

The environmental effects of the 1743 Salento earthquake (Apulia, southern Italy): a contribution to seismic hazard assessment of the Salento Peninsula

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Abstract The aim of this study was to provide a contribution to seismic hazard assessment of the Salento Peninsula (Apulia, southern Italy). It is well known that this area was struck by the February 20, 1743, earthquake ($I_0 = IX$ and $M_w = 7.1$), the strongest seismic event of Salento, that caused the most severe damage in the towns of Nardò (Lecce) and Francavilla Fontana (Brindisi), in the Ionian Islands (Greece) and in the western coast of Albania. It was also widely felt in the western coast of Greece, in Malta Islands, in southern Italy and in some localities of central and northern Italy. Moreover, the area of the Salento Peninsula has also been hit by several low-energy and a few high-energy earthquakes over the last centuries; the instrumental recent seismicity is mainly concentrated in the western sector of the peninsula and in the Otranto Channel. The Salento area has also experienced destructive seismicity of neighboring regions in Italy (the Gargano Promontory in northern Apulia, the Southern Apennines chain, the Calabrian Arc) and in the Balkan Peninsula (Greece and Albania). Accordingly, a critical analysis of several documentary and historical sources, as well as of the geologic–geomorphologic ground effects due to the strong 1743 Salento earthquake, has been carried out by the authors in this paper; the final purpose has been to re-evaluate the 1743 MCS macroseismic intensities and to provide a list of newly classified localities according to the ESI-07 scale on the base of recognized Earthquake Environmental Effects. The result is a quite different damage scenario due to this earthquake that could raise the seismic potential currently recognized for the Salento area, and consequently upgrade the seismic hazard classification of the Salento. Indeed it is important to remind that currently, despite the intense earthquake activity recorded not only in the Otranto Channel, but especially in Greece and Albania, this area is classified in the least dangerous category of the Seismic Classification of the Italian territory (IV category).

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1 Introduction

The Salento Peninsula (Apulia, southern Italy) over the last centuries has been epicentral area of several low- and medium-energy earthquakes with magnitude $3 \leq M_w \leq 5$, apart from the February 20, 1743, earthquake with $I_0 = IX$ and $M_w = 7.1$ (Rovida et al. 2011), considered as the strongest seismic event of this area. The 1743 epicenter is still very controversial due to different locations ascribed respectively on land, near the town of Nardò by the Catalogue of Strong Earthquakes in Italy and Mediterranean Area (CFTI4Med, Guidoboni et al. 2007), and offshore, in various positions of the Ionian Sea (Shebalin et al. 1974; Postpischl 1985; Camassi and Stucchi 1997; Papazachos and Papazachou 2003; Rovida et al. 2011; Stucchi et al. 2013). The Salento area has also suffered destructive seismicity of the Gargano Promontory (northern Apulia), of the Southern Apennines chain and of the Calabrian Arc, in Italy. Moreover, the Salento has been affected by the effects of the strongest earthquakes from Albania and Ionian Islands (western Greece) (Grünthal et al. 2013; Stucchi et al. 2013). Nevertheless, this area is actually included in the IV category of the Italian Seismic Classification; this category is the least dangerous, in fact municipalities of this area have a low probability of seismic damages. According to the Ordinance of President of the Council of Ministers no. 3519 (28 April 2006), the seismic areas of this category have acceleration with probability of exceeding the threshold $a_g \leq 0.05$ equal to 10 % in 50 years (where ‘ a_g ’ is the peak acceleration on rigid ground (www.protezionecivile.gov.it)).

In order to contribute, on the basis of a detailed study of the 1743 earthquake, to an updated evaluation of the seismic hazard of the Salento area, currently underestimated, the following matters have been examined:

1. Historical and recent seismicity of the Apulia region and particularly of the Salento Peninsula from available catalogues (Guidoboni et al. 2007; Rovida et al. 2011; ISIDE working group 2016);
2. Macroseismic revision of the February 20, 1743, earthquake according to the Mercalli Cancani Sieberg (MCS) scale, on the basis of scientific papers (Margottini 1981, 1985; Ferrari 1987; Galli and Naso 2008; De Lucia et al. 2014; Gaudiosi et al. 2015; Nappi et al. 2015) and historical documents found in the State and Religious Archives.
3. Earthquake Environmental Effects (EEEs) from the available collected documents, according to the Environmental Seismic Intensity 2007 (ESI-07) scale (Michetti et al. 2007; Audemard et al. 2015).

As regards the methodology of earthquake intensity assessment, the traditional MCS scale and the new macroseismic scale ESI-07 have been applied in this paper (Gaudiosi et al. 2014; Michetti et al. 2007; Audemard et al. 2015).

The intensity evaluated through the MCS scale is a major seismic hazard parameter because is not only used for the description of earthquake effects, but it also describes the damage pattern. The intensity is the direct measure of damage and is commonly used in hazard assessment (D’Amico and Albarello 2008; Pasolini et al. 2008), in seismic risk management, post-earthquake emergency planning, earthquake loss estimation and damage scenarios.

The ESI-07 scale was ratified by the INQUA (International Union for Quaternary Research) during the XVII Congress in Cairns, Australia, 2007; it represents a new

macroseismic scale that measures the intensity based on the effects induced by earthquakes on the environment. This scale integrates the traditional macroseismic scales, of which it represents an evolution, allowing to assess the intensity parameter exclusively on the basis of environmental effects, also where buildings are absent, and when diagnostic elements damage-based have saturated. The ESI-07 scale is a 12° scale: Each degree reflects the corresponding strength of an earthquake and provides a measure of the intensity on the basis of its characteristics. The main advantage of the ESI-07 scale is the classification, quantification and measurement of several known geological, hydrological, geomorphologic and botanical features that are associated with each intensity degree. This scale has been tested worldwide, in the case of several modern, historical earthquakes and paleoearthquakes (Silva et al. 2008; Reicherter et al. 2009; Lekkas 2010; Papanikolaou 2011; Giles 2013; Porfido et al. 2015a, b; Serva et al. 2015; Heddar et al. 2016; Quigley et al. 2016; Sanchez and Maldonado 2016).

Based on the above-mentioned seismic intensities scales, the reassessment of both the 1743 macroseismic effects on man-made structures and the triggered effects in the natural environment have allowed to elaborate a quite different scenario of the 1743 earthquake, leading to other intensity values for some localities and increasing the number of the newly classified localities, represented in this paper with a new intensity map.

2 Geodynamic framework of the study area

The Apulia region (southern Italy), NW–SE elongated, represents the emerged part of the Adriatic foreland domain, shared by the Apennines chain to the west and the Dinarides–Albanides–Hellenides chains to the east (Caputo et al. 1970; Moretti and Royden 1988). The geodynamic background of this area, located in the central sector of the Mediterranean basin, shows complex tectonics since it is a plate boundary collision zone (Fig. 1), characterized by the ongoing subduction of the Ionian slab beneath the Calabrian Arc, to the southwest, and the Dinarides–Albanides–Hellenides thrust front, to the northeast. Such compressional regime is still active and featured by frequent and strong seismicity occurring mostly in the Ionian Sea and western Greece (Slejko et al. 1999; Castello et al. 2006; Markusic et al. 2015).

In the framework of the Mediterranean basin tectonic evolution, the relative motion of the Adriatic foreland respect to the African plate is still under debate; particularly many geological and geophysical data point out an independent Adriatic microplate, moving by counter-clockwise rotation, which deformation shows different pattern near its borders (Argnani et al. 2001; Serpelloni et al. 2005; Argnani 2012).

In Fig. 1, the Apulian block and its surrounding regions have been mapped; several normal faults, NW–SE and NNW–SSE trending, dissect this area and dislocate the sea floor by about 200–300 m (Merlini et al. 2000). Moreover, major E–W strike slip fault zones divide Apulia into structural blocks behaving independently, the Gargano Promontory, the Murge Ridge and the Salento Peninsula. The spatial distribution of earthquakes shows different pattern of seismic activity inside these three zones, and some of the mapped faults are presently active (Fig. 1).

The outcropping rocks of the Apulian foreland are prevalently limestone-dolomite units belonging to the Apulia platform, with carbonatic-terrigenous marine deposits at the top of the stratigraphic sequence, Middle Eocene–Upper Pleistocene age (Mastronuzzi et al. 2011).

