



## **Statistical and temporal properties of 596 triggered landslide events in the Emilia-Romagna region of Italy**

**M. Rossi** (1), S. Peruccacci (1), A. Witt (2), F. Guzzetti (1), B.D. Malamud (2), M. Pizziolo (3)

(1) Consiglio Nazionale delle Ricerche, Istituto di Ricerca per la Protezione Idrogeologica, via Madonna Alta 126, 06128 Perugia, Italy (Mauro.Rossi@irpi.cnr.it), (2) Department of Geography, King's College London, Strand, London WC2R 2LS, UK, (3) Servizio Geologico, Sismico e dei Suoli, Regione Emilia Romagna, Viale Silvani 4-3, 40122 Bologna, Italy

In this paper, we investigate the statistical and temporal properties of a large series of landslide events in the Emilia-Romagna Region of Italy. Quantitative information on triggered landslide events over an extended temporal period is difficult to find. Indeed, there are only a few records of series of triggered landslide events, of which none are extensive over time. As instrumental records of landslide events are extremely difficult to obtain for the last 50 years, we turn here to a historical catalogue consisting of 'proxies' for 2253 landslides that have occurred from 1951 to 2002 in the Emilia-Romagna Region of northern Italy. The historical catalogue was compiled through a thorough and systematic search of existing catalogues of historical landslide events, supplemented by an extensive search of local historical archives and chronicles. Care was taken in reporting the date or the period and the location of the reported landslides, and that no duplicates were listed. The 2253 individual landslides were further grouped into 596 different landslide events (Sevent), consisting of 1 to 129 landslides each. Grouping was performed by considering the successive landslides over time; during the winter (summer) a period of four (two) days without landslides was considered a separate event. We use the available historical catalogue to: (i) characterize the frequency-size distribution of the triggered landslide events, and (ii) investigate whether landslide events are correlated or uncorrelated in time. To characterize the frequency-size (frequency-magnitude) distribution of landslide events, we first determine the frequency density of landslide events, and we find that the empirical data are strongly power-law distributed over at least two orders of magnitude. We then con-

sider different distributions, including the Gamma, Exponential, Weibull, Pareto, and Zeta distributions, and we compare the empirical data and the predicted values, based on an assumed distribution. The best fits are obtained using the Pareto and the Zeta distributions. This was expected, given the fact that the empirical data are power-law distributed. To determine if landslide events are correlated or uncorrelated in time, we examine the statistical distribution of the interevent occurrence times, for landslide events of different magnitude (i.e., for  $S$  greater or equal than 2, 4, 8, or 16 landslides). We find that the empirical interevent occurrence times are approximately Weibull distributed, with exponent  $< 1.0$ . An exponent of 1.0 (i.e. an exponential distribution) would be expected for an uncorrelated time series. We conclude that the studied landslide events in the Emilia-Romagna Region of northern Italy are correlated in time. Based on this finding, we advise that care should be taken when estimating the recurrence times of landslide events using the simple assumption of a random Poissonian process.