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# The role of strong earthquakes and tsunami in the Late Holocene evolution of the Fortore River coastal plain (Apulia, Italy): A synthesis

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ABSTRACT

Morphological analysis of the Fortore River coastal plain and the Lesina Lake coastal barrier integrated with radiocarbon age data indicates that the evolution of the coastal landscape has been strongly affected by a number of strong earthquakes and related tsunamis which occurred during the last 3000 years. The first seismic event struck this coastal area in the V century BC. It produced strong erosion of the Fortore River coastal plain and significant emersion of Punta delle Pietre Nere, as well as the large tsunami responsible for the development of the Sant'Andrea washover fan. The second event occurred in 493 AD; it induced severe erosion of the Fortore River coastal plain and triggered the large tsunami that hit the Lesina Lake coastal barrier, producing the Foce Cauto washover fan. Then later in 1627, an earthquake was responsible for the further coseismic uplift of Punta delle Pietre Nere, the subsidence of Lesina village area and the development of a tsunami which produced two washover fans.

Morphological analysis points out that seismic events strong enough to control the morphological evolution of local coastal landscapes show a statistical return period of about 1000 years. These major events produced important coseismic vertical movements and large tsunamis. However, the correct identification of the tectonic structure responsible for the generation of these strong earthquakes is still an unsolved problem.


## 1. Introduction

The evolution of a coastal landscape in seismically active areas can be strongly influenced by relative sea-level changes produced by large earthquakes. Seismic deformation cycles have been defined in some of these areas (e.g. Atwater, 1987; Taylor et al., 1990; Ward and Valensise, 1994). The cycles comprise a slow pre- and post-event change of relative sea level and rapid, coseismic vertical movements that have been recorded on rocky coasts by biological and/or archaeological markers (e.g. Laborel and Laborel-Deguen, 1994; Pirazzoli et al., 1996; Ramírez-Herrera and Zamorano Orozco, 2002). In saltmarsh areas, sedimentological, palynological and palaeontological studies suggest that the coupling of co-seismic subsidence (causing a rapid sea-level rise) and post-seismic uplift (causing a rapid sea-level fall) are typical for many earthquake deformation cycles (e.g.; Shennan et al., 1996, 1999; Hamilton et al., 2005). These vertical movements, if they occur at the sea bed, can generate rapid and catastrophic sea-level changes, i.e. tsunamis, which are able to produce important modifications to the coastal landscape (e.g. Dawson, 1994; Pirazzoli et al., 1999; Bryant and Nott, 2001; Scheffers and Kelletat, 2003; Bouhadad et al., 2004; Vött et al., 2006).

The northern coast of the Gargano Promontory (Fig. 1) is one of most seismic areas of the Apulia, region and during historical times was struck by several large earthquakes with epicentres both onshore and offshore (Boschi et al., 1997; Gruppo di Lavoro CPTI, 2004). A detailed analysis of historical chronicles supplies a complete list of earthquakes that occurred during the last 1000 years, some of which have been responsible for the generation of large tsunamis (Tinti et al., 1995). In particular, the most severe historical event that struck this area occurred on July 30th 1627. It reached XI MCS grade and was responsible for the generation of a large tsunami that hit the northern coast of Apulia and Molise causing severe damage. It is not possible to accurately identify the earthquake-generative fault based on the available data. Yet, according to Panza et al. (1991), the isoseismals are compatible with movements along dip-slip faults with a NNW–SSE orientation. Tinti and Platanesi (1996) indicate a coastal fault uplifting the crustal block in front of Lesina Lake as the most probable candidate for the generation of the 1627 earthquake and the associated tsunami. Salvi et al. (1999) suggest that the earthquake-causative fault is located along the ENE–WSW structure of Apricena-Sannicandro. Finally, according to Patacca and Scandone (2004), the 1627 seismic event was produced by the Apricena fault (Fig. 2). This fault extends for about 30 km in the WNW–ESE