According to Ambrosetti et al. (1986), Bigi et al. (1983) and Gambini and Tozzi (1996), the major structural lineaments cutting the Apulian foreland and to be considered as

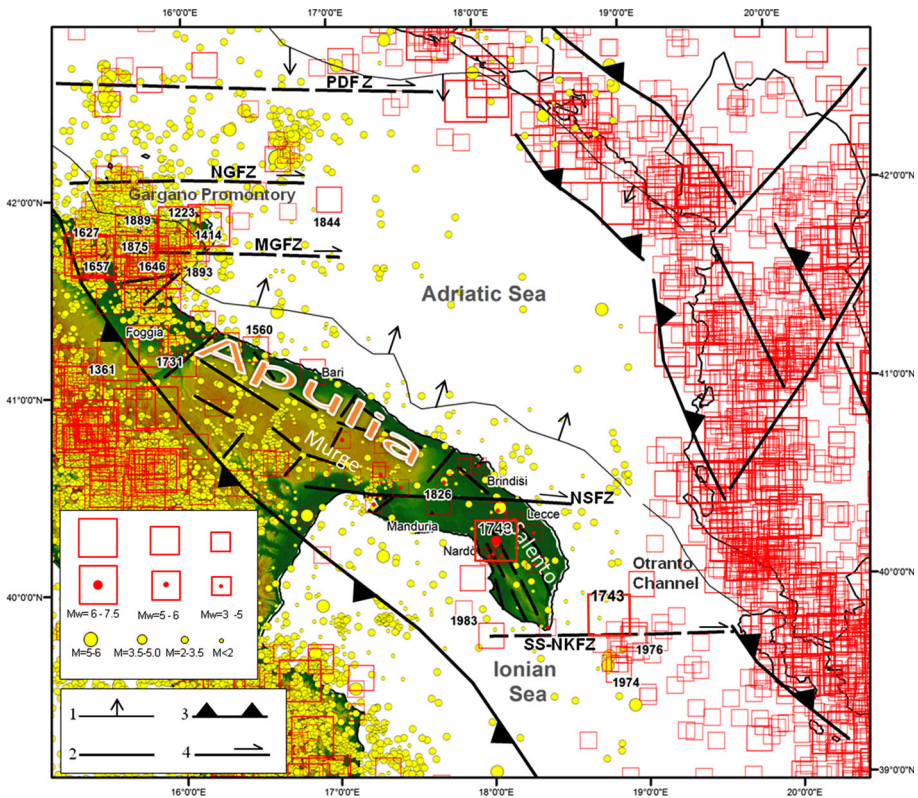


Fig. 1 Apulia seismotectonic map. Historical seismicity of Apulia and surrounding areas: *Red squares* represent earthquakes from the CPTI11 catalogue (Rovida et al. 2011) for southern Italy and from the SHARE European Earthquake Catalogue (Stucchi et al. 2013; Grünthal et al. 2013) for the Balkan peninsula; *red squares*, with full *red circles* inside, represent earthquakes of Salento Peninsula from CFTI4Med catalogue (Guidoboni et al. 2007). The epicenter of the 1743 earthquake located onland (from CFTI4Med), and offshore (from CPTI11) in the Otranto Channel, is identified by the year of its occurrence. Instrumental seismicity of Apulia and surrounding areas: *Yellow circles* represent earthquakes from ISIDE Working group (2016). Structural map: simplified from Ambrosetti et al. (1986), Bigi et al. (1983) and Gambini and Tozzi (1996). (1) Apulian and Dalmatian Platform Margin; (2) main normal faults; (3) main thrust belt fronts; (4) main strike slip faults, which are PDFZ, Pescara-Dubrovnik Fault Zone; NGFZ, Nord-Gargano Fault Zone; MGFZ, Mattinata-Gondola Fault Zone; NSFZ, North-Salento Fault Zone; and NKFZ, North-Kerkira Fault Zone

significant probable seismogenic sources are (Fig. 1): the Pescara-Dubrovnik Fault Zone (PDFZ); the Nord-Gargano Fault Zone (NGFZ); the Mattinata-Gondola Fault Zone (MGFZ); the North-Salento Fault Zone (NSFZ) and the North-Kerkira Fault Zone (NKFZ).

3 Seismicity of the Salento Peninsula

The seismic history of Apulia and surrounding regions has been analyzed consulting the available catalogues on the INGV Web site. The historical earthquakes were extracted from the 2011 version of the Parametric Catalogue of Italian Earthquakes (CPTI11) (Rovida et al. 2011), proposed by its authors as the reference document for new hazard

estimates. The CPTI11 updates a previous version of 2004 (Gruppo di lavoro CPTI 2004) and is based on both the Italian Macroseismic Database DBMI11 (Locati et al. 2011) and instrumental databases, from 1000 to 2006. In the CPTI11, when both macroseismic and instrumental seismic parameters are available, the epicenter is selected according to expert judgment. Magnitude of instrumental data (after 1980) is obtained from moment tensor or spectral method (M_w), while magnitude of macroseismic data (before 1980) is a weighted mean of previous magnitude values calculated from magnitude–intensity empirical relations (Rovida et al. 2011).

In addition, the CFTI4Med catalogue (Guidoboni et al. 2007) has been consulted to improve the completeness of the seismic database of the southern Apulia. This catalogue lists earthquakes occurred in Italy between 461 BC and 1997, and earthquakes occurred in the Mediterranean area between the eighth century BC and the sixteenth century. The CFTI4Med contains all Italian earthquakes with epicentral intensity VIII or larger and a selection of smaller earthquakes (total number of earthquakes: 1257) among which there are many events occurred in the Salento region and lacking in the CPTI11 catalogue. The whole data from this catalogue are based on *ad hoc* historical investigations and on new interpretations of historical seismic sources.

The historical seismicity of the Balkan peninsula has been extracted from the SHARE European Earthquake Catalogue consisting of two portions: (1) the SHARE European Earthquake Catalogue (SHEEC) 1000–1899 (Stucchi et al. 2013), built on the data contained in the Archive of Historical Earthquake Data (AHEAD) and (2) the SHARE European Earthquake Catalogue (SHEEC) 1900–2006 (Grünthal et al. 2013) that represents a temporal and spatial selection of the “European-Mediterranean Earthquake Catalogue” (EMEC).

The instrumental seismicity has been extracted from the Italian Seismological Instrumental and parametric Data-basE (ISIDE working group INGV 2016, <http://iside.rm.ingv.it/iside/standard/index.jsp>). ISIDE gives accurate and reviewed information on the current seismicity in Italy. It includes also the data of past instrumental seismicity from the Italian Seismic Bulletin that listed the earthquakes recorded by the Italian National Seismic Network since 1985.

The historical seismicity of Apulia and neighboring areas and instrumental seismicity from 1985 to 2015 are shown in Fig. 1.

The historical and recent seismicity of the Apulia region is characterized by a higher frequency of earthquakes in the northern sector (Gargano), than in the southern one (Murge, Salento) (Fig. 1). The strongest historical earthquakes ($I_0 \geq$ VIII MCS) of the last centuries in the whole Apulian region from Gargano to Salento, extracted from CPTI11 (Rovida et al. 2011), are (Table 1): the 1223 (Gargano, $I_0 =$ VIII–IX MCS, $M_w = 5.8$); the July 17, 1361 (Ascoli Satriano, $I_0 =$ IX MCS, $M_w = 6.0$); the 1414 (Vieste, $I_0 =$ VIII–IX, $M_w = 5.8$); the May 11, 1560 (Barletta-Bisceglie $I_0 =$ VIII MCS, $M_w = 5.6$); the July 30, 1627 (Gargano, $I_0 =$ X MCS, $M_w = 6.7$); the May 31, 1646 (Gargano, $I_0 =$ IX–X MCS, $M_w = 6.6$); the January 29, 1657 (Lesina, $I_0 =$ VIII–IX MCS, $M_w = 6.4$); the March 20, 1731 (Foggia, $I_0 =$ IX MCS, $M_w = 6.5$); the February 20, 1743 (Ionian Sea, $I_0 =$ IX MCS, $M_w = 7.1$); the February 7, 1844 (Adriatic Sea, $I_0 =$ VIII MCS, $M_w = 5.6$); the December 6, 1875 (San Marco in Lamis, $I_0 =$ VIII MCS, $M_w = 6.0$) and the August 10, 1893 (Gargano, $I_0 =$ VIII MCS, $M_w = 5.4$).

The analysis of the historical seismicity of Apulia highlights that the Gargano area has been hit by several high-energy earthquakes ($I_0 \geq$ VIII MCS, $M_w \geq 6.0$) in the last thousand years, while southern Apulia (Murge and Salento) historically experienced only a few moderate earthquakes (Fig. 1).

Table 1 Strongest historical earthquakes with $I_0 \geq$ VIII MCS in the whole Apulian region from Gargano to Salento extracted from CPTI11 (Rovida et al. 2011)

Date	T_0	I_0 (MCS)	I_{\max}	M_w	Lat N	Long E	Location
1223		VIII–IX	IX	5.8	41.873	15.981	Gargano
1361-07-17	17:15	IX	X	6.0	41.205	15.561	Ascoli Satriano
1414		VIII–IX	VIII–IX	5.8	41.882	16.180	Vieste
1560-05-11	04:40	VIII	VIII	5.6	41.248	16.485	Barletta-Bisceglie
1627-07-30	10:50	X	X	6.7	41.737	15.342	Gargano
1646-05-31		IX–X	X	6.6	41.727	15.764	Gargano
1657-01-29		VIII–IX	IX–X	6.4	41.726	15.393	Lesina
1731-03-20	03:00	IX	IX	6.5	41.274	15.757	Foggiano
1743-02-20	16:30	IX	IX	7.1	39.852	18.777	Ionian Sea
1844-02-07	22:16	VIII		5.6	42.000	17.000	Basso Adriatico
1875-12-06		VIII	VIII	6.0	41.689	15.677	S.Marco in Lamis
1893-08-10	20:52	VIII	VIII–IX	5.4	41.713	16.075	Gargano

The earthquakes parameters are: T_0 : origin time; Lat N: latitude (north); Long E: longitude (east); I_0 : MCS epicentral intensity; I_{\max} : maximum MCS intensity; M_w : moment magnitude estimated from macroseismic data

The historical and recent earthquakes of Salento extracted from parametric catalogues and the instrumental seismicity with $M \geq 3.0$ extracted from ISIDe working group INGV (2016) are shown, respectively, in Tables 2 and 3.

The Salento Peninsula has been generally considered almost aseismic. It is a common opinion that the seismic hazard of this area is exclusively associated with damage caused by sources from the Ionian Sea and from the eastern side of the Adriatic Sea, including the Hellenic Arc. In particular, the Salento region is close to areas with frequent and intense seismicity; in fact it is less than 100 km far from Albanian and Greek coasts where many energetic earthquakes occurred and are strongly felt in the Salento Peninsula. For example, the 10.10.1858 earthquake, located near Brindisi in the PFG catalogue ($I =$ VI MCS; $M = 4.6$, Postpischl 1985), actually occurred in Albania near the town of Delvino ($I_0 =$ VIII–IX; $M_w = 6.4$, Stucchi et al. 2013) and, due to the Cathedral of Brindisi collapses, damaged its mosaic floor.

