RAINFALL THRESHOLDS FOR LANDSLIDE PREDICTION: A FLAGSHIP FOR CNR IRPI

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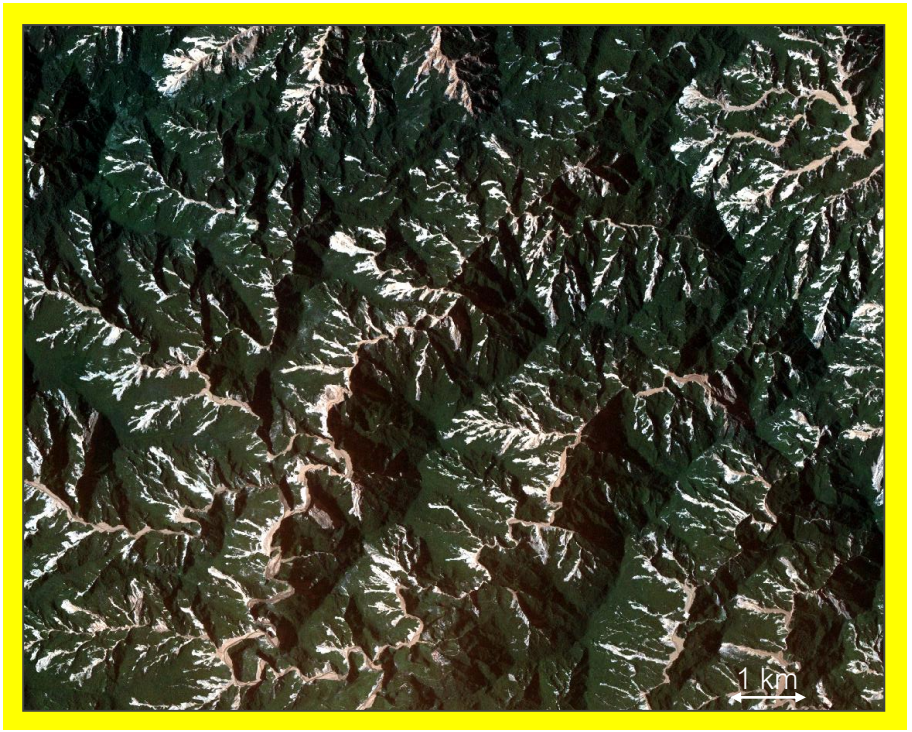
PREDICTING POPULATION OF LANDSLIDES

earthquake triggered landslides,
Atsuma, Japan

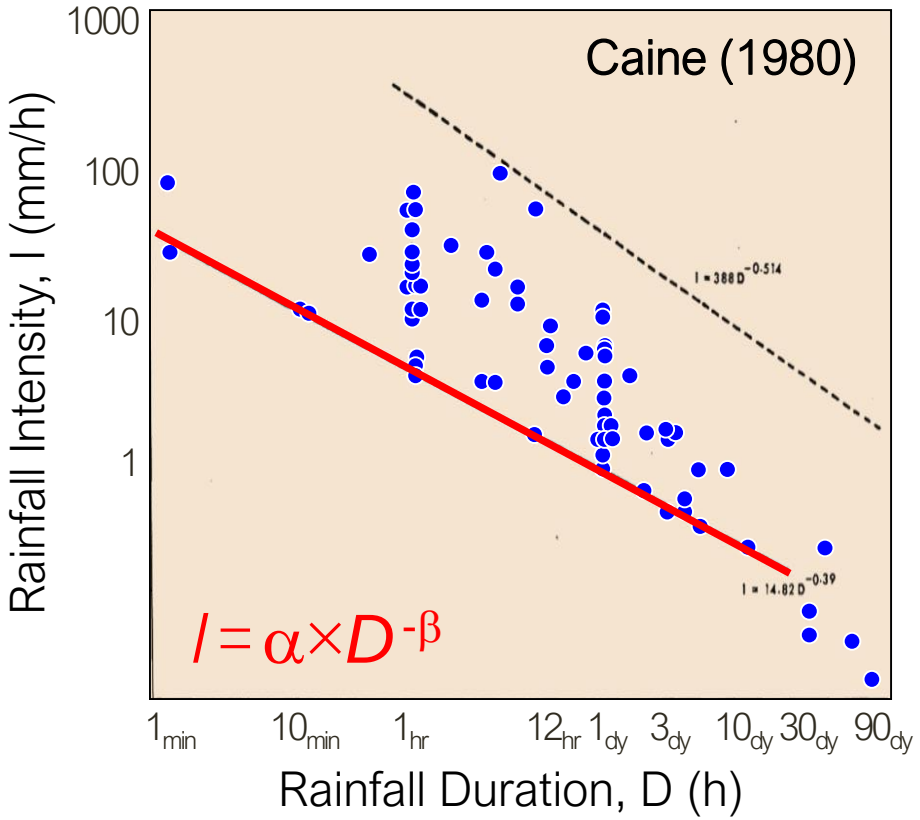
source: www.sbs.com.au/

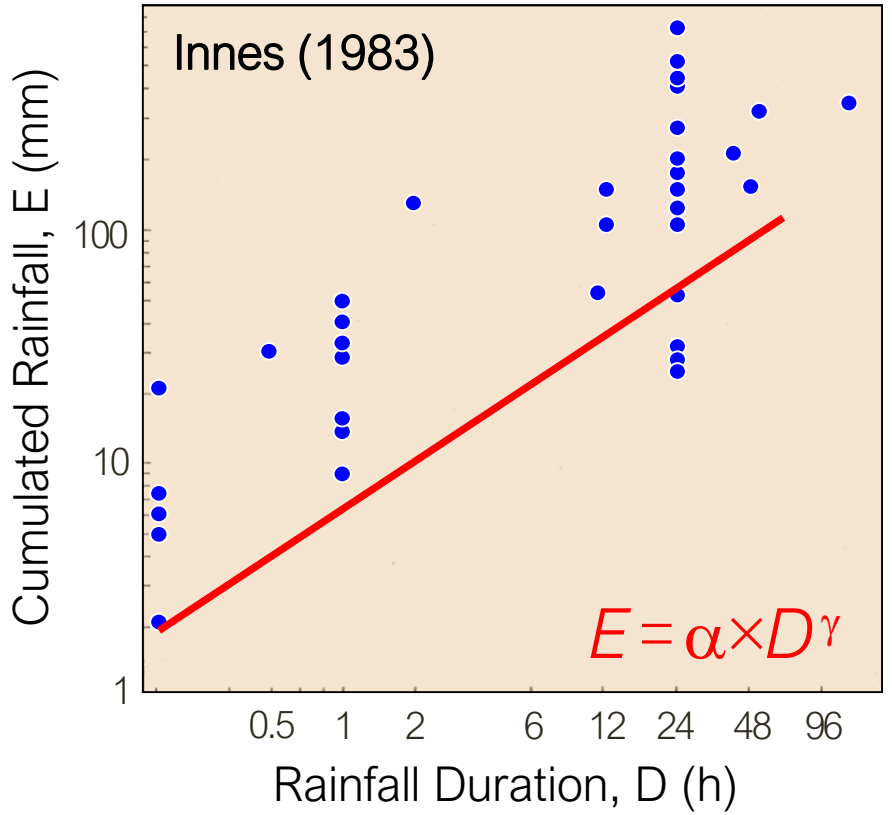


rainfall-induced landslides caused by
Typhoon Morakot, Taiwan

source: A.C. Mondini, CNR IRPI

EMPIRICAL RAINFALL THRESHOLDS





PROBLEMS WITH THRESHOLDS

- **Intensity-Duration** (ID) thresholds
- **Scarcity** of empirical **data**
- **Rainfall** conditions **poorly** defined
- **Non-reproducible** thresholds
- **Uncertainty** not given

