

3.5 「降雨による地すべり予測・警戒システム」

水文地質防災研究所ペルージャ支部研究員

シルヴィア・ペルカッチ

SANF: A National Warning System to Forecast Rainfall Induced Landslides

Silvia Peruccacci
Consiglio Nazionale delle Ricerche, Italy

MOTIVATION

In Italy, landslides have caused **17,610 casualties** (deaths, missing persons, injured people) between **843** and **2012**, ...

... of which at least **6,505** between **1950** and **2012**.

Casualties due to landslides were **36** in **2011**, and **17** in **2012**.



Giampileri, 1 Ottobre 2009

GOALS

- **Scientific goal ...**

... study of the conditions that trigger rainfall-induced landslides and the definition of empirical rainfall thresholds.

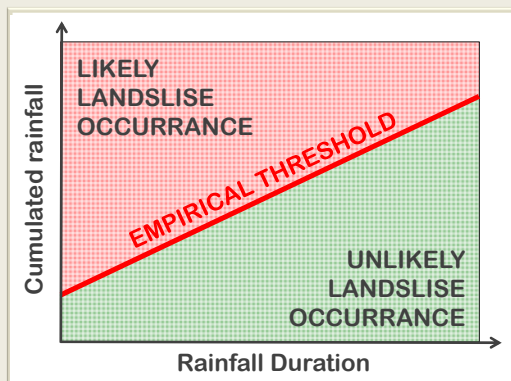
- **Operational goal ...**

... design of a national warning system to forecast the possible occurrence of rainfall induced landslides.



RAINFALL THRESHOLD

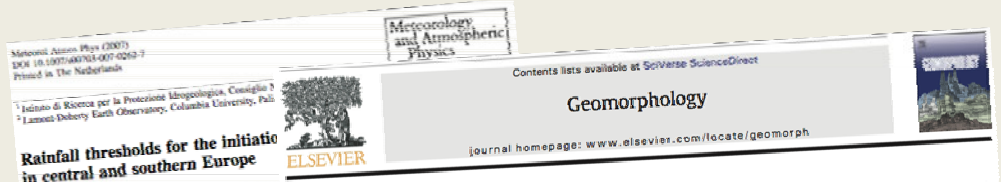
For rainfall-induced landslides, a **threshold** may define the amount of rainfall that, when reached or exceeded, is likely to trigger landslides.



- **Empirical** thresholds are obtained analyzing past rainfall events that have resulted in landslides.



RESEARCH & DEVELOPMENT



 Meteorology and Atmospheric Physics
 Contents lists available at ScienceDirect
Geomorphology
 journal homepage: www.elsevier.com/locate/geomorph

Rainfall thresholds for the initiation in central and southern Europe
 F. Guzzetti¹, S. Peruccacci¹, M. Rossi¹, and C. P. ...
 Istituto di Ricerca per la Protezione Idrogeologica, Consiglio Nazionale delle Ricerche, Roma, Italy
 Lamont-Doherty Earth Observatory, Columbia University, Palisades, NY, USA

Lithological and seasonal control on rainfall thresholds for the possible initiation of landslides in central Italy
 Silvia Peruccacci^{a,*}, Maria Teresa Brunetti^a, Silvia Luciani^{a,b}, Carmela Venturi^b, Fausto Guzzetti^a
^aIRPI, Consiglio Nazionale delle Ricerche, Roma, Italy
^bUniversità degli Studi di Perugia, Perugia, Italy

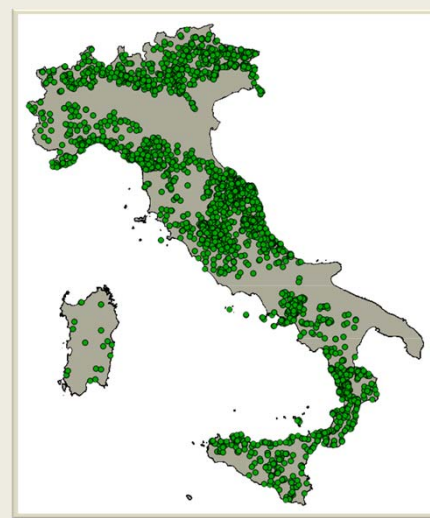
Rainfall thresholds for the possible occurrence of landslides in Italy
 M. T. Brunetti¹, S. Peruccacci¹, M. Rossi¹, S. Luciani², D. Valigi², and F. Guzzetti¹
¹IRPI, Consiglio Nazionale delle Ricerche, Roma, Italy
²Università degli Studi di Perugia, Perugia, Italy