The only strong earthquake affecting seriously the Salento Peninsula is represented by the February 20, 1743, earthquake ($I_0 =$ IX, $M_w = 7.1$, Rovida et al. 2011), which caused the most severe damage in the Salento area, in the towns of Nardò (Lecce), and Francavilla Fontana (Brindisi), in the Ionian Islands (Greece) and in the western coast of Albania. It was also widely felt in Malta Islands, in southern Italy and in some localities of central and northern Italy. The total number of casualties is undefined, probably several hundreds. The most striking effect of this earthquake was a large tsunami on the Salento coasts (Mastronuzzi et al. 2007).

The CPTI11 catalogue (Rovida et al. 2011) indicates that the maximum felt intensity was IX MCS in Nardò and Amaxichi (Lefkada, GR) and locates the epicenter in the Ionian Sea (Fig. 1). On the other hand, according to the CFTI4Med catalogue, the 1743 earthquake ($I_0 =$ IX, $M_e = 6.9$, Guidoboni et al. 2007) is located onland in the Salento Peninsula near the town of Nardò (Fig. 1). However, the location and geometry of the seismogenetic source of the 1743 Salento earthquake is still a subject of scientific debate and will be discussed later.

Table 2 Historical and recent earthquakes occurred in the Salento Peninsula and surrounding seas extracted from CPTI04 (Gruppo di lavoro CPTI 2004), CPTI11 (Rovida et al. 2011), CFTI4Med (Guidoboni et al. 2007)

Date	T_0	I_0 (MCS)	I_{max}	M_w	Lat N	Long E	Location	Catalogue
1087-09-10		VI–VII	VI–VII	4.9	41.128	16.864	Bari	CPTI11
1713-01-03		V–VI	VI–VII	4.5	40.589	17.113	Massafra (TA)	CPTI11
1743-02-20	16:30	IX	IX	7.1	39.852	18.777	Ionian Sea	CPTI11
1826-10-27	18:00	VI–VII	VI–VII	5.4	40.451	17.678	Manduria (TA)	CPTI11
1844-02-07	22:16	VIII		5.6	42.000	17.000	Basso Adriatico	CPTI11
1848-08-03	00:05	VII		5.1	42.000	17.000	Basso Adriatico	CPTI11
1909-01-05	20:00	IV–V	IV–V	4.1	40.283	18.300	Vernole (Le)	CFTI4Med
1909-01-06	02:00	III	III	3.5	40.117	18.300	Maglie (LE)	CFTI4Med
1909-01-20	19:58	V	VI	4.6	40.183	18.033	Salento	CFTI4Med
1926-12-14	21:00	III	III	3.5	40.633	17.950	Brindisi	CFTI4Med
1931-04-24	21:10	III–IV	III–IV	3.7	40.550	17.717	Latiano (BR)	CFTI4Med
1932-07-19	12:31	III	III	3.5	40.750	17.317	Locorotondo (BA)	CFTI4Med
1935-03-01	12:38	IV	IV	3.9	40.350	18.167	Lecce	CFTI4Med
1935-03-01	17:17	III	III	3.5	40.350	18.167	Lecce	CFTI4Med
1935-05-29	13:00	IV	IV	3.9	39.800	18.367	S. Maria di Leuca (LE)	CFTI4Med
1936-06-13	00:35	III	III	3.5	40.783	17.050	Bari-Taranto	CFTI4Med
1937-10-17	10:00	III	III	3.5	40.450	17.250	Taranto	CFTI4Med
1938-03-04	02:00	IV	IV	3.9	40.400	18.067	Trepuzzi (Le)	CFTI4Med
1947-06-20	21:50	II–III	II–III	3.2	40.533	17.433	Grottaglie (TA)	CFTI4Med
1948-05-07	15:57:24	V–VI		4.8	40.000	19.000	Canale d'Otranto	CPTI04, CPTI11
1974-06-29	22:32:03			4.1	39.648	18.833	Alto Ionio	CPTI11
1974-10-01	00:34:40			4.4	39.699	18.814	Alto Ionio	CPTI11
1974-10-07	11:43:40			4.5	39.786	18.915	Alto Ionio	CPTI11
1974-10-20	11:25:50			5.0	39.572	18.826	Alto Ionio	CPTI11
1974-10-22	07:29:04			4.5	39.705	18.717	Alto Ionio	CPTI11

Table 2 continued

Date	T_0	I_0 (MCS)	I_{max}	M_w	Lat N	Long E	Location	Catalogue
1974-11-23	07:52:28	VII		4.6	39.774	18.810	Alto Ionio	CPTI04, CPTI11
1974-11-23	18:46:36			4.8	39.742	18.839	Alto Ionio	CPTI11
1976-10-22	11:23:27			4.9	39.724	18.928	Canale d'Otranto	CPTI11
1976-10-27	10:14:56			4.6	39.600	18.835	Alto Ionio	CPTI11
1976-11-06	20:57:04			4.6	39.606	18.772	Alto Ionio	CPTI11
1976-11-07	02:10:18			4.4	39.645	18.868	Alto Ionio	CPTI11
1976-11-08	18:08:41			4.4	39.220	18.609	Alto Ionio	CPTI11
1976-11-12	19:36:36			4.5	39.657	18.934	Alto Ionio	CPTI11
1976-11-13	05:29:37			4.3	39.661	18.976	Alto Ionio	CPTI11
1977-06-05	23:19:47			4.6	39.601	18.831	Alto Ionio	CPTI11
1983-05-07	22:09:14			5.0	40.062	17.890	Penisola salentina	CPTI11
1983-11-08	20:11:40			4.6	39.907	17.825	Penisola salentina	CPTI11
1985-09-19	04:54:26			4.4	39.674	18.833	Alto Ionio	CPTI11
2001-09-23	21:16:57			5.0	39.767	18.001	Penisola salentina	CPTI11

The earthquakes parameters are: T_0 : origin time; Lat N: latitude (north); Long E: longitude (east); I_0 : MCS epicentral intensity; I_{max} : maximum MCS intensity; M_w : moment magnitude estimated from macroseismic and instrumental data

Table 3 Salento Peninsula instrumental seismicity ($3 < M < 5$), extracted from ISIDE working group (2016)

Date	T_0	M	Lat N	Long E	Location
1985-09-24	22:56:20	$M_d = 3.5$	39.553	18.804	Canale D'Otranto
1994-01-07	18:30:11	$M_d = 3.5$	40.176	17.285	Golfo di Taranto
2001-07-15	11:17:30	$M_d = 3.0$	40.665	17.54	Ostuni
2003-04-06	19:07:56	$M_d = 3.4$	39.868	18.954	Canale d'Otranto
2008-12-10	18:44:42	$M_l = 3.3$	39.348	19.090	Canale d'Otranto
2011-06-27	18:35:53	$M_l = 3.1$	40.108	18.809	Canale d'Otranto
2013-01-30	04:28:10	$M_l = 3.0$	39.301	19.338	Canale d'Otranto
2013-07-30	21:13:08	$M_l = 3.1$	39.358	18.880	Canale d'Otranto
2015-11-10	17:50:58	$M_l = 3.1$	39.898	18.727	Canale d'Otranto

T_0 : origin time; Lat N: latitude (north); Long E: longitude (east); M (magnitude): M_l (local magnitude) or M_d (magnitude from duration of signal)

This area suffered other strong earthquakes as suggested by Pieri et al. (1997), considering the occurrence of seismites in the Tyrrhenian deposits along the Adriatic–Apulian coast of the Salento and on the basis of geomorphologic (tsunami deposits) and archaeological data (Galli and Naso 2008; Mastronuzzi et al. 2007, 2011). However, the internal part of the Salento shows a minor, but not negligible, seismic activity (Tables 2, 3; Fig. 1) as the 1826 Manduria earthquake with $I_0 = \text{VI–VII}$, $M_w = 5.3$. In particular, analyzing the CFTI4Med catalogue, 13 earthquakes located in the Salento Peninsula with $3.2 < M_w < 4.6$ in the twentieth century have been added to the CPTI11 extracted events (Table 1). The instrumental seismicity in the Murge and in the Salento Peninsula is characterized by scattered seismicity of low energy, mainly concentrated in the western sector of Salento, in the Gulf of Taranto and in the Otranto channel. In particular, the instrumental seismicity in the Gulf of Taranto has moderate energy with epicenters not far from the coasts of Salento, as in the case of the May 7, 1983, earthquake ($M_w = 5.0$) (Fig. 1). Moreover, the area of the Otranto channel has been hit by two seismic sequences in the 1974 (maximum magnitude $M_w = 5.0$, Rovida et al. 2011) and 1976 (maximum magnitude $M_w = 4.9$, Rovida et al. 2011), in the same area where the 1743 earthquake probably occurred, following Rovida et al. (2011).

Low-magnitude earthquakes could not be localized until about 15 years ago due to the small number of seismic stations of the INGV seismic network in the central and southern Apulia. The increase in the number of seismic stations since 2000 provides more complete hypocentral determinations of low-magnitude earthquakes, occurring in the Apulia foreland (Del Gaudio et al. 2005; Pierri et al. 2013). The distribution of earthquakes in the Salento Peninsula shows a clear concentration of seismic events along the NE–SW Taranto–Brindisi depression zone separating the Murge from the Salento Peninsula (Fig. 1).