PROBLEMS WITH THRESHOLDS

- **Intensity-Duration** (ID) thresholds

Problem: lack of scientific rigour in the definition and use of the thresholds

- **Non-reproducible** thresholds
- **Uncertainty** not given

PROPOSED SOLUTIONS

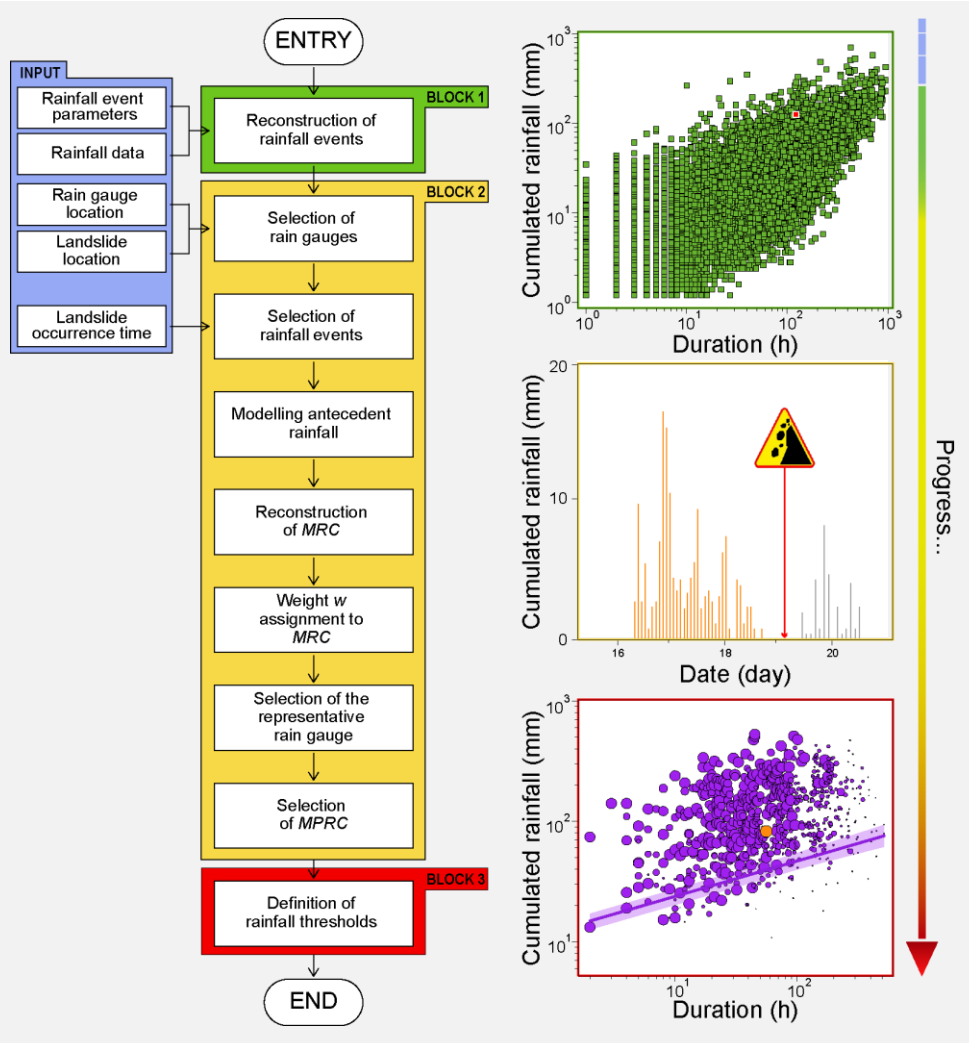
- **Cumulated Rainfall-Duration** (ED) thresholds
- **Criteria** for collecting **landslide** and **rainfall** data
- **Procedures** for the definition of rainfall **events** and rainfall **thresholds** [tool]
- Definition of **uncertainties** [tool]

Guzzetti et al (2007, 2008), Brunetti et al (2010), Gariano et al (2015), Melillo et al (2015, 2018), Peruccacci et al (2012, 2017)

CTRL_T

CTRL_T:
Calculation of
Thresholds for
Rainfall-induced
Landslides_
Tool

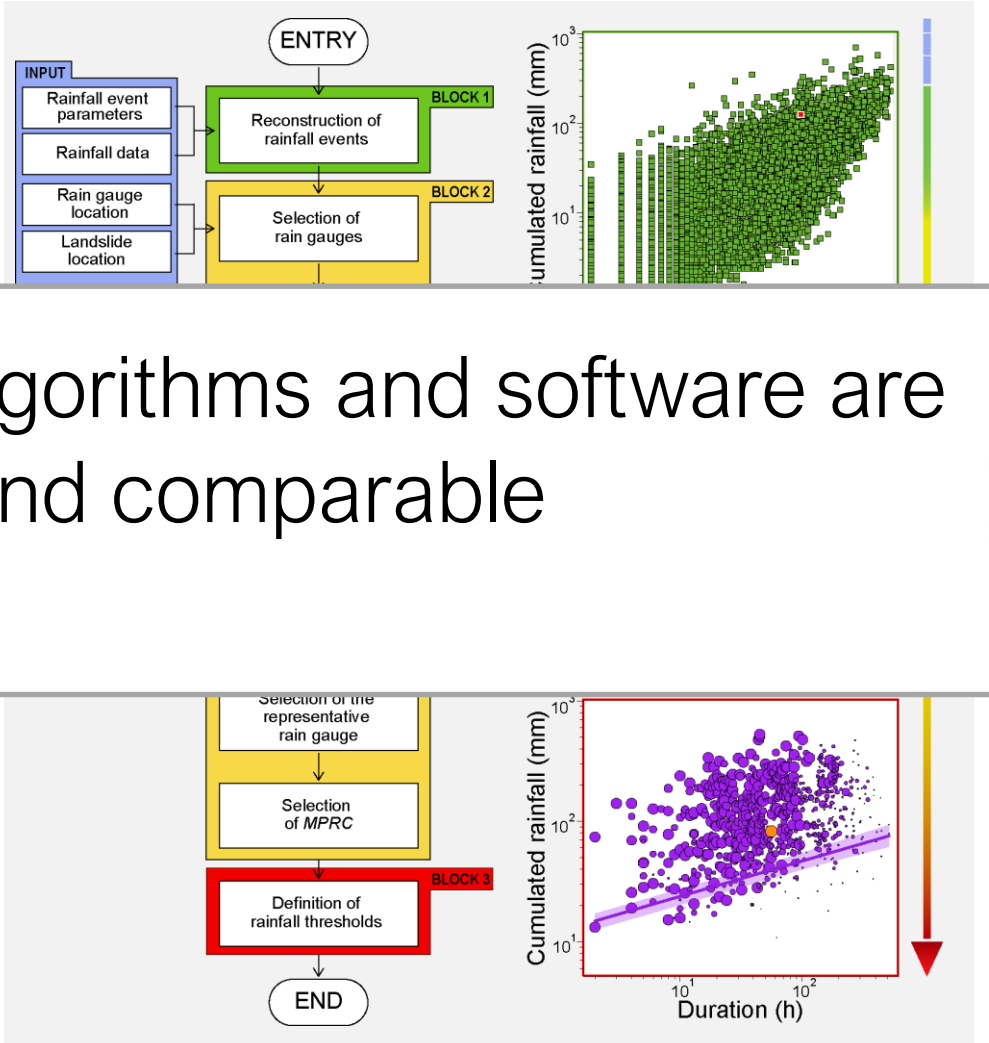
Melillo et al (2015, 2018)



- **Rainfall events**
- **Rainfall conditions responsible for failures**
- **Frequentist *ED* thresholds**

CTRL_T

CTRL_T:
C
T
R
Landslides_
Tool

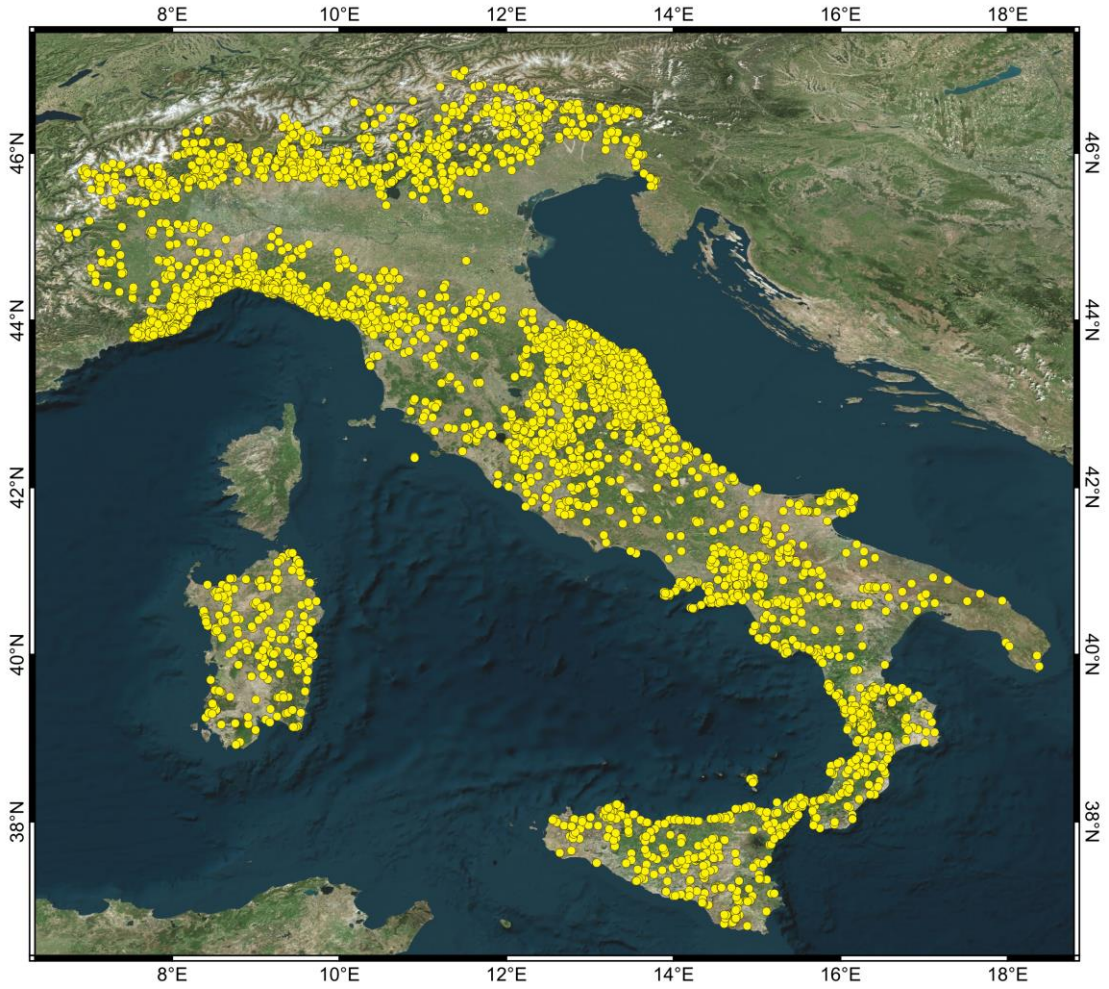


Conclusion: algorithms and software are key to reliable and comparable thresholds