Forecast rainfall induced landslides in Italy
 M. T. Brunetti, S. Peruccacci, M. Rossi, F. Guzzetti, P. Reichenbach, F. Ardizzone, M. Cardinali, A. Mondini & P. Salvati
 Consiglio Nazionale delle Ricerche, IRPI, via Madonna Alta 126, 06128 Perugia, Italy
 G. Tonelli
 via Emilia 221/A, San Lazzaro di Savena, Bologna, Italy
 D. Valigi & S. Luciani
 Università degli Studi di Perugia, piazza dell'Università, 06123 Perugia, Italy

system for rainfall-induced landslides in Italy
 © 2012 Taylor & Francis Group, London, ISBN 978-0-415-62123-6

LANDSLIDE CATALOGUE

- Catalogue of more than **2300 rainfall events** that have resulted in **landslides** in Italy.



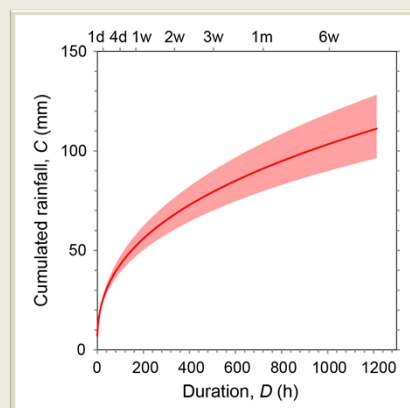
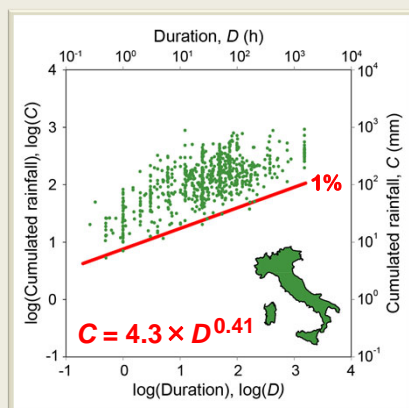
INFORMATION SOURCES

- National, regional and local **newspapers**.
- Blogs and **on-line** sources.
- Reports of local **Fire Brigades**.
- Reports of **CCISS** (agency that provides traffic and travel information).



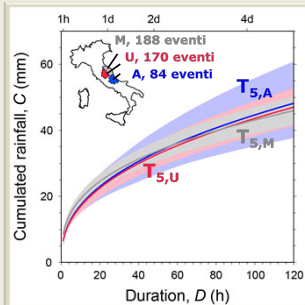
NATIONAL THRESHOLDS

- Reproducible **Cumulated event rainfall–rainfall duration (CD) thresholds**, including the parameter uncertainty

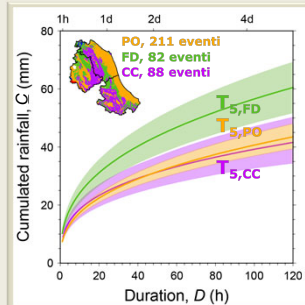


THRESHOLDS FOR CENTRAL ITALY

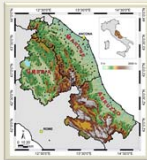
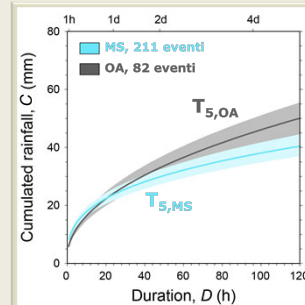
Regional thresholds



Lithological thresholds



Seasonal thresholds



442 rainfall events that triggered **573** landslides between February **2002** and August **2010**.