4 The February 20, 1743, earthquake

The February 20, 1743, earthquake caused heavy damages in the Salento Peninsula and is considered the strongest seismic event occurred in the area in the last centuries (Basso Ionio $I = \text{IX MCS}$, $M_w = 7.1$, Rovida et al. 2011), over a seismic period that began in

1741 (Margottini 1985; Guidoboni et al. 2007; Galli and Naso 2008). The event was felt in the whole Apulia region, in many cities as Napoli, Matera, Reggio Calabria, Messina in southern Italy and even in some localities of central and northern Italy as Parma, Venezia, Vicenza, Trento and Udine (Baratta 1901), the last two cities far from the epicentral area more than a 1000 km. This earthquake was also felt in a wide sector of the Mediterranean area causing considerable damage along the western coast of Greece, Albania and Malta Islands (Malta and Gozo). It also generated a large tsunami, quoted in many references and databases as the Euro-Mediterranean Tsunami Catalogue (Maramai et al. 2014) and the Global Historical Tsunami Database of NOAA (NGDC/WDS 2014).

4.1 The chronological occurrence of the 1743 main seismic events

The February 20, 1743, earthquake was a complex seismic event, consisting in at least three distinct shocks, beginning approximately from 23.30 to 23.45 “Italian time” (*orario all’ italiana*), corresponding to 16.30–16.45 GMT. It is noteworthy that, according to the “Italian time,” the day started at sunset, and consequently, also the counting of the hours (Dominici and Marcelli 1979). According to the descriptions and the accounts of some witnesses, as Cagnes and Scalese (1743) in Brindisi, and local notaries in Lecce and in Nardò (ASL 1743a, b, c; De Simone 1993; Camarda 1997), the three shocks followed each other in about 20 min, as reported in Table 4. According to Ambraseys (2009), there were more shocks over 1 h involving the Ionian Islands. Far from the epicentral area, in the Malta Island the earthquakes were also perceived with very long duration, lasting 7½ min (De Soldanis 1746).

4.2 The different epicentral locations of the 1743 main seismic event

The location and geometry of the 1743 seismogenetic source are still a subject of scientific debate, due to the different locations ascribed, respectively, on land (Guidoboni et al. 2007)

Table 4 Coeval noteworthy quotation relative to the 1743 events chronological occurrence from archival sources Archivio di Stato di Lecce (ASL) and Biblioteca Arcivescovile di Brindisi “A. De Leo” (BAD), also reported in modern studies (De Simone 1993; Camarda 1997)

Locality	Contemporary brief description	References
Brindisi	<i>at 23:45 it was in this city a most terrible earthquake, which lasted two minutes in three aftershocks</i>	BAD, Cagnes and Scalese (1743)
Lecce	<i>in the same time, 23.30 h, there was such a terrible earthquake that lasted about two minutes ... Ceased the first shock, from which we remained safe, after a few minutes the second and then the third one occurred, but always with the same vehemence and power</i>	ASL, Notary F. Piccinni (1908) Camarda (1997)
Lecce	<i>a very terrible earthquake, which lasted for the space of seven minutes for three times</i>	ASL, Notary V. Fedele (1743c) De Simone (1993)
Lecce	<i>a terrible earthquake ... with three successive movements of the ground, which became undulating like the waves of the stormy sea ..., lasted a third of hour</i>	ASL, Notary N. Bona (1743b) De Simone (1993)
Nardò	<i>at 23.30 h it was a tremendous earthquake of three continuous shocks that lasted more than eight minutes</i>	ASL, Notary O. De Carlo (1743a)

on the basis of the severe damages which affected the town of Nardò, Francavilla Fontana and other Salento villages, and offshore, in the Ionian Sea (Shebalin et al. 1974; Postpischl 1985; Camassi and Stucchi 1997; Papazachos and Papazachou 2003; Rovida et al. 2011; Stucchi et al. 2013). (Table 5). In Fig. 2, the two most updated different epicentral locations, onland (Guidoboni et al. 2007) and offshore (Rovida et al. 2011), with felt reports are shown.

Most authors agree on the hypothesis of a seismic source in the Otranto channel (Galli and Naso 2008; Locati et al. 2011), in the same epicentral area of the instrumental seismicity recorded recently (1974 and 1976 seismic sequences). According to Galli and Naso (2008), the strong intensity values recorded in Nardò, Francavilla Fontana, Leverano and other localities in Salento as well as in Greece have been caused by local amplification site effects, a “double-resonance” phenomenon that occurred in villages characterized by thin soft Pleistocene sediments.

The authors of this paper carried out a critical revision of both original archival sources and the most important historical and recent papers, taking into account the macroseismic evaluations of Mercalli (1883), De Giorgi (1898), Baratta (1901), Margottini (1981, 1985), Ferrari (1987), Guidoboni et al. (2007), and the detailed studies of Mastronuzzi and Sansò (2004), Mastronuzzi et al. (2007), Galea (2007), Galli and Naso (2008) in order to figure out the effects of this earthquake on the urban and natural environment.

Many primary sources have been found in the writings of local historians, as De Simone (1993) and Camarda (1997), who reported detailed accounts by notaries and witnesses from Salento. In fact at that time (1743), the notary protocols often reported news about the extraordinary events occurred in their regions. Other information from the Vatican archives are reported in Guidoboni et al. (2007) and Galli and Naso (2008), while Ambraseys (2009) accounts for both occidental and oriental primary sources, as those from the Venice State Archive (ASV) and from Ottoman archives in Istanbul.

Table 5 Different epicentral locations of the 1743 mainshock from the available most important Catalogues

Catalogue	Lat N	Long E	M	I_0	References	Location
<i>The 20, February 1743 seismological parameters in different Catalogues</i>						
Shebalin et al. 1974	39.000	20.000			Shebalin et al. (1974)	South of Corfu
CNR-PFG 1985	38.0	18.0	$M_k = 5.6$	9	Postpischl (1985)	Basso Ionio
NT4.1			$M_s = 7.0$	10.5	Camassi and Stucchi (1997)	Canale D'Otranto
Papazachos and Papazachou 2003	39.200	20.100	$M_w = 7.10$	8	Papazachos and Papazachou (2003)	Corfu
CPTI04	39.850	18.780	$M_w = 6.9$	9.5	CPTI Working Group (2004)	Basso Ionio
CFTI4Med 2007	40.25	18.05	$M_c = 6.9$	9	Guidoboni et al. (2007)	Basso Ionio
CPTI11	39.852	18.777	$M_w = 7.13$	9	Rovida et al. (2011)	Basso Ionio
2013	39.846	18.772	$M_w = 7.10$	9	Stucchi et al. (2013)	Basso Ionio

Lat N : latitude (north); Long E : longitude (east); M (magnitude): M_c (equivalent magnitude computed on macroseismic data), M_k (macroseismic magnitude according to Karnik (1969)), M_s (magnitude from surface seismic waves), M_w (moment magnitude estimated from macroseismic data)

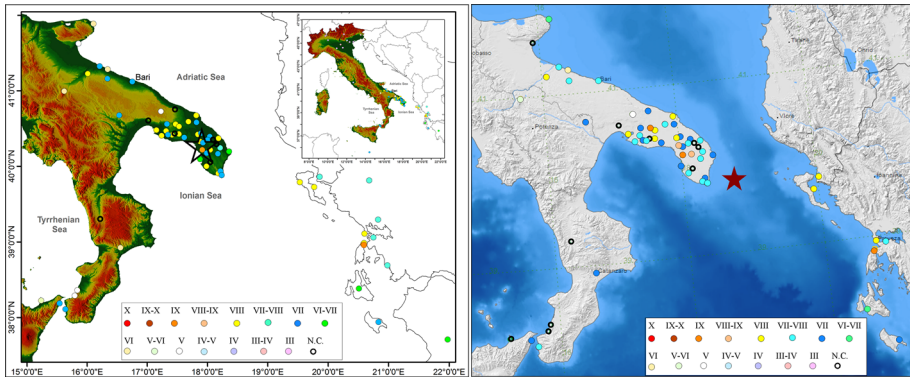


Fig. 2 The 1743 two different epicentral locations with felt reports. *Left* the *empty black star* shows the epicenter located onland, near the town of Nardò, according to CFTI4Med (modified from Guidoboni et al. 2007). *Right* the *burgundy star* shows the epicenter located offshore, in the Ionian Sea according to CPTI11 (modified from Rovida et al. 2011)

According to historical sources, the number of casualties is variable from about 200–300 (Notary Oronzo De Carlo, ASL Notary Protocols 1743a) to 160 by notary Nicola Bona (ASL Notary Protocols 1743b; De Simone 1993). Guidoboni et al (2007) report 180 victims, of which 150 in the town of Nardò (Lecce).

As regards the damage level in the Salento Peninsula, the towns of Nardò (Lecce), Francavilla Fontana (Brindisi) and Brindisi were particularly affected by serious devastation. In Greece, the localities of Amaxichi (Lefkada) and Kérkira (Corfù) were strongly hit: Most houses collapsed, and the remaining had major damages, and several people died. Significant damages were reported also in the nearby town of Preveza, in other villages of inland Greece, Albania and Malta (Margottini 1981, 1985; Galea 2007; Galli and Naso 2008).

5 Macroseismic analysis of the 1743 earthquake

In this paper, a revaluation of the 1743 earthquake MCS intensity for the damaged localities has been carried out on the basis of historical documents of contemporary witnesses, as Cagnes and Scalese (1743), Leo (1743), Forleo (1743), De Soldanis (1746) and Saracino (1744) found both in private and public archives, in historiographical books (De Giorgi 1898; De Simone 1993; Camarda 1997), and in the recent scientific literature (Margottini 1981, 1985; Ferrari 1987; Galea 2007; Galli and Naso 2008; Guidoboni et al. 2007; Ambraseys 2009). Geological and geomorphologic studies from Mastronuzzi and Sansò (2004) and Mastronuzzi et al. (2007) were also considered. In addition, for some localities local historiographical Web sites have been also consulted.

