Available online at www.sciencedirect.com
SCIENCE DIRECT®
Geomorphology 65 (2005) 257–278
GEOMORPHOLOGY
www.elsevier.com/locate/geomorph

Inconsistent patterns of historical seismicity and earthquake-triggered landsliding in southeastern Sicily: an alarm bell?

Pier Giorgio Nicoletti*

Consiglio Nazionale delle Ricerche, Istituto di Ricerca per la Protezione Idrogeologica (Sezione di Cosenza), Via C.B. Cavour 4-6, 87030 Roges di Rende (CS), Italy

Received 28 April 2004; received in revised form 15 September 2004; accepted 20 September 2004
Available online 18 November 2004

Abstract

In southeastern Sicily, the distribution pattern of earthquake-triggered landslides is inconsistent with historically known seismic activity. In particular, historical seismicity has been stronger in the eastern sector, while earthquake-triggered landsliding is much more developed in the western sector, and this contrasts with expectations. This paper describes the patterns of seismicity and landsliding, and tackles the problem of whether greater landsliding in the western sector may be due (a) to seismicity of the eastern sector or (b) to a high-magnitude, low-recurrence seismicity generated in the western sector itself. It is statistically shown that lithostructural characteristics of rock masses and geometry of hillslopes cannot justify, either singly or jointly, greater landsliding in the western sector if triggering earthquakes are generated in the eastern sector. As a consequence, it is possible that landsliding of the western sector is due to earthquakes generated locally, but having higher magnitude and longer recurrence intervals than historically observed.
© 2004 Elsevier B.V. All rights reserved.

Keywords: Earthquake-triggered landslides; Historical seismicity; Seismic hazard; Seismogenic zoning; Sicily

1. Introduction

In southeastern Sicily, both earthquake-triggered landsliding and historical seismicity show patterns different in the east and in the west. However, while earthquake-triggered landsliding is more developed in the west, energy of historical earthquakes was mostly released in the east (Tables 1 and 2). Empirically, one would expect landslide size and incidence to decrease with distance from seismic sources (Wilson and Keefer, 1985; Rodríguez et al., 1999), while the opposite seems to occur in this case (Nicoletti et al., 2000a). Here lies the inconsistency observed, whose nature and implications are dealt with in this paper. In particular, the question is posed whether landsliding in the west may be due (a) to the earthquakes generated in the east or (b) to earthquakes generated in the west itself, but having

* Fax: +39 0948 835319.
E-mail address: nicoletti@irpi.cnr.it.

0169-555X/$ - see front matter © 2004 Elsevier B.V. All rights reserved.
doi:10.1016/j.geomorph.2004.09.005

Table 1
Earthquakes in Sicily before AD 1000[a]

Date	Location	Estimated I_{max} [MCS]	Earthquake description	Concomitant phenomena
426–425 BC	Sicily	?	Very strong	Eruption of Etna
126 BC	Mt. Etna	?	Tremor of Etna	Eruptions of Etna and Aeolian volcanoes
AD 17	Sicily[b]	VIII–IX	Damaged several towns in Sicily and around Reggio Calabria[c]	Not mentioned
Between AD 350 and 363	Sicily[b]	X	Great cities in ruins	Not mentioned
Second half of VII century	Sicily[b]	?	Strong tremors	Eruption of Mt. Vulcano (Aeolian Islands)
AD 853 (31 August)	Sicily[b]	IX–X	Great earthquake	Not mentioned

[a] According to known historical sources. Data are after Guidoboni (1989) and Guidoboni et al. (1994, 2000).
[b] Presumably the northeastern part of the island.
[c] Reggio Calabria is in peninsular Italy, just beyond the Straits of Messina.

magnitudes and recurrence intervals in excess of those known historically. For answering, the relationships linking landslide area to lithostructural characteristics of rock masses and to geometry of slopes are examined through bivariate and multivariate statistical analyses. Results indicate that such factors cannot explain the size and incidence of the landsliding in the west if causative earthquakes occur in the east, so that the occurrence of high-magnitude and low-recurrence earthquakes in the west cannot be excluded.

Earthquake-triggered landslides in southeastern Sicily, 146 in number, range in area between 9000 and 3,200,000 m^2; their state is dormant or, seldom, stabilised. Their reactivation may produce serious damage in many places. Previous papers (Adorni et al., 1998; Nicoletti and Terranova, 1998; Nicoletti et al., 1998, 1999a,b, 2000b; Nicoletti and Catalano, 2000, 2001; Gringeri Pantano et al., 2002; Nicoletti and Parise, 2002) illustrate, with greater or lesser detail, the local seismic history, the geo-environmental context, the characteristics of those landslides, the reasons indicating their seismic origin, evaluations of hazard, and, finally, samples of landslides and related landforms. As concerns these topics, only the essential will be repeated here.

2. Geology and seismicity of southeastern Sicily

2.1. Geological setting

The study area consists of about 4400 km^2 and comprises the horst of the Hyblaean Mountains at the core and marginal sectors of lower lands, hilly to flat (Fig. 1). The Hyblaean Mts are followed northwestward by the Gela–Catania Foredeep and, beyond this, by the Gela Nappe, which belongs to the thrust belt of the Apennine–Maghrebian Chain (Lentini et al., 1994) and is radically different in geologic and geomorphic terms. The Catania Plain, also belonging to the Gela–Catania Foredeep, delimits the study area on the northern side; further north, the volcanic edifice of Mt. Etna rises. Climate of SE Sicily is warm-temperate with dry summers. The study area counts more than 800,000 inhabitants.

The Hyblaean Mts are mostly underlain by carbonate rocks, moderately to well indurated and generally having subhorizontal bedding (Lentini, 1984; Fig. 2). Volcanic or volcaniclastic rocks blanket a conspicuous sector in the northern part. The lower marginal sectors are underlain by sedimentary rocks loose to moderately indurated and also having subhorizontal bedding. Density of jointing is, overall, low to moderate; its attitude is mostly subvertical (Ghisetti and Vezzani, 1980). This comparatively uniform and undisturbed geological setting is explained by southeastern Sicily being mostly located in a foreland area and originates a landscape basically consisting of a plateau incised by canyons and valleys (Fig. 3). Relief is low: hillslopes are seldom higher than 250–300 m, although may be steeply inclined along canyons, and maximum elevation, which is found some 40 km inland, is of only 986 m (Monte Lauro; Fig. 1). This geologic and geomorphic context has two notable effects: (a) it controls the typological and geometrical characteristics of the observed landslides (see Section 3.2) and (b) it

Download English Version:

https://daneshyari.com/en/article/9525013

Download Persian Version:

https://daneshyari.com/article/9525013

Daneshyari.com