- **Rainfall events**
- **Frequentist *ED* thresholds**

Melillo et al (2015, 2018)

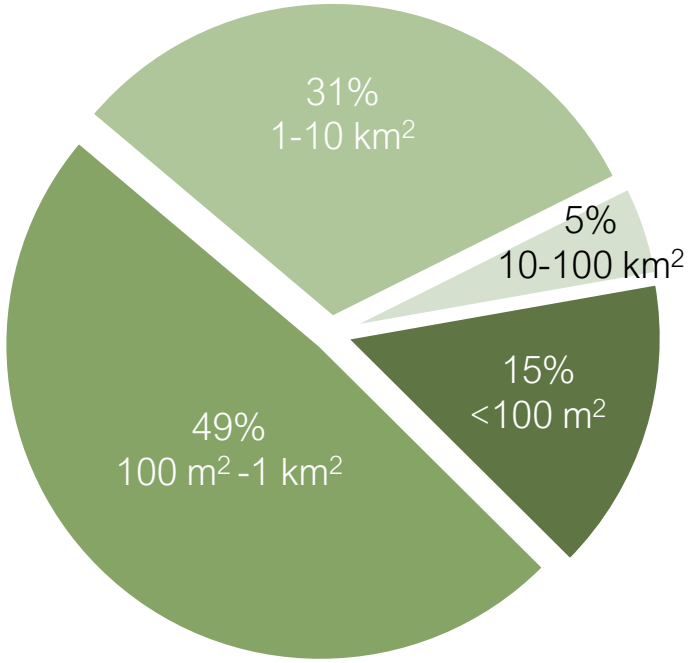
RAINFALL-INDUCED LANDSLIDES



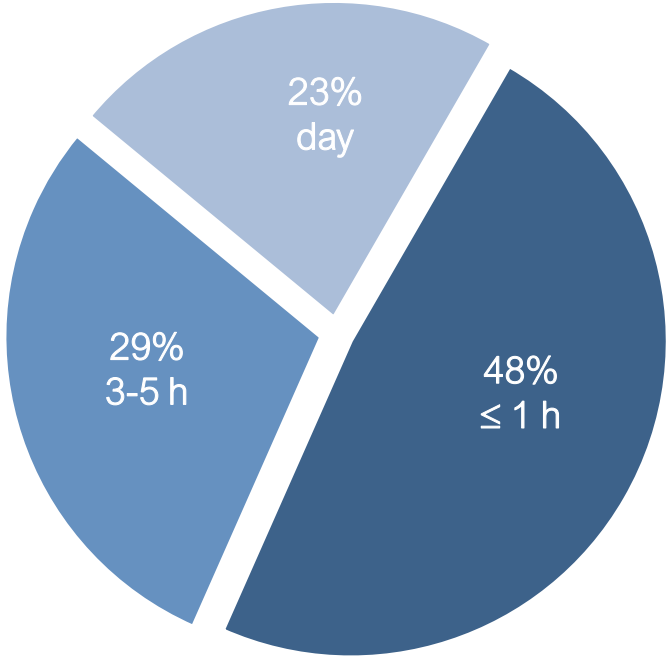
Catalogue of **6129 rainfall-induced landslides** between **1996** and **2020**

HOW GOOD IS THE LANDSLIDE INFORMATION?

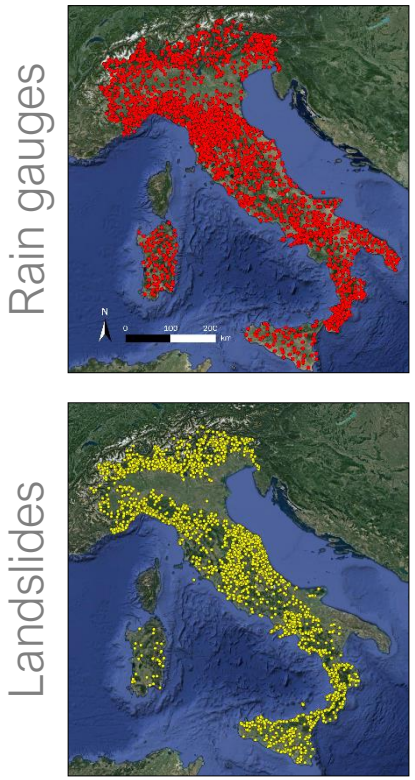
MAPPING ACCURACY

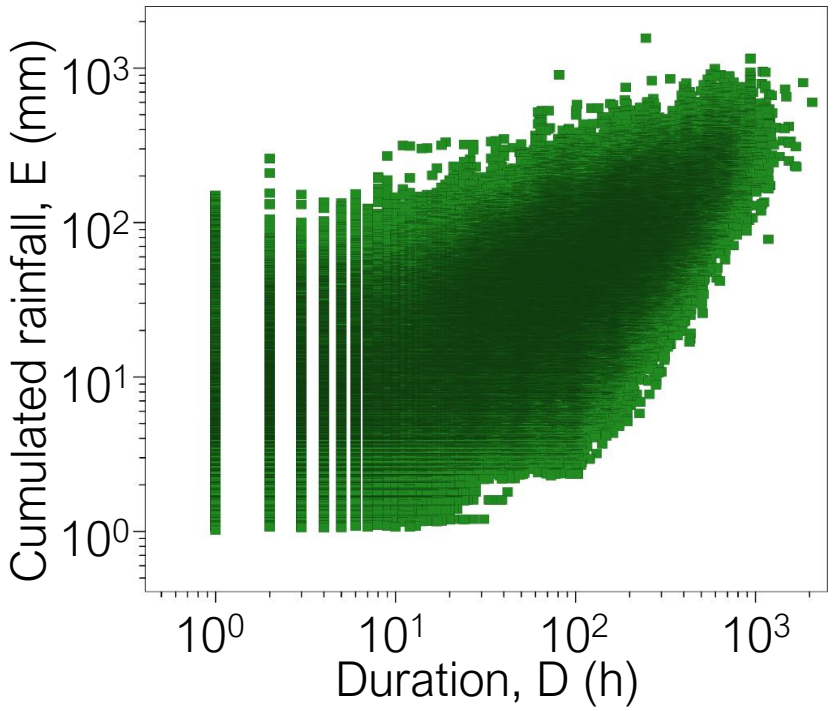


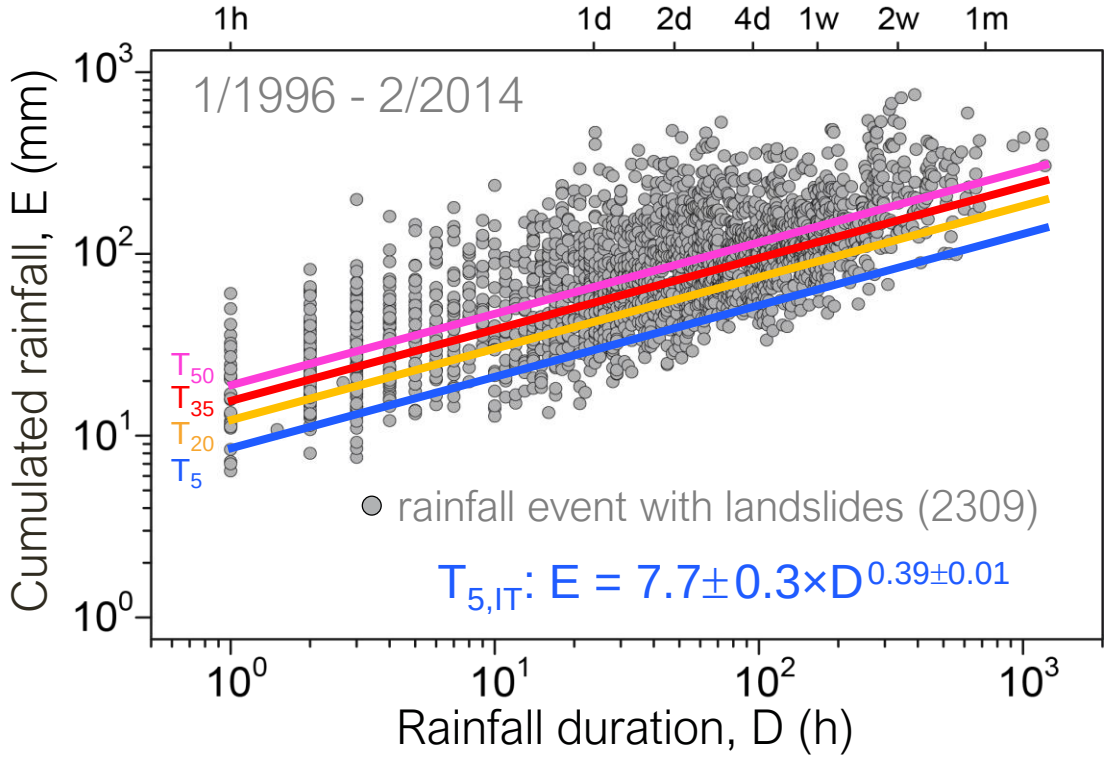
TEMPORAL ACCURACY



NATIONAL RAINFALL THRESHOLDS



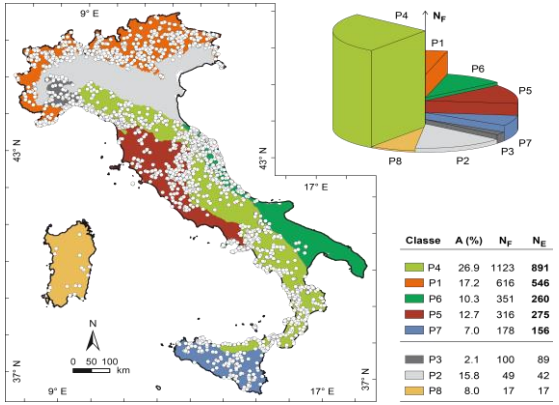




Peruccacci et al (2017)