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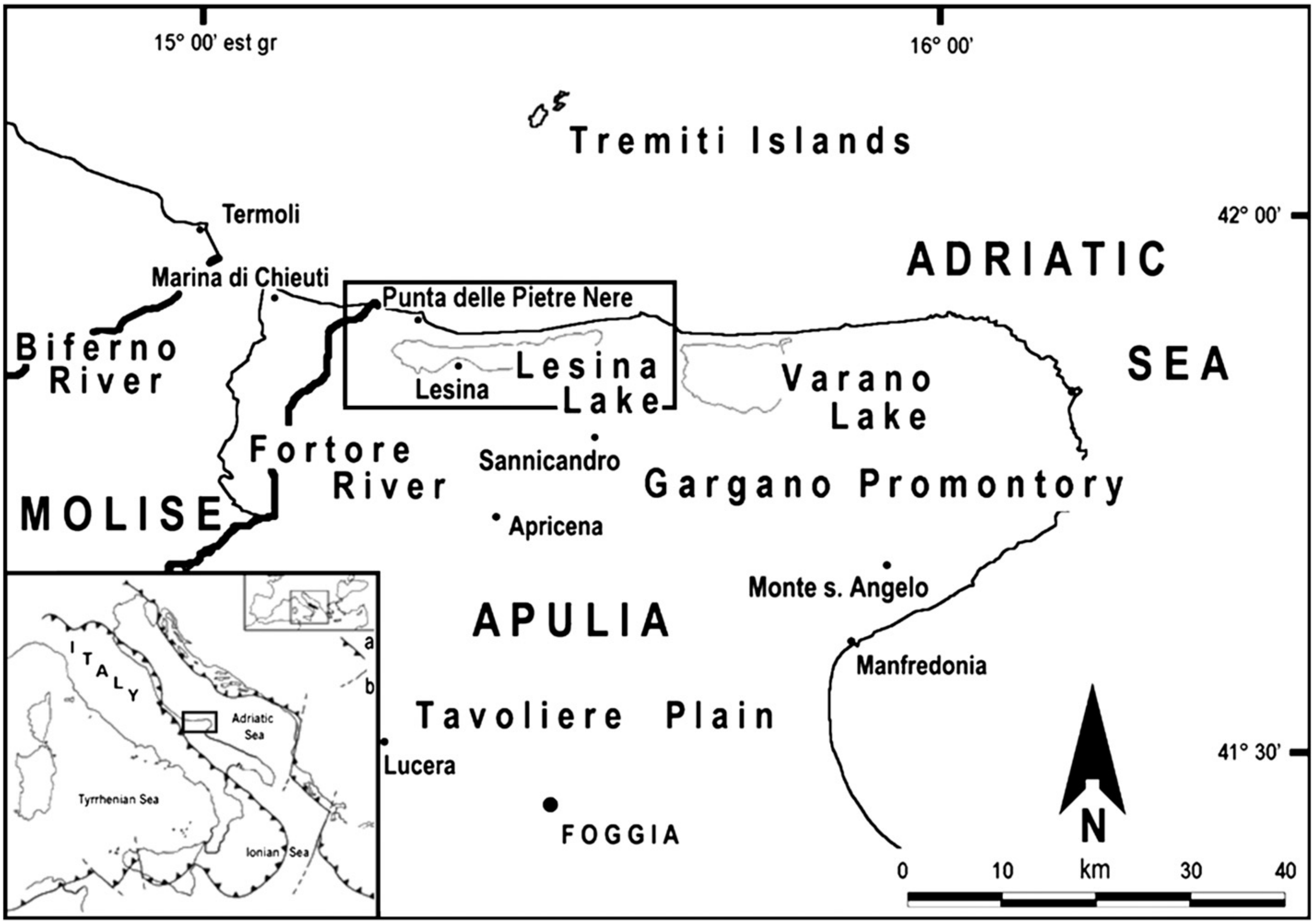


**Fig. 1.** The box indicates the geographical position of the studied area.

direction, dipping SSE. It cuts the entire sequence of Quaternary deposits and would be the only tectonic structure occurring in the area that shows evidence of recent activity.

This paper is an attempt to stress the combined role of major earthquakes and tsunamis in the evolution of the northern Apulia coastal area over the last 3000 years from a synthesis of available geomorphological and geochronological data for the Fortore River coastal plain, the Punta delle Pietre Nere and the Lesina Lake coastal barrier (Gianfreda et al., 2001; Mastronuzzi and Sansò, 2002; Gravina et al., 2005). The chronological data reported in previous papers have been recalibrated according to the up-to-date Calib 6.0 software (Stuiver et al., 2010) (Table 1). Furthermore, the definition of the main geomorphological effects on a landscape struck by earthquake-generated tsunamis, will supply a number of new elements useful in determining the earthquake-causative structure, which to this date is still an unsolved problem.

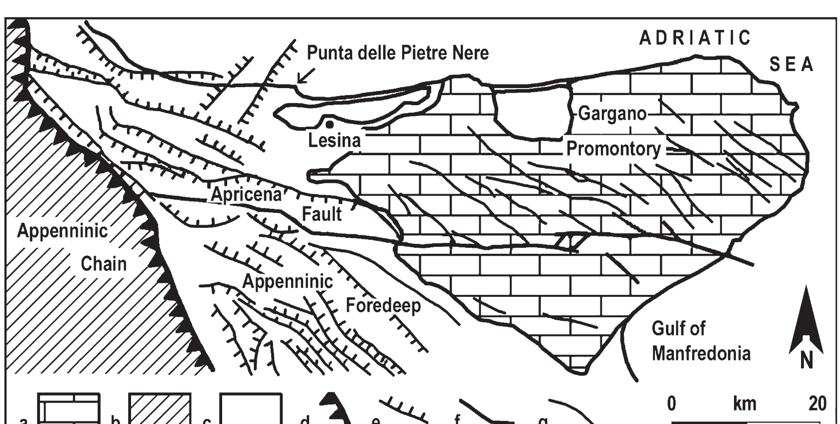


**Fig. 2.** Structural sketch of studied area (from Patacca and Scandone, 2004; mod.). Legend: a — Mesozoic and Tertiary limestones (Foreland Units); b — Apenninic Units (Chain Units); c — Plio-Pleistocene units (Foredeep Units); d — Front of Apenninic nappes; e — normal fault; f — Apricena fault; g — fault.