The assessment of the macroseismic degree has been made using the traditional MCS scale. Moreover, for a more complete evaluation of this event, the indirect geomorphologic data referable to environmental earthquake effects have been utilized to evaluate the intensity according to the ESI-07 scale. For both MCS and ESI-07 scales, the authors have decided to assign a well-defined unique intensity value for each locality, based on the collected data and on their professional judgment. In this study, the new MCS intensities have been assessed for 18 localities, mainly in the Salento Peninsula. In Table 6, the MCS

Table 6 MCS intensity values for 18 localities hit by 1743 earthquake, with a brief description of the felt reports, the damage level, the main archival sources and the relative recent literature

Locality	Brief description	Reference	I (MCS) current work
Nardò (Lecce, IT)	<p><i>On February 20 of the year 1743 ... happened a fierce earthquake that ... ruined the foundations of the town of Nardò ... 228 people and other 29 from Gallipoli died... 349 people died, mostly children.... The damage was about one million and one hundred sixty-five thousand ducats. The earthquake was felt throughout Europe, even all over the world</i></p> <p><i>...one hundred and sixty people dead and buried under stones, and almost sixty were wounded and injured</i></p> <p><i>On February 20, at 23.45, such a large earthquake began that not only plunged the whole city, but the following 112 people died under the stones</i></p> <p><i>...it was so horrible that ruined all the houses, palaces, many of which have fallen, and many are not able to be inhabited, but all the houses were damaged and generally very compromised</i></p>	<p>ASL, Notary O. De Carlo (1743a), Notarial Protocols, De Simone (1993)</p> <p>ASL, Notary N. Bona (1743b), Notarial Protocols, De Simone (1993)</p> <p>ACN, Registro dei Morti 1743, De Simone (1993)</p> <p>BAD, Cagnes and Scalese (1743), Margottini (1981)</p>	X
Brindisi (IT)	<p><i>On February 20, 1743 there was a severe earthquake ... so that many churches, palaces and houses collapsed ... Under the ruins of the buildings many people died</i></p> <p><i>If you looked at that beautiful road of the Carmine you found those beautiful palaces ... all shattered and some of them fallen to the ground</i></p>	<p>Leo (1743), Camarda (1997)</p> <p>Forleo (1743), Camarda (1997)</p>	IX
Francavilla Fontana (Brindisi, IT)	<p>Many houses totally collapsed or were severely damaged; the main church collapsed almost completely</p>	<p>De Simone (1993), Guidoboni et al. (2007)</p>	VIII
Malta (MT)	<p><i>It [the earthquake] did great damage to both islands. In Gozo, St. George's Church, St. James' Church and the chapel of Our Lady at Qala were badly damaged. In Malta, St. John's at Valetta, Mdina Cathedral and numerous other churches in the countryside were also heavily damaged</i></p>	<p>De Soldamis (1746), Galea (2007)</p>	VIII
Manduria (Taranto, IT)	<p><i>This earthquake was so terrible that the bell tower of the main church collapsed, as well as the church of the Servite fathers ... with many buildings and houses, and a pregnant woman died under stones</i></p>	<p>Saracino (1744), in: Margottini (1981)</p>	VIII

Table 6 continued

Locality	Brief description	Reference	I (MCS) current work
MCS intensities evaluation of 1743 earthquake			
Mesagne (Brindisi, IT)	The earthquake caused severe damage: many houses and public and religious buildings suffered collapses or became uninhabitable	Margottini (1981), De Simone (1993), Guidoboni et al. (2007)	VIII
Oria (Brindisi, IT)	The earthquake caused severe damage to the houses and the main church of the village	Margottini (1981), Guidoboni et al. (2007)	VIII
Racale (Lecce, IT)	The earthquake caused severe damage and partial collapse in the majority of the houses of the village. The main church was badly damaged and partly collapsed	Serio and Santantonio (1983), Guidoboni et al. (2007)	VIII
Salve (Lecce, IT)	The earthquake damaged almost all the buildings, some collapsed and others resulted significantly damaged	Cardone (1969)	VIII
Tuturano (Brindisi, IT)	The earthquake damaged houses, the tower and the mill of the village	ASB Notarial archive 1745, Guidoboni et al. (2007)	VIII
Calimera (Lecce, IT)	The Immacolata church was rebuilt after the 1743 earthquake	http://www.viveresalento.info/p/calimfi/cult.asp	VII
Castignano del Capo (Lecce, IT)	The earthquake severely damaged the parish church so as to make it unfit for use	Parish Archive of Castignano del Capo, Margottini (1981), Guidoboni et al. (2007)	VII
Copertino (Lecce, IT)	The earthquake significantly damaged two churches that had to be repaired and consolidated	Guidoboni et al. (2007)	VII
Lecce (IT)	The earthquake was clearly felt but did not cause collapses or casualties, damage and injuries were recognized many houses, churches and convents	Notary F. A. Piccinni (1908), Camarda (1997), Margottini (1981)	VII
Ostuni (Brindisi, IT)	The Church of St. Francis of Assisi was rebuilt after 1743, following the earthquake that damaged it seriously	http://www.webdiocesi.chiesacattolica.it , http://www.ostuni.tv/PortNotizie.htm	VII
Secilì (Lecce, IT)	The earthquake caused great damage to the church annexed to the Carmelite monastery	http://win.associazioneitaloellenica.org/SECLJ_ROSSANA.HTM	VII

Table 6 continued

MCS intensities evaluation of 1743 earthquake			
Locality	Brief description	Reference	I (MCS) current work
Napoli (IT)	<i>...there was one significant earthquake, which lasted for many minutes of time ...the motion, however, was wavelike and horizontal, so neither happened any pain, nor any damage</i>	ASN, State Councillor, Duke of Salas (1743) Napoli	V
English translations of original texts from archival sources are written in italics. In parentheses are the province and the country of each locality			
ASB Archivio di Stato di Brindisi, ASL Archivio di Stato di Lecce, ASN: Archivio di Stato di Napoli, ACN Archivio della Cattedrale di Nardò, BAD Biblioteca Arcivescovile di Brindisi "A. De Leo"			

revaluated intensity values with a brief description of the felt reports, the damage level, the main archival sources and the recent literature consulted, are listed.

The most damaged town by the 1743 earthquake was Nardò, to which the X MCS intensity value was assigned. Many coeval accounts attest the high degree of damage suffered by the town and the high number of deaths (Table 6).

Accordingly, it has been possible to attribute the value of $I = IX$ MCS to the town of Francavilla Fontana (Table 6), because in this town many edifices and churches were destroyed and many casualties occurred, as witnessed by reliable local chroniclers (Leo 1743).

Also the city of Brindisi has been evaluated with an intensity $I = IX$, on the basis of the heavy damages suffered, as reported in the chronicle of the mayors of the city, by the priest and eyewitness Nicola Scalese (Cagnes and Scalese 1743) (Table 6). Moreover, a value of VIII MCS has been attributed to the towns of Leverano, Manduria, Mesagne, Oria, Racale, Salve and Tutturano and VII MCS to Calimera, Castrignano del Capo, Copertino, Lecce, Ostuni and Seclì. Furthermore, the Maltese Islands, Malta and Gozo, have been classified with a MCS intensity $I = VIII$ due to the severe damages (De Soldanis, 1746).

In the city of Naples ($I = V$ MCS), far from the Salento area more than 300 km, according to the Duke of Salas, Secretary of State in the Kingdom of Naples, the earthquake was significant, but without damage (Fig. 3).

6 Environmental effects of the 1743 earthquake

For a comprehensive evaluation of the 1743 earthquake, it is essential to take into account both the direct information derived from archival and historical sources and also the geomorphologic data concerning the Environmental Earthquake Effects (EEEs).

Although for this earthquake the primary effects such as faults, uplift, subsidence phenomena have not been clearly recognized, neither in the ground nor in the seabed, this event triggered several secondary effects. The most important EEE was the tsunami, whose deposits consist of a series of boulders along the Adriatic coasts of the Salento Peninsula, according to Mastronuzzi and Sansò (2004) and Mastronuzzi et al. (2007) who first

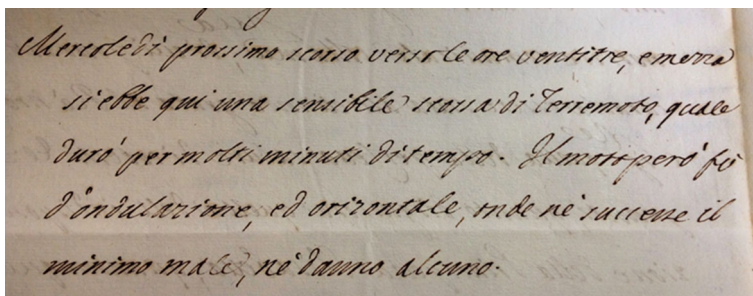


Fig. 3 Contemporary document of ASN (Archivio di Stato di Napoli). Letter from the State Councillor, Duke of Salas, to the Count Finocchietti, Naples, February, 26, 1743. Original Italian text: *Mercoledì prossimo scorso verso le ore ventitrè e mezza si ebbe qui una sensibile scossa di terremoto, quale durò per molti minuti di tempo. Il moto però fu d'ondulazione, ed orizzontale, onde nè successe il minimo male, nè danno alcuno.* English translation of original text: *The last Wednesday, at approximately 23.30, there was here a significant earthquake, which lasted for several minutes. The motion, however, was wavelike and horizontal, so neither happened the minimum pain, nor any damage*