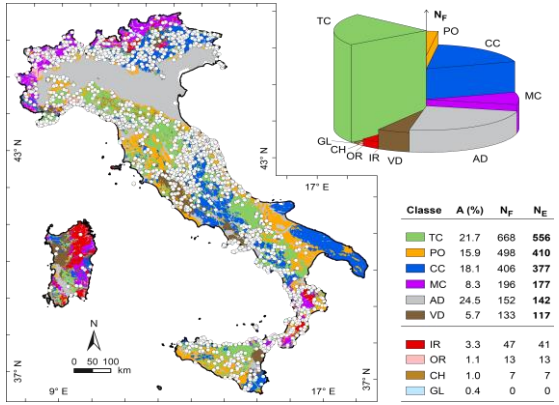
THEMATIC THRESHOLDS

PHYSIOGRAPHY



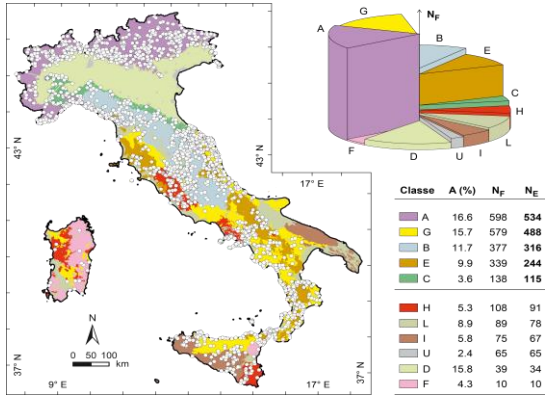
Classe	A (%)	N_F	N_E
P4	26.9	1123	891
P1	17.2	616	546
P6	10.3	351	260
P5	12.7	316	275
P7	7.0	178	156
P3	2.1	100	89
P2	15.8	49	42
P8	8.0	17	17

LITHOLOGY



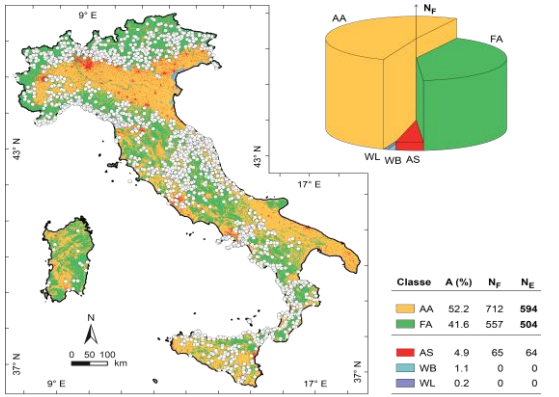
Classe	A (%)	N_F	N_E
TC	21.7	668	556
PO	15.9	498	410
CC	18.1	406	377
MC	8.3	196	177
AD	24.5	152	142
VD	5.7	133	117
IR	3.3	47	41
OR	1.1	13	13
CH	1.0	7	7
GL	0.4	0	0

SOIL



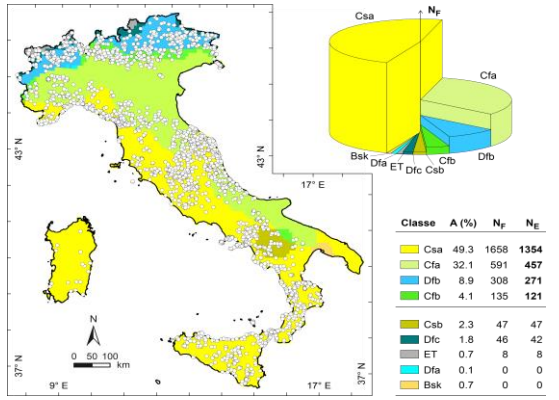
Classe	A (%)	N_F	N_E
A	16.6	598	534
G	15.7	579	488
B	11.7	377	316
E	9.9	339	244
C	3.6	138	115
H	5.3	108	91
L	8.9	89	78
I	5.8	75	67
U	2.4	65	65
D	15.8	39	34
F	4.3	10	10

LAND COVER



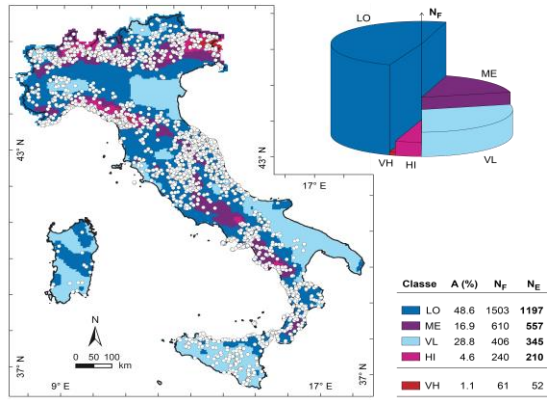
Classe	A (%)	N_F	N_E
AA	52.2	712	594
FA	41.6	557	504
AS	4.9	65	64
WB	1.1	0	0
WL	0.2	0	0

CLIMATE



Classe	A (%)	N_F	N_E
Csa	49.3	1658	1354
Cfa	32.1	591	457
Dfb	8.9	308	271
Cfb	4.1	135	121
Csb	2.3	47	47
Dfc	1.8	46	42
ET	0.7	8	8
Dfa	0.1	0	0
Bsk	0.7	0	0

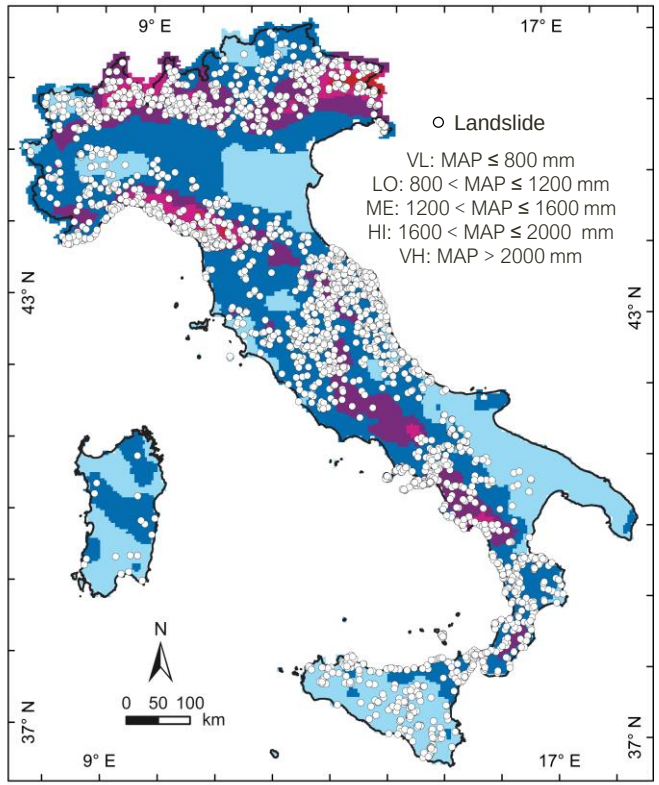
METEOROLOGY

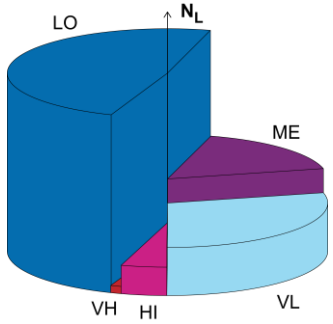


Classe	A (%)	N_F	N_E
LO	48.6	1503	1197
ME	16.9	610	557
VL	28.8	406	345
HI	4.6	240	210
VH	1.1	61	52

Peruccacci et al (2017)

