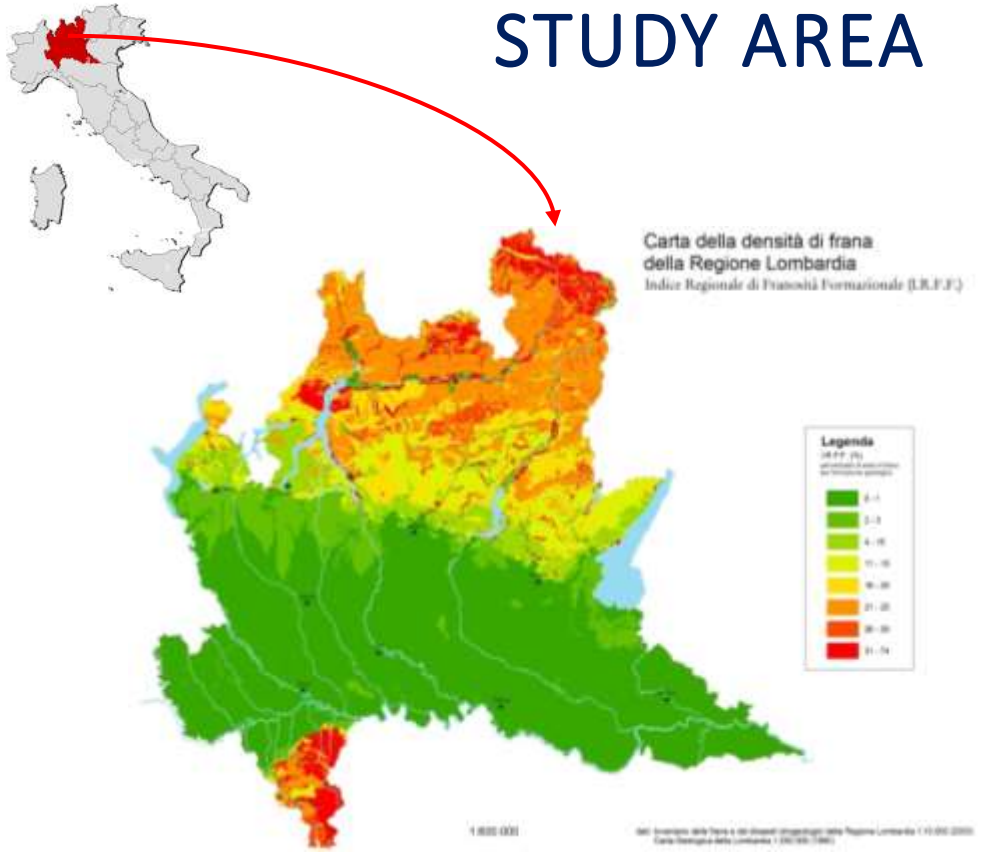
Multivariate statistical analysis to investigate the performance of multiple combinations of rainfall variables and event soil moisture data in the identification of regional rainfall thresholds for landslide initiation