150 rain gauges.



A National Warning System to Forecast Rainfall Induced Landslides in Italy

9/21

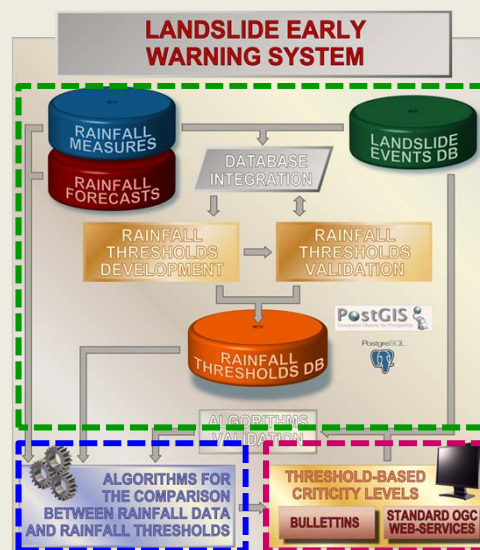
SYSTEM LOGICAL FRAMEWORK

The system compares **rainfall measurements** and **rainfall estimates** with empirical **rainfall thresholds**.

Input and Storage

Analysis

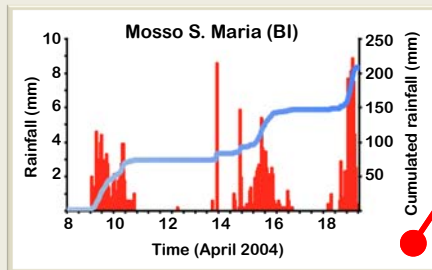
Output and Delivery



A National Warning System to Forecast Rainfall Induced Landslides in Italy

10/21

RAINFALL MEASUREMENTS



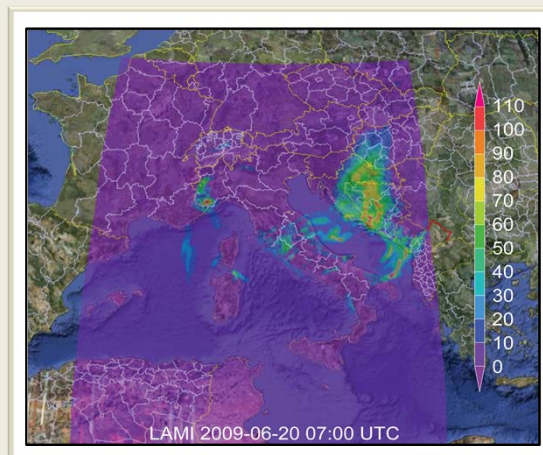
Every **6 hours**, rainfall measurements obtained from **1950 rain gauges** in Italy are stored in the system.



A National Warning System to Forecast Rainfall Induced Landslides in Italy

11/21

RAINFALL FORECASTS



Every **12 hours**, 72-hour rainfall forecasts produced by a **Local Area Model (LAMI)** are stored in the system.



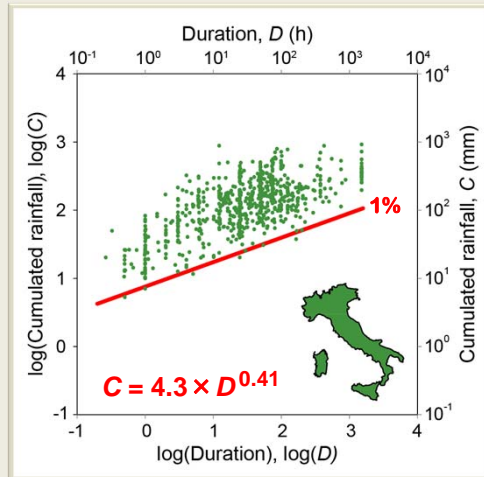
A National Warning System to Forecast Rainfall Induced Landslides in Italy

12/21

NATIONAL THRESHOLD

The system uses a single **CD** empirical **threshold**.

The threshold corresponds to a **1%** exceedence probability level.