METEOROLOGICAL DOMAINS





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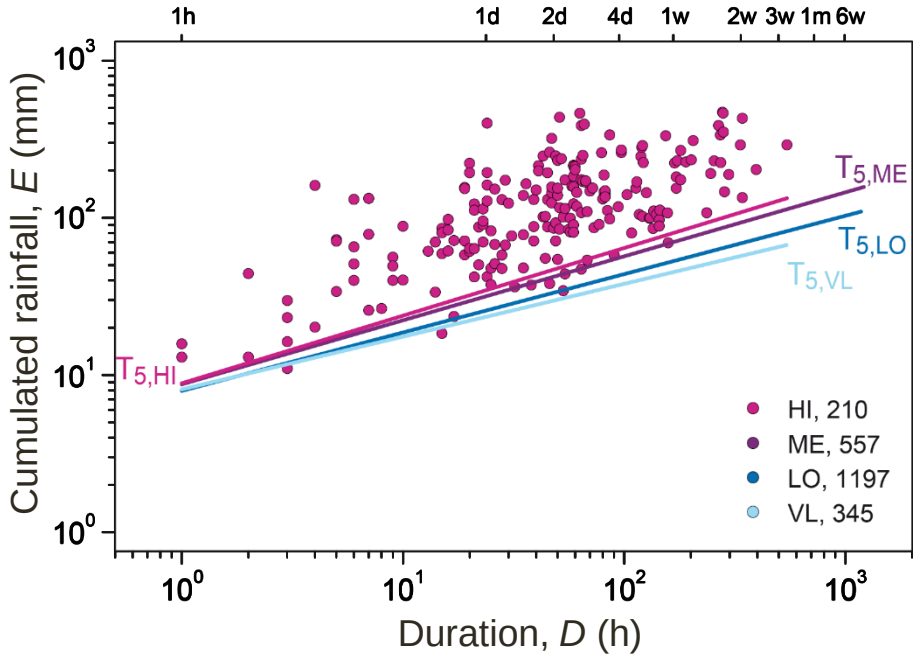


$T_{5,HI} : E = (8.9\pm1.3)\times D^{0.43\pm0.03}$

$T_{5,ME} : E = (8.7\pm0.8)\times D^{0.41\pm0.02}$

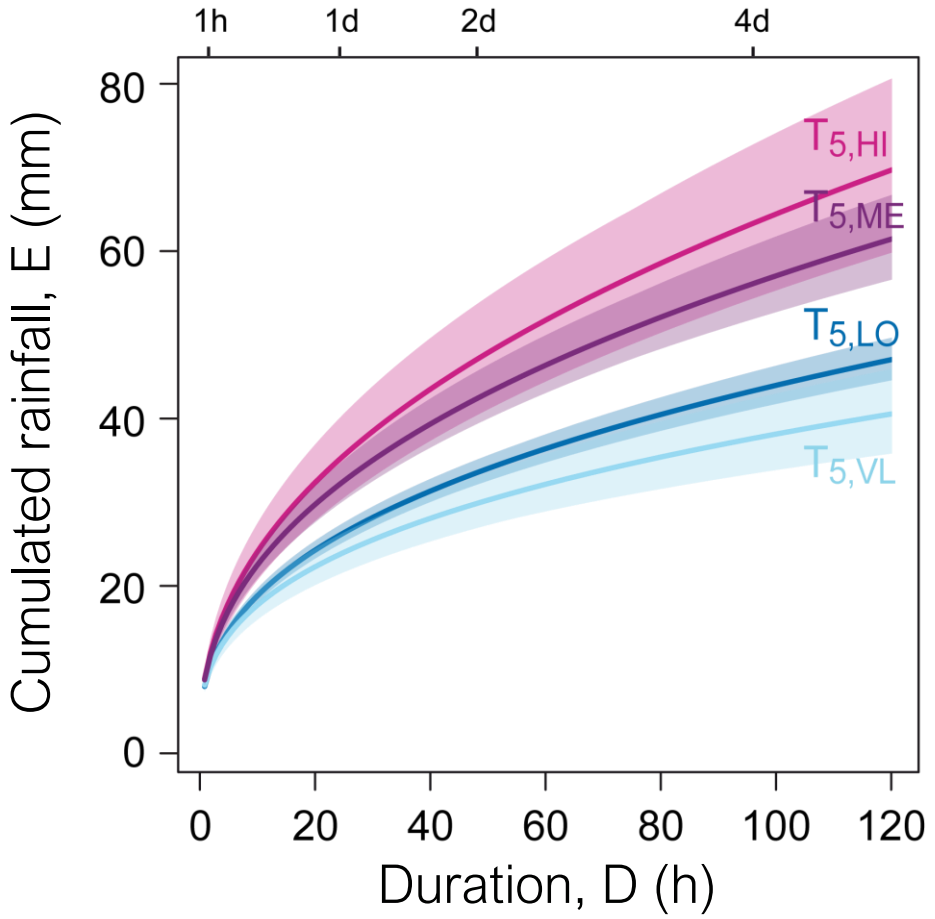
$T_{5,LO} : E = (7.9\pm0.4)\times D^{0.37\pm0.01}$

$T_{5,VL} : E = (8.1\pm0.8)\times D^{0.34\pm0.02}$

Peruccacci et al (2017)

UNCERTAINTY OF THE THRESHOLDS

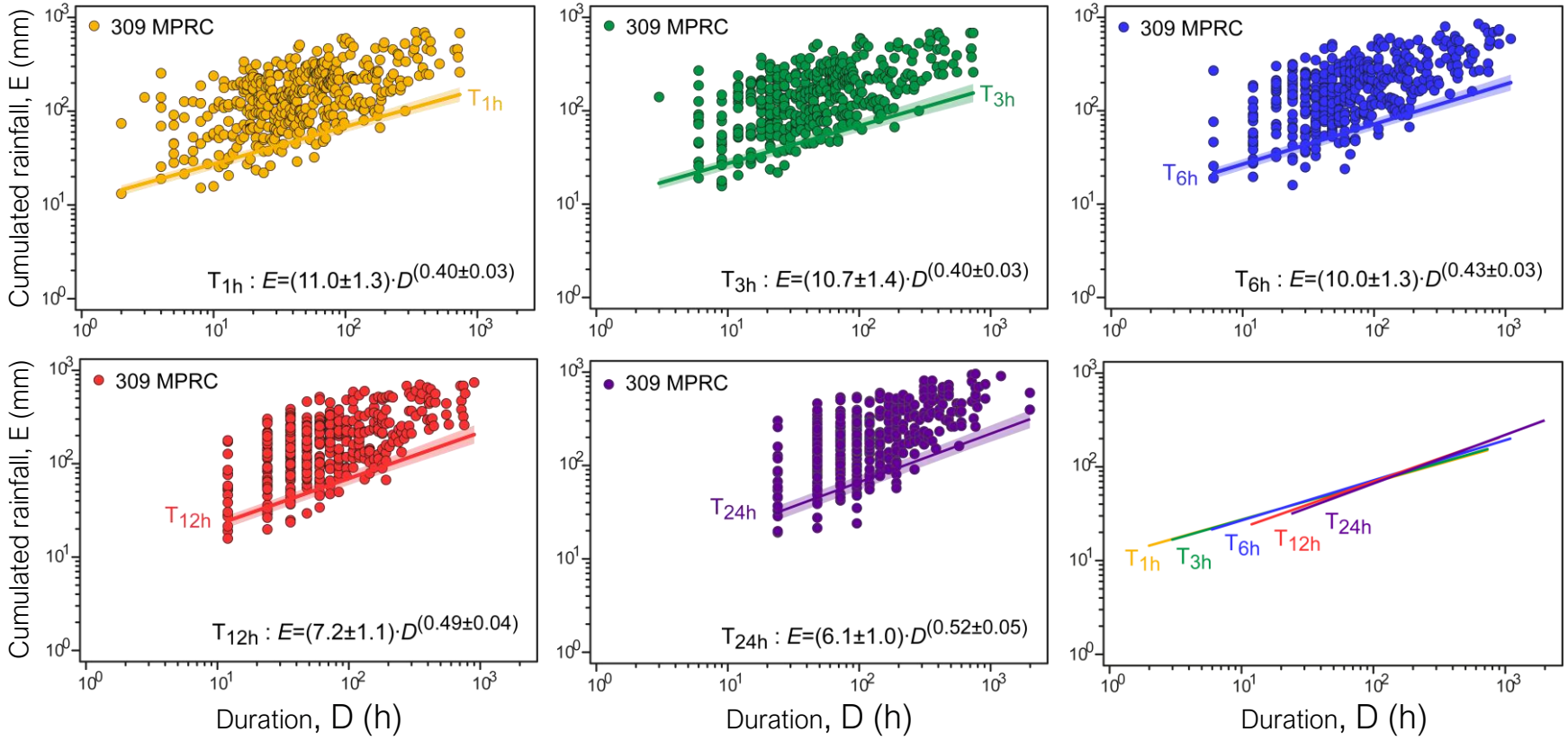
knowing the **uncertainty is essential** to use a threshold effectively



Peruccacci et al (2017)

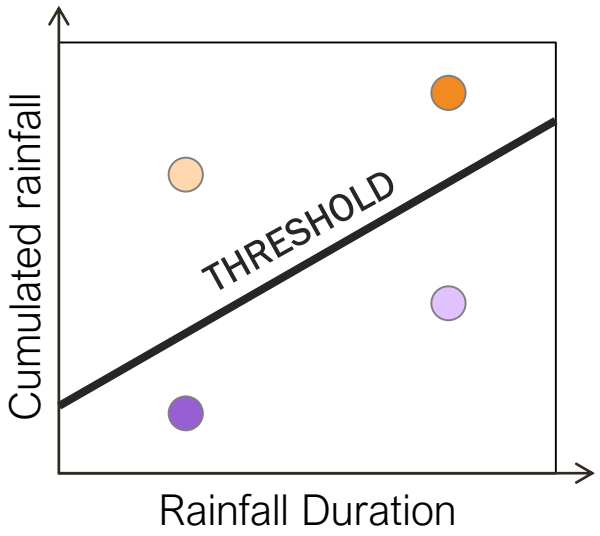
RAINFALL TEMPORAL RESOLUTION

The use of **coarse** rainfall **temporal resolution** results in **steeper thresholds** with **higher uncertainties**