Table 7 Environmental Earthquake Effects (EEEs) induced by the 1743 earthquake and corresponding ESI-07 intensity

Locality	Type of effect	EEE description	References	Intensity ESI-07
<i>Environmental Earthquake Effects induced by the 1743 earthquake</i>				
Torre Sant' Emiliano (Otranto, Lecce, IT)	Tsunami	Evidence of tsunami deposits consisting of large boulders, with a maximum weight of about 70 t and a run up of about 11 m	Mastronuzzi et al. (2007)	X
Brindisi (IT)	Tsunami	<i>...it was so scary that, retiring the sea, you could see fractures of the ground, and the pier of Porta Reale divided into three parts...</i>	BAD, Cagnes and Scalsese (1743), Margottini (1981)	IX
Torre Santa Sabina (Carovigno, Brindisi, IT)	Tsunami	Evidence of tsunami deposits consisting of large boulders, with a maximum weight of about 8 t and a run up of about 1.5 m	Mastronuzzi and Sansò (2004)	IX
Torre Sasso (Tricase, Lecce, IT)	Tsunami	Evidence of tsunami deposits consisting of large boulders with a maximum weight of 31 t, and a run up of about 5 m	Mastronuzzi et al. (2007)	IX
Butrinto (AL)	Liquefaction/ground cracks	<i>...and the ground opened, and it was rising up, and water and smoke come through the cracks; then it stopped...</i>	ASV b. 988, in Ambraseys (2009)	VIII
Castel Sant'Angelo (Corfù Island, GR)	Landslides	The rocky cliff on which the Castel Sant' Angelo fortress is built partly collapsed	Guidoboni et al. (2007)	VIII
Gozo (MT)	Landslides	<i>At Wardija in Qala, Gozo, the people reported that they saw the ground rise and fall with such force that the soil was left floating in the air, causing a mist like fog for a long time. Many sections from hills in Gozo crumbled from the quake</i>	De Soldanis (1746), Galea (2007)	VIII
Nardò (Lecce, IT)	Hydrological changes	<i>On the day of Wednesday, February 20, 1743, ... at 23 h a strong wind began to blow... The water in the wells was jumping and falling, ... the earth was moving like water bustles in the pot ...</i>	ASL Notary O. De Carlo, (1743a), De Simone (1993).	VIII
Kefalonia Island (GR)	Hydrological changes	<i>It has been observed that strong odours of sulphur came up from the wells</i>	Saint Sauver, 1794, in Ambraseys (2009)	VII

A brief description of the EEEs and the relative references are listed. English translations of original texts from archival sources are written in italics. In parentheses are the province and the country of each locality

ASL Archivio di Stato di Lecce, ASV Archivio di Stato di Venezia, BAD Biblioteca Arcivescovile di Brindisi "A. De Leo"

associated these boulders to the 1743 earthquake. Other secondary effects are represented by hydrological changes, landslides, liquefaction phenomena and ground cracks (Table 7).

On the basis of the 1743 EEEs, new local intensities, from VII to X ESI-07, have been assessed for 9 localities, according to the professional judgment of the authors, considering the effects description of the ESI-07 scale (Michetti et al. 2007; Audemard et al. 2015). In Table 7, the new classified localities are listed together with a brief description of the observed EEEs, by coeval chroniclers, and the main relative references.

The 1743 earthquake triggered a high-energy tsunami that produced devastating effects on the coasts of the Salento Peninsula (Maramai et al. 2014; NOAA (NGDC/WDS 2015). The tsunami effects are evidenced both by historical accounts (Fig. 4), as the withdrawal of the sea in the Brindisi harbor (Cagnes and Scalese 1743), and by the presence of large boulders found near the coastline and inland.

Two main sites of boulders accumulation have been recognized along the Otranto–Leuca coast: the Torre Sasso locality, near the village of Tricase, and the Torre S. Emiliano site (Otranto). At the first locality, boulders are spread on the coast from sea level up to 5 m of elevation, with weight up to 31 tons. In the second locality, boulders are distributed along the coastline in a belt 30 m large and 2.5 km long, with maximum weight of about 70 tons, and a run up of about 11 m (Fig. 5). At Torre Santa Sabina (Carovigno, Brindisi), the tsunami impact produced large boulders with maximum weight of about 8 tons, and a run up of about 1.5 m (Mastronuzzi and Sansò 2004; Mastronuzzi et al. 2007).

As regards other secondary environmental earthquake effects, in the town of Nardò variations of the water flow rate of wells were observed, together with changes in

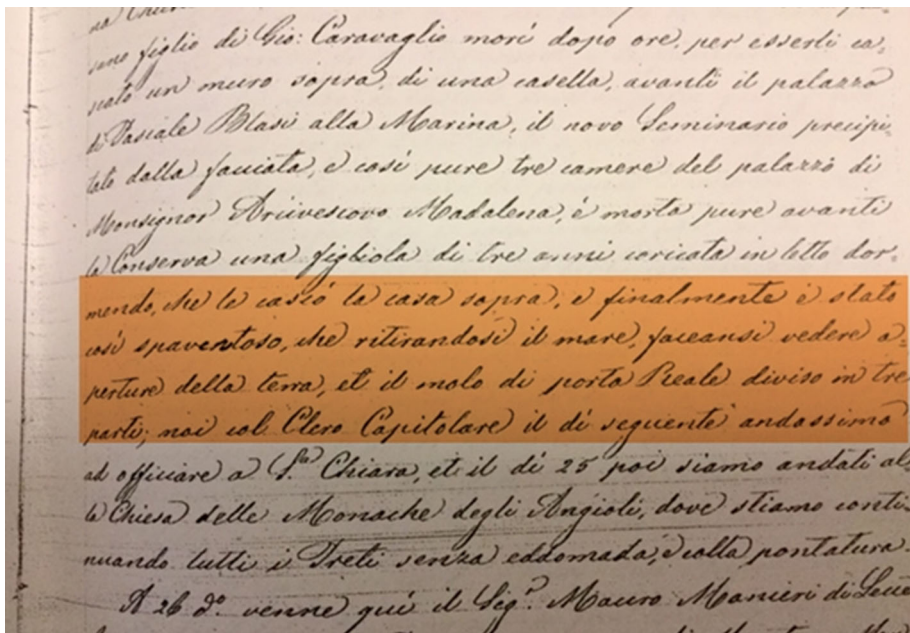


Fig. 4 Chronicle of the February 20, 1743, event, written by the mayors of Brindisi (Italy). In the orange paragraph, the original Italian text : ... è stato così spaventoso che, ritiratosi il mare, faceansi vedere aperture della terra, et il molo di porta Reale diviso in tre parti. English translation of original text: ... it was so scary that, retiring the sea, you could see fractures of the ground, and the pier of Porta Reale divided into three parts (Cagnes and Scalese 1743)



Fig. 5 Boulders attributed to the tsunami induced by the 1743 event on the Salento eastern coast (Torre S. Emiliano near Otranto (Lecce)). (Photo by S. Porfido)

chemical–physical properties of water (ASL Notarial Protocols 1743). The same effects were observed also in the northern area of the island of Kefalonia (Greece) (Saint-Sauveur, 1794, in Ambraseys 2009). Moreover, landslides were observed in the locality of Castel Sant’Angelo (Corfù, Greece), where the earthquake triggered a rockfall (Guidoboni et al. 2007), and very far from the epicentral area, in the island of Gozo (Malta) where some portions of the hill crumbled (De Soldanis 1746). Furthermore, in the neighboring of the Butrinto fortress (Albania) ruptures and probably liquefaction phenomena in the ground were detected, as reported by Mamunà, Governor of Corfù in 1743 (ASV 1743; Ambraseys 2009).

7 Discussion

The aim of this study is providing a contribution to seismic hazard assessment of the Salento Peninsula (Apulia, southern Italy) through the analysis of historical and recent seismicity, and the reassessment of the 1743 earthquake MCS macroseismic intensities. The low hazard level that characterizes nowadays the Salento Peninsula is prevalently attributed to the lack of high-level seismicity inside the area. A great effort has been made to collect all historical and instrumental seismic data, because this area, mainly marine, is surrounded by various nations, with different seismic networks whose data are available in different catalogues at present not yet completely homogeneous. Moreover, low-magnitude earthquakes of the area could not be well localized due to the small number of seismic stations of the INGV seismic network in the central and southern Apulia, until about 15 years ago. The increase in the number of seismic stations since 2000 provides the occurrence of a high number of low-magnitude earthquakes previously not localizable in the Apulia foreland (Pierri et al. 2013). The obtained epicentral map of Fig. 1 illustrates that the Salento area is seismically active characterized by an historical and instrumental

seismicity of low and moderate energy ($3 < M < 5$) that cannot be neglected. The February 20, 1743, earthquake is considered the only and strongest event ($I_0 = IX$, $M_w = 7.1$, Rovida et al. 2011) that hits the Salento area. Moreover, it is essential to remind that this area has also experienced in the past many strong earthquakes located in the Gargano Promontory (northeastern Apulia) where occurred the July 30, 1627, earthquake ($I = X$ MCS). It was also hit by strong earthquakes of southern Italy as the 1456 Campania-Lucania earthquake ($I_{max} = XI$ MCS); the 1694 Irpinia earthquake ($I_{max} = XI$ MCS); the 1857 Basilicata earthquake ($I_{max} = XI$ MCS); the July 23, 1930, Irpinia earthquake ($I_{max} = X$ MCS); and the November 23, 1980, Irpinia-Lucania earthquake ($I_{max} = X$ MCS). Several earthquakes with epicenter in the central-eastern Mediterranean (Greece, Ionian Islands, Albania) were also strongly felt in the Salento Peninsula, probably with environmental effects like tsunamis. Recently, the Kefalonia seismic event of November 17, 2015 ($M_1 = 6.5$), has caused extensive felt effects in Italy, on the Apulian and Calabrian coasts, and a tsunami-like sea level oscillation was recorded by a tide gauge station in Crotona (Ionian coast of Calabria) (Papadopoulos 2015).