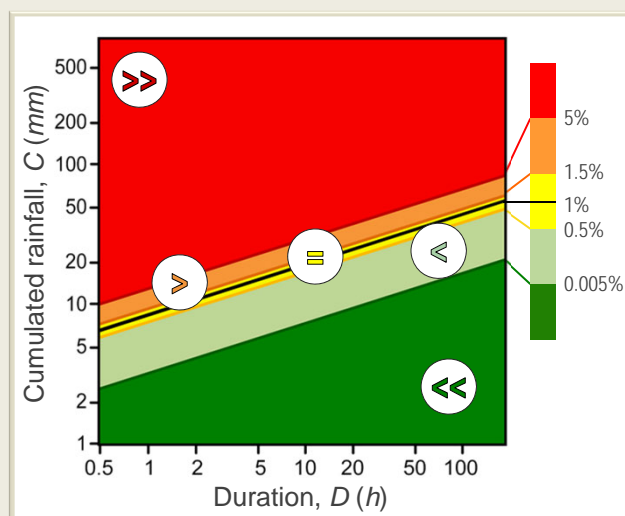


A National Warning System to Forecast Rainfall Induced Landslides in Italy

13/21

CRITICAL LEVELS

- Well above the threshold
- Above the threshold
- On the threshold
- Below the threshold
- Well below the threshold



A National Warning System to Forecast Rainfall Induced Landslides in Italy

14/21

A FORECAST

for 1950 rainfall alert zones



irpi A National Warning System to Forecast Rainfall Induced Landslides in Italy

15/21

CONSIDERING SUSCEPTIBILITY

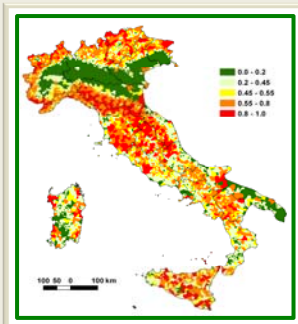
RAINFALL FORECAST

LANDSLIDE SUSCEPTIBILITY

COMBINED FORECAST



×



=



irpi A National Warning System to Forecast Rainfall Induced Landslides in Italy

16/21

CONSIDERING SUSCEPTIBILITY

RAINFALL FORECAST



COMBINED FORECAST



BULLETTIN

The bulletin page is divided into several columns. The first column contains the title 'Sistema di Allert il possibile innesco pioggia'. The second column is titled 'Indi' and contains a legend for 'Piacimenti' and 'Zone di allerta'. The third column is titled 'Prognosi' and contains a legend for 'Piacimenti' and 'Zone di allerta'. The fourth column is titled 'Piacimenti previsti e suscettibilità' and contains four maps of Italy showing predicted rainfall and susceptibility levels. The fifth column is titled 'Legenda pioggia prevista' and contains a legend for 'Piacimenti' and 'Zone di allerta'. The sixth column is titled 'Legenda pioggia prevista e suscettibilità' and contains a legend for 'Piacimenti' and 'Zone di allerta'. The seventh column is titled 'Legenda altri' and contains a legend for 'Piacimenti' and 'Zone di allerta'.

WEB SITE



irpi A National Warning System to Forecast Rainfall Induced Landslides in Italy

19/21

ADVANCEMENTS NEEDED

Several **problems** affect the system ...

... possible **solutions**:

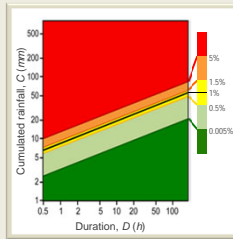
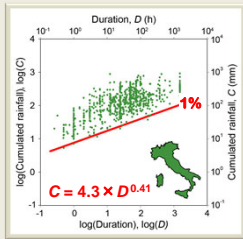


- **More frequent forecasts**
- Use of new **regional / local thresholds**
- Integration of **different rainfall forecasts**
- Better integration of landslide **susceptibility**
- Integration with **vulnerability criteria**

irpi A National Warning System to Forecast Rainfall Induced Landslides in Italy

20/21

... thank you.



Silvia.Peruccacci@irpi.cnr.it