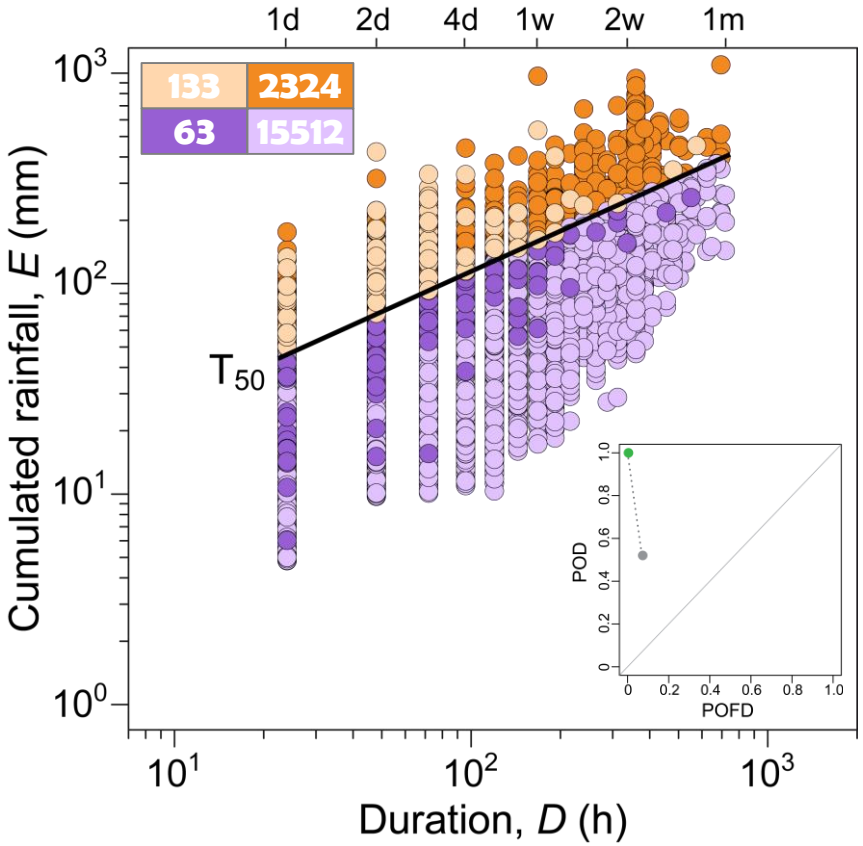


Gariano et al (2020)

THRESHOLD VALIDATION

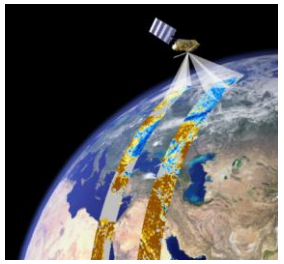


PREDICTED AND REPORTED (TP)	PREDICTED BUT NOT REPORTED (FP)
NOT PREDICTED BUT REPORTED (FN)	NOT PREDICTED AND NOT REPORTED (TN)

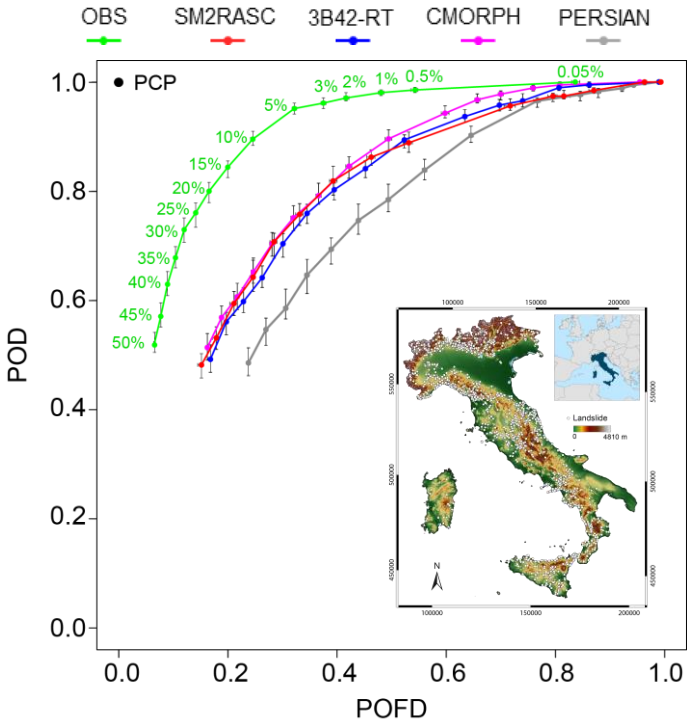


Gariano et al (2015), Brunetti et al (2020)

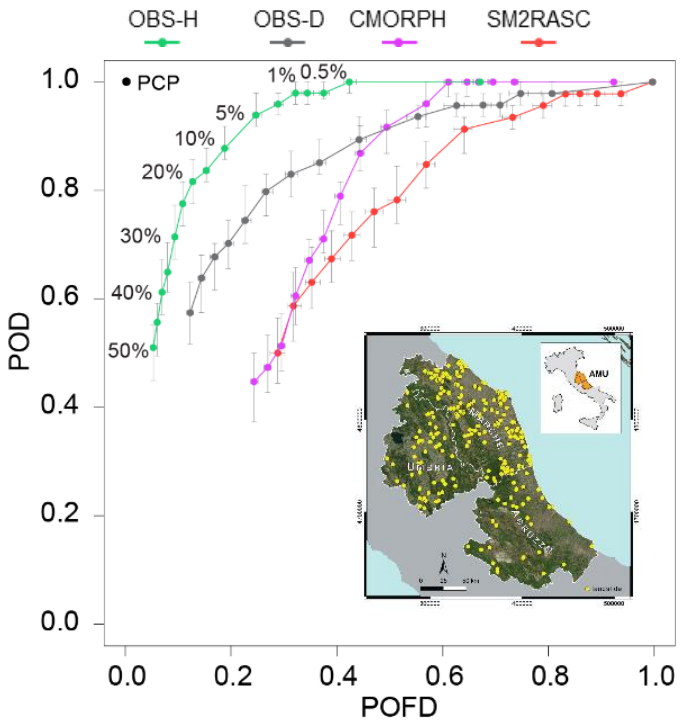
SATELLITE RAINFALL PRODUCTS



Satellite rainfall products **predict satisfactorily landslide** occurrence in Italy. The **lower performance** with respect to **ground observations** are due to the high-quality of rain gauge data.

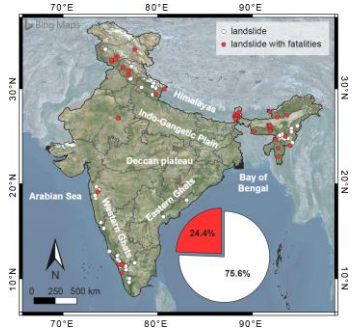


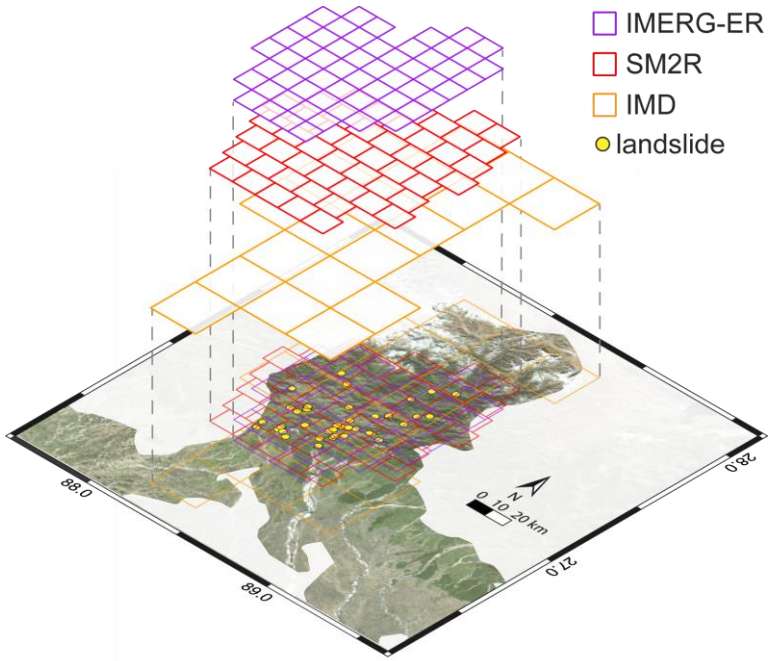
Brunetti et al (2018)



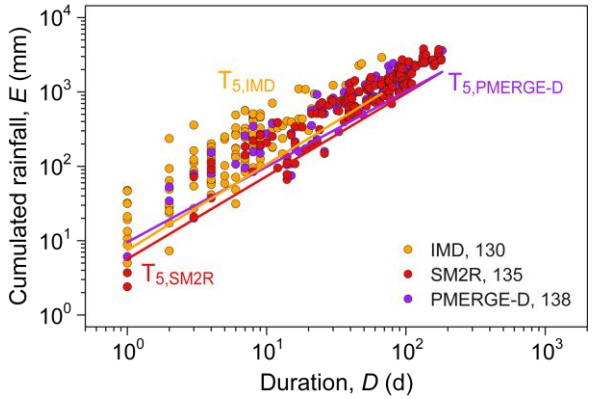
Brunetti et al (2021)