In order to contribute to an updated evaluation of the seismic hazard of the Salento area, currently underestimated, the reassessment of both the 1743 macroseismic effects on man-made structures and the triggered effects in the natural environment has allowed to elaborate a quite different scenario of the 1743 earthquake, leading to other intensity values

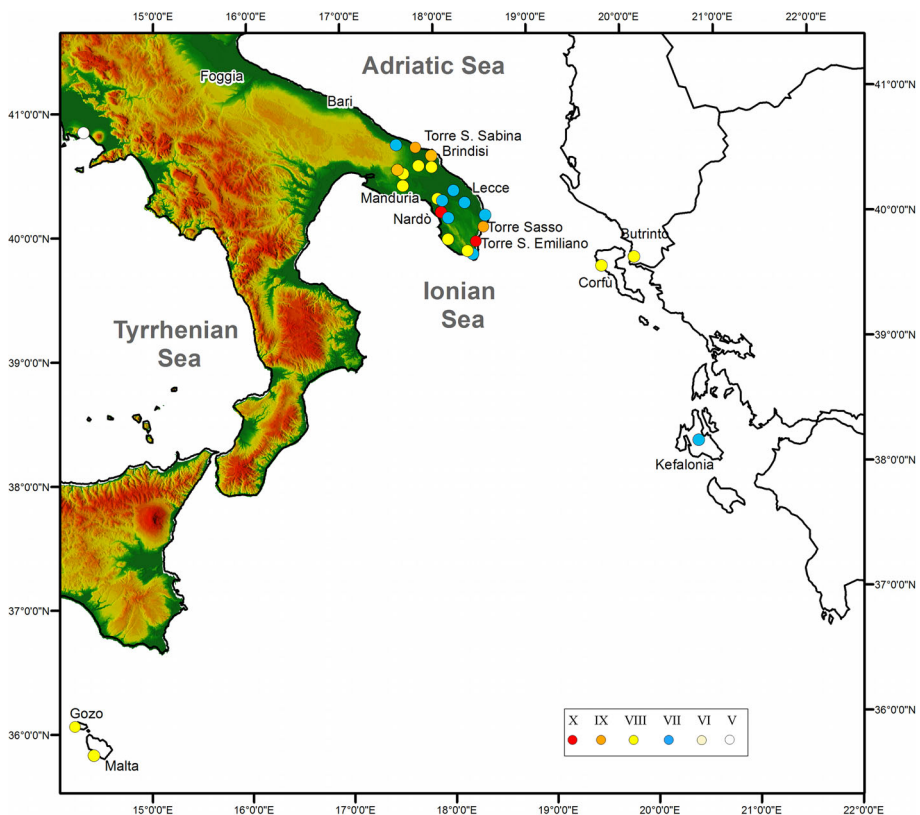


Fig. 6 Map of the intensity values of the 1743 Salento earthquake reevaluated in this paper according to the traditional MCS scale and the ESI-07 scale

Table 8 The 1743 earthquake MCS intensity values according to recent authors; in the last column, the macroseismic MCS and ESI intensities evaluated in this paper are reported

Locality	Lat N	Long E	Margottini (1981, 1985)	Guidoboni et al. (2007)	Galli and Naso (2008)	Rovida et al. (2011)	Current work
<i>Italy</i>							
Nardò (LE)	40.178	18.031	IX	IX	IX–X	IX	X
Torre S. Emiliano (LE)	40.090	18.496					X ESI
Brindisi	40.636	17.945	VIII–IX	VIII	VIII	VIII	IX ESI
Francavilla Fontana (BR)	40.529	17.583	VIII–IX	VIII	IX	IX	IX
Torre Santa Sabina (BR)	40.757	17.700					IX ESI
Torre Sasso (LE)	39.952	18.398					IX ESI
Galatina (LE)	40.175	18.168		VIII	VIII	VIII–IX	
Leverano (LE)	40.288	17.998		VIII	VIII–IX	VIII–IX	VIII
Canosa di Puglia (FG)	41.223	16.066		VIII	VIII	VIII	
Manduria (TA)	40.399	17.634	VIII	VIII	VIII	VIII	VIII
Oria (BR)	40.498	17.642	VIII	VIII	VIII	VIII	VIII
Salice Salentino (LE)	40.384	17.964		VIII	VIII	VIII	VIII
Taranto	40.458	17.246	VIII	VIII	VIII	VIII	
Carpignano S. (LE)	40.196	18.340		VII–VIII	VII–VIII	VII–III	
Corato (BA)	41.153	16.411		VII	VII–VIII	VII–VIII	
Guagnano (LE)	40.401	17.950			VII–VIII		
Leporano (TA)	40.383	17.334		VIII	VII–VIII	VII–VIII	
Madonna di Pasano (TA)	40.388	17.516		VIII	VII–VIII	VII–VIII	
Maglie (LE)	40.119	18.299		VII	VII–VIII	VII–VIII	
Messagne (BR)	40.558	17.808	VIII	VIII	VII–VIII	VII–VIII	VIII
Racale (LE)	39.959	18.094	VII	VIII	VII–VIII	VII–VIII	VIII
Salve (LE)	39.859	18.294		VIII	VII–VIII	VII–VIII	VIII
San Pietro in L. (LE)	40.307	18.129		VII	VII–VIII	VII–VIII	

Table 8 continued

Locality	Lat N	Long E	Margottini (1981, 1985)	Guidoboni et al. (2007)	Galli and Naso (2008)	Rovida et al. (2011)	Current work
Tuturano (BR)	40.544	17.946		VII	VII–VIII	VII	VIII
Vanze (LE)	40.322	18.318		VIII	VII–VIII	VII–VIII	
Alessano (LE)	39.889	18.331		VII	VII	VII	
Avetrana (TA)	40.349	17.726		VII	VII	VII	
Bari	41.106	16.846		VII	VII	VII–VIII	
Barletta (BAT)	41.318	16.279	VII	VII	VII	VII–VIII	
Calimera (LE)	40.250	18.280		VII	VII		VII
Campi Salentina (LE)	40.398	18.019		VII	VII	VII	
Castignano del C. (LE)	39.833	18.348	VIII	VII	VII–VIII	VII–III	VII
Copertino (LE)	40.271	18.048		VII	VII	VII	VII
Catanzaro	38.914	16.586		VI	VII	VII	
Gallipoli (LE)	40.055	17.988	VI	VI–VII	VII	VII	
Grottaglie (TA)	40.535	17.433		VII	VII	VII	
Lecce	40.351	18.169	VII	VII	VII	VII	VII
Lizzano (TA)	40.391	17.448		VII	VII	VII	
Masseria Li Sicuri (LE)	40.223	18.112		VII	VII		
Matera	40.665	16.607		VII	VII	VII	
Messina	38.187	15.549	VII	VII	VII	VII	
Monteparano (TA)	40.443	17.414		VIII	VII	VII–VIII	
Ostuni (BR)	40.729	17.577		VII	VII	VII	VII
Reggio Calabria	38.108	15.647	VII	VII	VII	VII–VIII	
Seclì (LE)	40.131	18.105		VII	VII		VII
Otranto (LE)	40.144	18.491		VI–VII	VII		VII
Galatone (LE)	40.147 18.070	40.147 18.070			VI–VII		
Vieste (FG)	41.882	16.179		VI	VI–VII	VI–VII	

Table 8 continued

Locality	Lat N	Long E	Margottini (1981, 1985)	Guidoboni et al. (2007)	Galli and Naso (2008)	Rovida et al. (2011)	Current work
<i>Other Countries</i>							
Amaxichi Lefkada (GR)	38.831	20.703	IX	IX	IX		
Kérkira (Corfù, GR)	39.621	19.925	IX	VIII	VIII	VIII	
Castel Sant'angelo Corfù (GR)	39.694	19.683	VIII	VIII			VIII ESI
Santa Maura Lefkada (GR)	38.848	20.715		VIII			
Préveza (GR)	38.969	20.733		VIII	VIII	VIII	
Artia (GR)	39.143	21.089		VII–VIII	VII–VIII		
Butrinto (AL)	39.752	20.026		VII–VIII	VII–VIII	VIII	VIII ESI
Gozo (MT)	36.045	14.251					VIII ESI
Ioannina (GR)	39.663	20.869		VII–VIII	VII–III		
Vonitsa (GR)	38.912	20.879		VII–VIII	VII–III	VII–VIII	
Xeromero (GR)	38.533	21.083		VII–VIII	VII–VIII		
Malta (MT)	35.833	14.417	VIII	VII	VII	VII	VIII
Zakinthos (GR)	37.794	20.875		VII	VII	VII	
Kefallinia (GR)	38.250	20.583	VII	VI–VII	VI–VII	VI–VII	VII ESI

The only localities with $I > VI$ have been included

for some localities and increasing the number of the newly classified localities, represented in this paper with a new intensity map (Fig. 6; Table 8). For both MCS and ESI-07 scales, the authors have decided to assign a well-defined unique intensity value for each locality, based on the collected data and on their professional judgment.