DATABASE SET UP



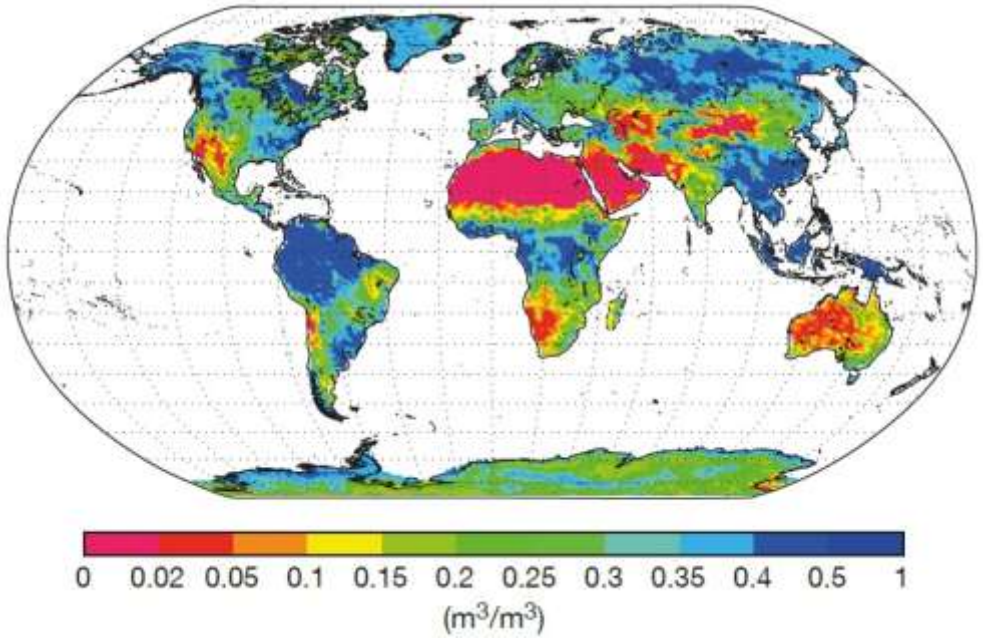
D [h]	I [mm/h]	ϑ_1 [m³/m³]	ϑ_2 [m³/m³]	ϑ_3 [m³/m³]	ϑ_4 [m³/m³]	Target
Rainfall event duration	Mean rainfall event intensity	Volumetric soil moisture at level L=1,2,3,4, at the beginning of the rainfall event				Binary vector containing 0 for non-triggering rainfall events, and 1 for triggering rainfall events

STUDY AREA



Landslide density of Lombardy region(2003)
Source: ARPA Lombardia

DATA: ERA5-Land Reanalysis



ERA5-Land soil moisture data. The chart shows mean soil moisture for May 2018 from ERA5-Land

THRESHOLDS IDENTIFICATION

1. **Principal Component Analysis** of reanalysis soil moisture data table

2. Identification of **parametric form of the threshold** (i.e., heuristically)

3. Testing **different combinations** of precipitation and soil moisture variables

- Mean rainfall intensity
- Rainfall depth
- Rainfall duration
- Rainfall peak intensity

First principal component corresponding to the highest explained variance

ROC PERFORMANCE

		Observed landslide	
		Landslide (P)	No landslide (N)
Predicted Landslide	Landslide	TP	FP
	No landslide	FN	TN

$$TPR = \frac{TP}{(TP + FN)} \qquad FPR = \frac{FP}{(TN + FP)} \qquad TSS = TPR - FPR$$

The highest performances correspond to $TSS = 1$, when, relatively to a given rainfall event, the model produces no false or missing predictions

RESULTS

TSS	First principal component of soil moisture	Soil moisture (0-7 cm)	Soil moisture (7-28 cm)
Mean rainfall intensity	0.41	0.37	0.37
Rainfall depth	0.42	0.36	0.36
Rainfall duration	0.25	0.20	0.20
Rainfall peak intensity	0.37	0.32	0.32

REFERENCE:
Intensity-Duration triggering threshold → TSS = 0.36

TAKE HOME MESSAGE

- The **ERA5-Land Reanalysis soil moisture** data can **improve** the identification of regional hydrometeorological thresholds
- The **PCA** enables by-passing the problem of identifying the most influential soil layer on landslide triggering, improving, moreover, prediction
- Greater performance can be obtained with more accurate in-situ distributed measurements (both soil moisture and precipitation)

Identification of regional landslide triggering thresholds in the Lombardy region using multivariate statistical analysis

Nunziarita Palazzolo [1,2], David J. Peres [2], Enrico Creaco [1] & Antonino Cancelliere [2]

(1) Department of Civil Engineering and Architecture, University of Pavia

(2) Department of Civil Engineering and Architecture, University of Catania

This presentation participates in OSPP

Outstanding Student & PhD candidate Presentation contest

Programme group: HS7

Session: HS7.5/NH1.11/NP8.8

25 May 2022, 14:02–14:08 - Room 2.44

nunziarita.palazzolo01@universitadipavia.it