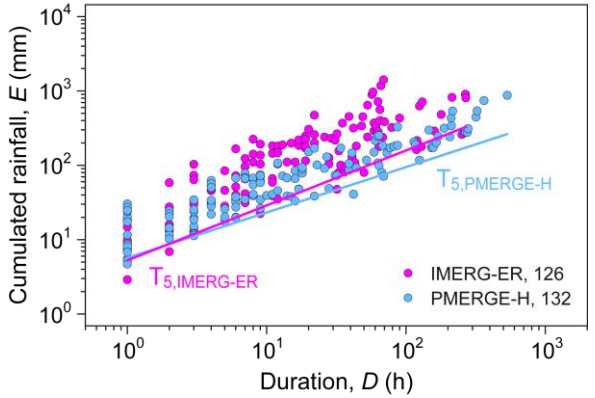
SATELLITE RAINFALL PRODUCTS

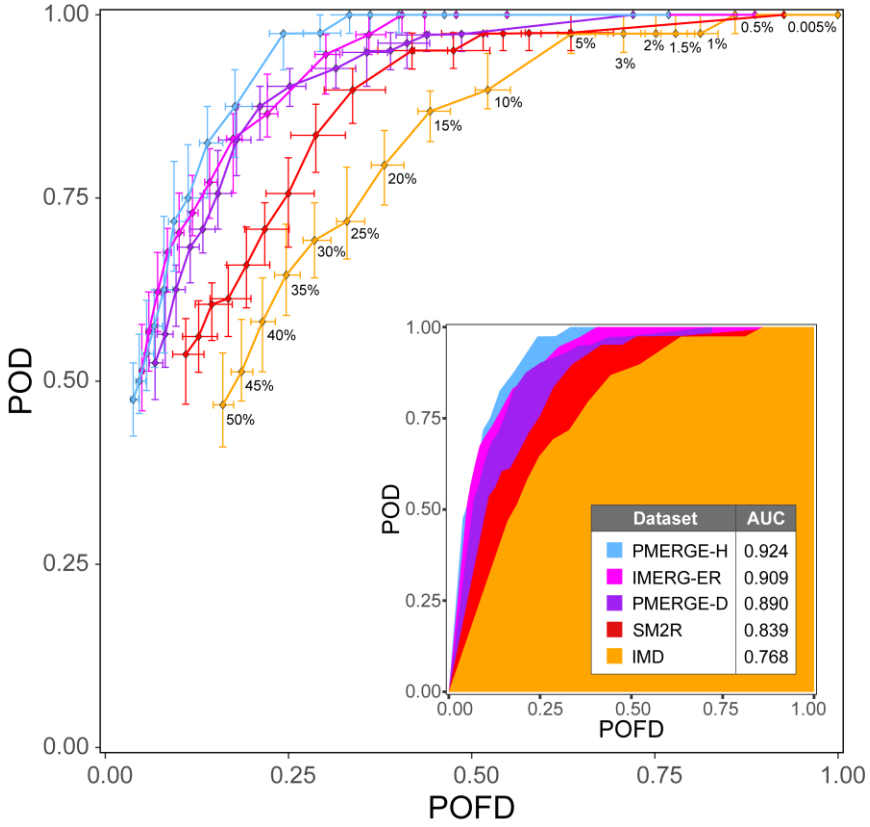




Brunetti et al (2021)