In Table 8, the intensity values for localities in Italy and in other countries (Greece, Albania, Malta), according to recent authors, are listed. In the last column of table, the macroseismic MCS and ESI intensities evaluated in this paper are presented. The threshold of $I > VI$ has been assumed for localities reported in our study; therefore, the city of Napoli, with a MCS $I = V$, has not been included. On the basis of a critical analysis of the 1743 intensity evaluations assigned by the various authors (Margottini 1981, 1985; Guidoboni et al. 2007; Galli and Naso 2008; Rovida et al. 2011), we have chosen to assign the felt reports by Guidoboni et al. (2007) to the localities not reevaluated in our study.

The authors emphasize that, when it has been possible to estimate two independent MCS and ESI-07 intensity values for one locality, the highest value has been chosen as final intensity, according to ESI-07 scale guidelines (Michetti et al. 2007). This is particularly evident for the town of Nardò, with X MCS final value, while the ESI-07 intensity value is VIII; in this case, the value of X has been assigned because it correctly represents the felt effects. An intensity value of IX MCS has been estimated for the city of Brindisi, also taking into account the tsunami effects. Moreover, the new intensity values assessed for the coastal localities of Torre S. Emiliano (Otranto) X ESI-07, Torre S. Sabina (Carovigno) IX ESI-07 and Torre Sasso (Tricase) IX ESI-07 are even more considerable, since these villages had no intensity evaluation before.

According to the primary historical documents quoted in this paper, the February 20, 1743, earthquake consisted in a multiple shocks sequence due to the activation of at least three distinct fault segments, within a few tens of minutes. The precise location and geometry of this complex seismogenetic source is still debated, but it was most likely nucleated offshore, in the Otranto Channel according to Galli and Naso (2008) and Rovida et al. (2011); the existence in the same area of recent instrumental seismicity like the 1974 and 1976 seismic sequences would strengthen this hypothesis.

Even results of other recent studies confirm the 1743 event complexity, since it generated a large tsunami which environmental effects are quite difficult to be interpreted and justified all over the affected areas, suggesting a probable submarine landslide off the Apulian coasts, as a possible additional source of the tsunami (Armigliato et al. 2007).

On the basis of the great damage caused by the 1743 event, and of the felt effects reported in the whole peninsular Italy, as well as in the Malta Islands, it is reasonable to hypothesize for this event a very efficient strong propagation with NW–SE preferential directivity. Indeed, the most serious macroseismic effects, as well as secondary environmental effects, were observed in an area with NW–SE rough direction (Fig. 7), including the Salento Peninsula, the western coast of Greece with the Corfù and Cefalonia islands and the Albania western coast. These effects were also observed in the Malta Islands and along the Calabria and Sicilia Ionian coasts, along NE–SW direction. In the map of Fig. 7 are plotted the MCS intensity values reevaluated in this study integrated with intensity values of other localities from CFTIMed04 (Guidoboni et al. 2007).

The total area affected by secondary environmental effects (tsunami, landslides, liquefaction and hydrological variations) useful for the determination of epicentral intensity, according to the ESI-07 scale guidelines (Michetti et al. 2007), could be approximately 30.000 km² wide; this consideration is based on the specific occurrence of hydrological changes in Nardò (Italy), as well as landslides and liquefaction, respectively, in Corfù (Greece) and Butrinto (Albania); consequently, it has been possible to hypothesize a new

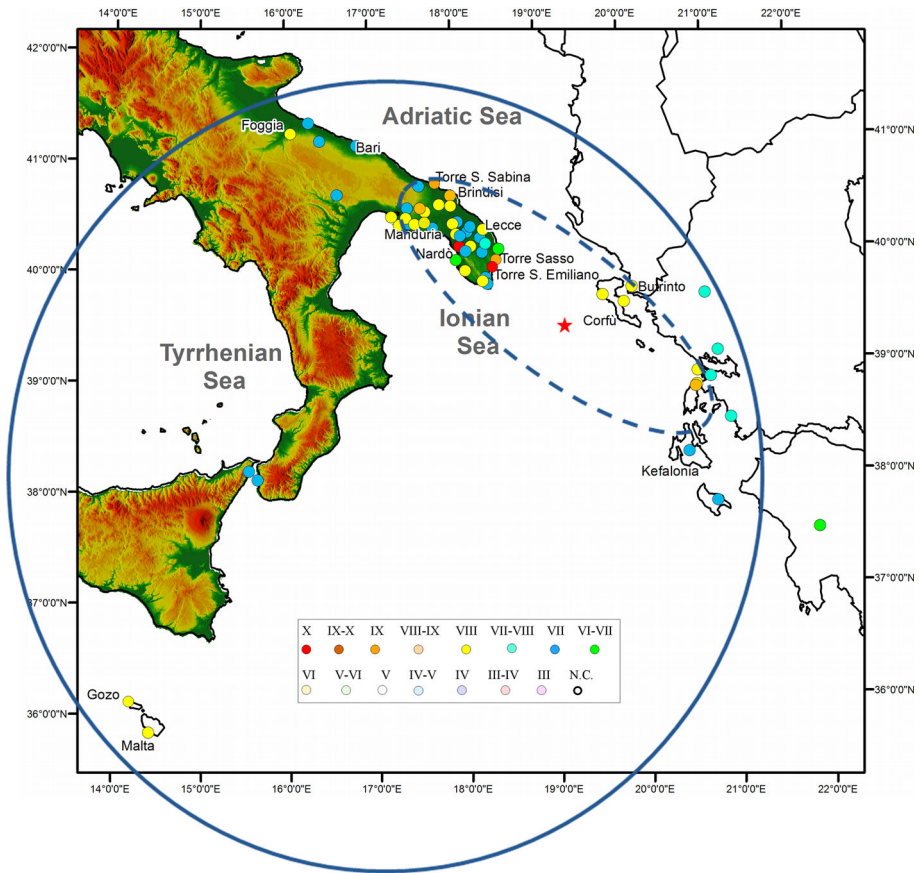


Fig. 7 Map of the intensity values of the 1743 Salento earthquake: MCS intensity values reevaluated in this study integrated with intensity values of other localities from CFTMed04 (Guidoboni et al. 2007). The red star represents the 1743 epicenter hypothesized in this paper. The dashed ellipse includes the localities with macroseismic MCS and ESI intensities $I \geq VIII$. The circle includes the localities with macroseismic MCS intensities $I > VI$

intensity value of $I_0 = XI-XII$ ESI-07 for the 1743 event. In Fig. 7, the dashed ellipse approximately includes the localities with macroseismic MCS and ESI intensities $I \geq VIII$, and its center (the red star) represents the hypothesized 1743 epicenter (Lat. N 39.44°, Long. E 19.21°). As regards the possible hypocentral depth of the 1743 earthquake, its value can be estimated of about 30 km, on the basis of the damage level detected in Salento ($I_{max} = X$, Nardò), in Greece ($I_{max} = IX$, Amaxichi), in Albania ($I_{max} = VIII$, Butrinto) and in the Malta Islands ($I_{max} = VIII$). Moreover, also the felt reports area in Italy, which extent reached the cities of Udine and Trento in northern Italy (Guidoboni et al. 2007), confirms this hypothesis. In the localities of Torre Santa Sabina, Torre Sasso e Torre S. Emiliano and Brindisi, EEE effects of intensity I between IX and X degree in the ESI-07 scale have been estimated in this paper (Table 7). According to the $I_0 = XI-XII$ ESI-07 value, also the 1743 magnitude value should be re-evaluated and estimated roughly higher than 7.1 as reported in the recent catalogues, taking also into account the paper of Biolchi et al. (2016),

where the boulders found along the Malta coasts have been related to good reliability to historically known tsunamis in the Mediterranean region, such as the 1743 earthquake.

8 Conclusions

The critical analysis of the collected documentary and historical sources, together with the geomorphologic evidences of the EEEs effects due to the strong 1743 event, has allowed us to re-evaluate this earthquake and remodel a quite different scenario, useful to the seismic hazard assessment of the Salento Peninsula.

The most relevant results of this study are:

1. the Salento Peninsula should not be considered a low seismic hazard area as above-discussed issues;
2. a new assessment of the intensity values for 25 localities with a MCS $I > VII$; moreover, a new value of $I = V$ MCS was assigned to the city of Naples (Table 8);
3. a new map of the MCS intensity values of the 1743 Salento earthquake according to the traditional MCS scale and the ESI-07 scale (Fig. 6). In particular, X MCS has been assigned to the city of Nardò previously evaluated IX MCS and IX–X MCS by other authors (Table 8); IX MCS to the city of Brindisi, also taking into account the tsunami effects, previously estimated VIII–IX MCS and VIII MCS (Table 8). Moreover, the new intensity values assessed for the coastal localities of Torre S. Emiliano (Otranto) X ESI-07, Torre S. Sabina (Carovigno) IX ESI-07 and Torre Sasso (Tricase) IX ESI-07 are even more considerable, since these villages had no intensity evaluation before;
4. a contribution to improve the uncertainty of the 1743 epicenter that, in this paper, has been located offshore (Fig. 7) in the Otranto Channel (Lat. N 39.44°, Long. E 19.21°);
5. the re-evaluation, on the basis of ESI-07 scale, of the 1743 $I_0 = XI$ value which would also require the re-evaluation of the magnitude that would be underestimated.

In conclusion, this study highlights that the seismic hazard of the Salento Peninsula, currently classified in IV category (Seismic Classification Map of the Italian territory; MPSO4—Order PCM 3519/2006), should be re-evaluated taking into account also the local effects due to the distant and strong earthquakes located in the central Mediterranean, and the relative damages on the urban structure and on the natural environment. Moreover, it is also important to remind, as regards the local risk level, that the Salento Peninsula represents one of the most crowded touristic destinations of the southern Italy, all over the summer season.

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