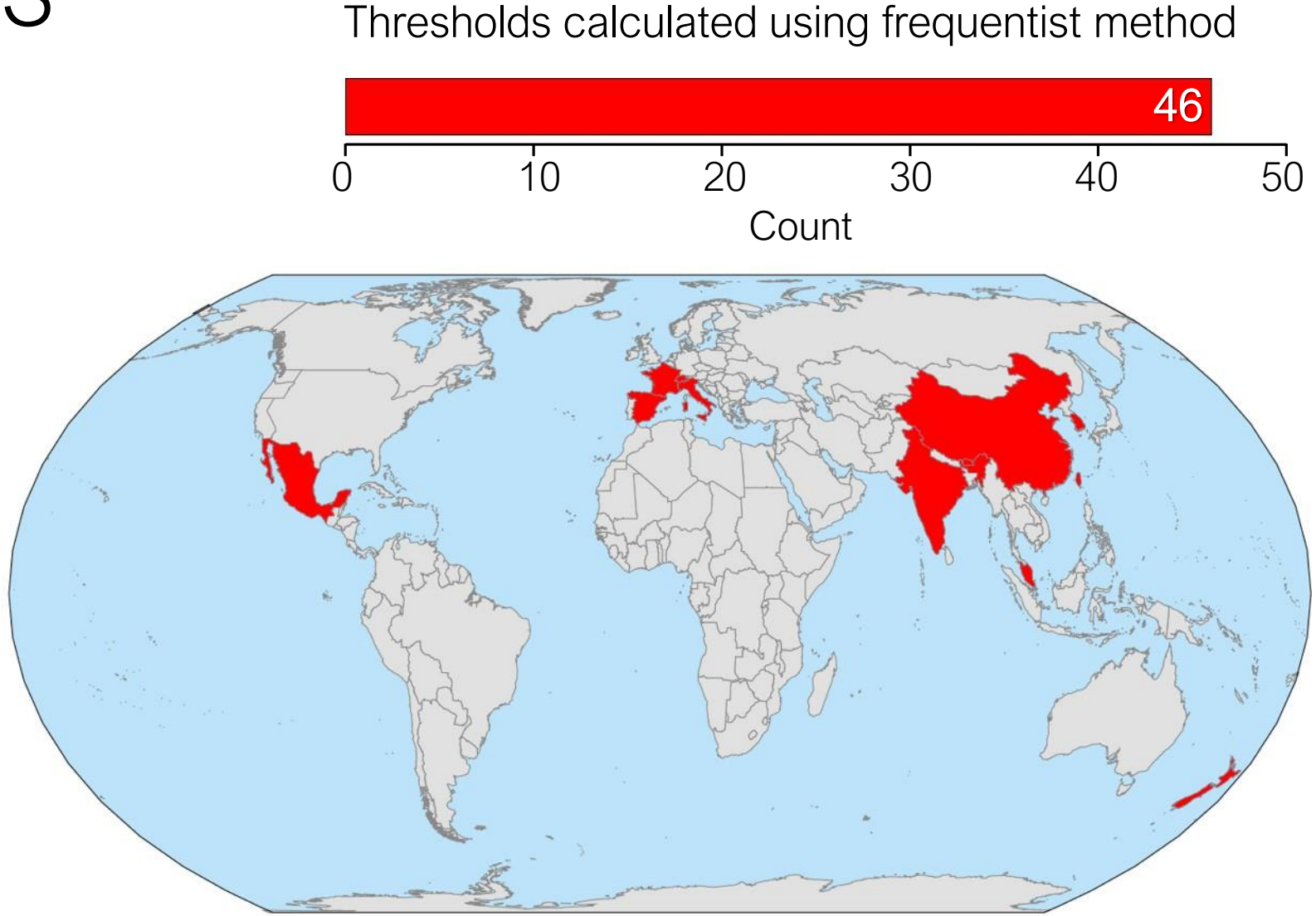


ITALIAN AND INTERNATIONAL PROJECTS

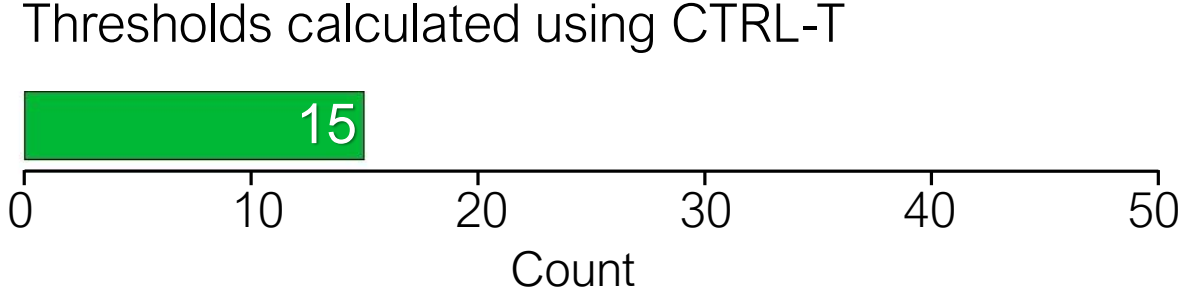
PAPERS

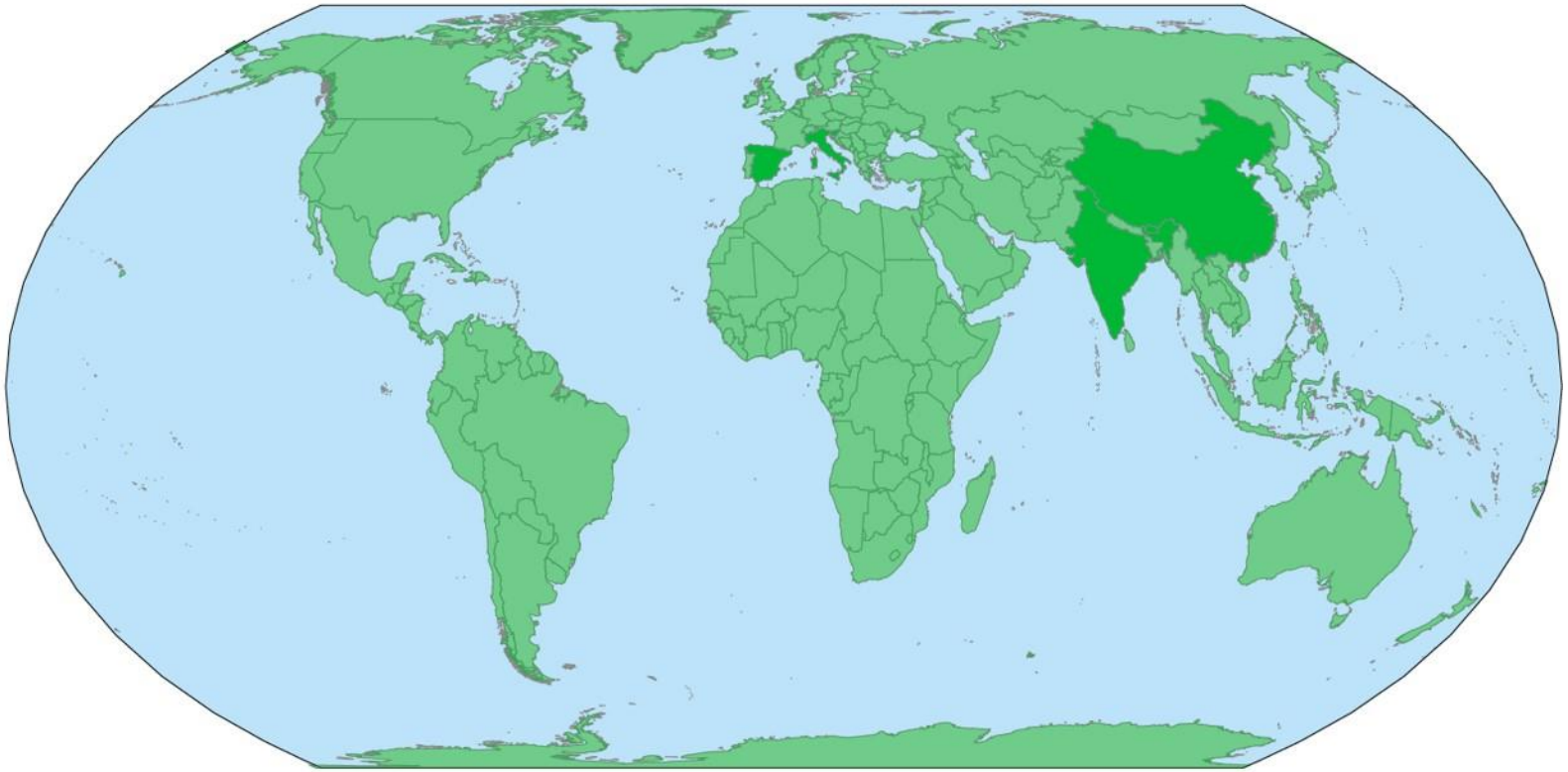

Satellite rainfall products outperform ground observations for landslide prediction in India
Rainfall thresholds for the possible landslide occurrence in Sicily (Southern Italy) based on the automatic reconstruction of rainfall events
Definition and performance of a threshold-based regional early warning model for rainfall-induced landslides
Landslides, floods and sinkholes in a karst environment: the 1–6 September 2014 Gargano event, southern Italy
Rainfall thresholds for the activation of shallow landslides in the Italian Alps: the role of environmental conditioning factors

APPLICATIONS

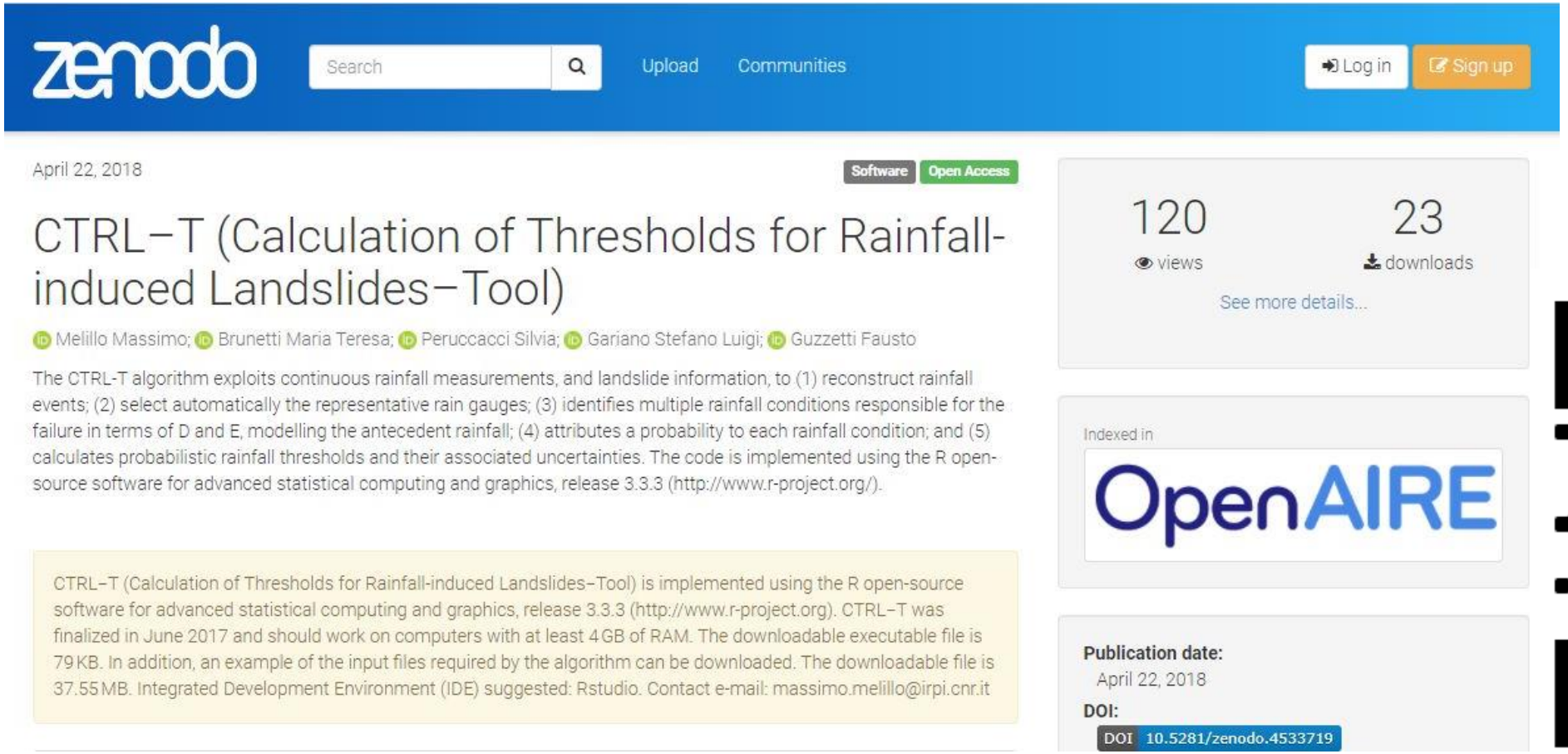


APPLICATIONS

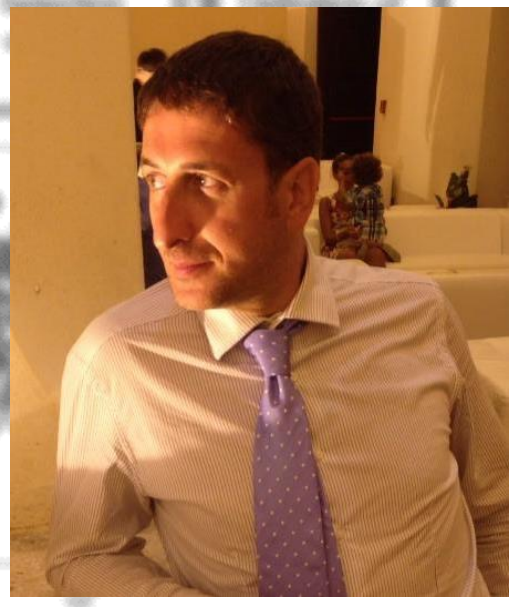




CTRL-T AVAILABILITY



GRUPPO «SOGLIE»



Loredana **ANTRONICO**, Devis **BARTOLINI**, Cinzia **BIANCHI**, Maria Teresa **BRUNETTI**, Costanza **CALZOLARI**, Andrea **DEGANUTTI**, Barbara **DENTI**, Stefano Luigi **GARIANO**, Fausto **GUZZETTI**, Giulio **IOVINE**, Silvia **LUCIANI**, Fabio **LUINO**, Ivan **MARCHESINI**, Maria Elena **MARTINOTTI**, Massimo **MELILLO**, Chiara **MONTALBANI**, Michela **PALLADINO**, Mario **PARISE**, Silvia **PERUCCACCI**, Luca **PISANO**, Anna **ROCCATI**, Mauro **ROSSI**, Monica **SOLIMANO**, Oreste **TERRANOVA**, Gabriele **TONELLI**, Laura **TURCONI**, Fabrizio **UNGARO**, Carmen **VENNARI**, Giovanna **VESSIA**, Alessia **VIERO**

THANKS FOR YOUR ATTENTION!