The Euro-Mediterranean Tsunami Catalogue

Alessandra Maramai*, Beatriz Brizuela, Laura Graziani

Istituto Nazionale di Geofisica e Vulcanologia, Rome, Italy

Article history
Received November 6, 2013; accepted July 16, 2014.
Subject classification:
Tsunami, Euro-Mediterranean region, Data dissemination, Collections, Catalogue.

ABSTRACT

A unified catalogue containing 290 tsunamis generated in the European and Mediterranean seas since 6150 B.C. to current days is presented. It is the result of a systematic and detailed review of all the regional catalogues available in literature covering the study area, each of them having their own format and level of accuracy. The realization of a single catalogue covering a so wide area and involving several countries was a complex task that posed a series of challenges, being the standardization and the quality of the data the most demanding. A "reliability" value was used to rate equally the quality of the data for each event and this parameter was assigned based on the trustworthiness of the information related to the generating cause, the tsunami description accuracy and also on the availability of coeval bibliographical sources. Following these criteria we included in the catalogue events whose reliability ranges from 0 ("very improbable tsunami") to 4 ("definite tsunami"). About 900 documentary sources, including historical documents, books, scientific reports, newspapers and previous catalogues, support the tsunami data and descriptions gathered in this catalogue. As a result, in the present paper a list of the 290 tsunamis with their main parameters is reported. The online version of the catalogue, available at http://roma2.rm.ingv.it/en/facilities/data_bases/52/catalogue_of_the_euro-mediterranean_tsunamis, provides additional information such as detailed descriptions, pictures, etc. and the complete list of bibliographical sources. Most of the included events have a high reliability value (3= "probable" and 4= "definite") which makes the Euro-Mediterranean Tsunami Catalogue an essential tool for the implementation of tsunami hazard and risk assessment.

1. Introduction

In the last two decades the interest of the scientific community in tsunami studies has increased significantly, especially in terms of hazard assessment and risk reduction. The occurrence of catastrophic Indonesian (2004) and Tohoku (2011) tsunamis lighted out the necessity of taking adequate countermeasures to protect coastal areas from this threat and implementing tsunami warning systems in all the regions prone to tsunami. In this context, the attention of scientists was also drawn on the European area where the tsunamigenic hazard was for long time underestimated. The European Union answered this demand by financing scientific projects on tsunami research in the European-Mediterranean (EM) area, in order to develop strategies for tsunami risk reduction.

One of the last EU financed project was TRANSFER (Tsunami Risk ANd Strategies For the European Region, 2006-2009), which aimed to improve the knowledge of tsunami processes within the EM area, in particular assessing the risk associated with tsunami and establishing risk methodologies and risk reduction policies, from prevention to mitigation. The project covered the whole Mediterranean basin, the north-eastern Atlantic, the North Sea and the Marmara and Black Seas and it maintained the continuity with the previous European projects such as GITEC and GITEC-TWO One of the main goals of the project was the upgrading of the GITEC-TWO tsunami catalogue that covers the same area and that was the result of efforts of various European research groups co-operating in the previous EU projects.

At the end of the TRANSFER project several regional tsunami catalogues were published. Nevertheless, despite the efforts made in the frame of all EU projects, a unified tsunami catalogue for the EM area, containing homogeneous and equally graded and rated data, has not been published yet.

Since a reliable and unified tsunami catalogue is an essential tool for the implementation of hazard and risk studies, in this work we present a Euro-Mediterranean Tsunami Catalogue (hereafter indicated as EMTC), as a result of the analysis of all the catalogues available in literature covering the study area, including the regional catalogues delivered in the frame of the TRANSFER project. An online version of the EMTC catalogue, where an interactive map allows the user to retrieve more details on each event, has also been realised. The online version is available at http://roma2.rm.ingv.

it/en/facilities/data_bases/52/catalogue_of_the_euro-mediterranean_tsunamis.

2. The European-Mediterranean Tsunami Catalogue

The realization of a single catalogue covering a vast geographical area and involving several countries is a complex task, a lot of work was done during this study to achieve a reliable tool. The EMTC is the result of a systematic revision of several data sets (see Table 1) characterized by different formats and levels of accuracy. In some cases the available catalogues covered geographical areas that partially overlapped and, therefore, sometimes for the same tsunami event discordant references or data were published. Moreover, it has to be mentioned that for some areas well compiled tsunami catalogues were already available and in these cases most of the work consisted in updating and adding details. In other regions the existing tsunami catalogues were very poor and scarcely documented, when that was the case, the necessity of consulting as much as original sources as possible was a fundamental matter.

Catalogue	ID code
Jørstad 1968	J68
Papadopoulos and Chalkis 1984	PC84
Papadopoulos 2000	P00
Soloviev et al. 2000	S00
Papadopoulos 2001	P01
Maramai et al. 2003	M03
Papadopoulos 2003	P03
Tinti et al. 2004	T04
Yalciner et al. 2004	Y04
Guidoboni and Comastri 2005	GC05
Papadopoulos and Fokaefs 2005	PF05
Sbeinati et al. 2005	SB05
Andrade et al. 2006	AN06
Long and Wilson 2007	LW07
Fokaefs and Papadopoulos 2007	FP07
Papadopoulos et al. 2007	P07
Salamon et al. 2007	S07
Yolsal et al. 2007	Y07
Baptista and Miranda 2009	BM09
Kaabouben et al. 2009	KA09
Papadopoulos et al. 2010	P10
Papadopoulos et al. 2011	P11
Altinok et al. 2011	A11
Lambert and Terrier 2011	LT11
Salamon et al. 2011	SA11
IGN 2013	IGN

Table 1. List of the examined datasets. The acronyms "ID code" are used in Appendix 2.

The revision consisted in examining each tsunami event contained in the above mentioned data sets, applying uniform criteria to evaluate the information sources and parameterize the data in order to establish a standard format and structure. Based on the invaluable work done by national groups of experts during the GITEC, GITEC-TWO and TRANSFER projects the first step was the analysis of the bibliographical sources in order to get information on the generating cause, on the accuracy of the tsunami description and on the quality of the sources themselves, to ascertain if the event was worthy of being included in the EMTC. In other words, to each event a *reliability* value has been attributed following the criteria suggested by Tinti et al. [2004].The reliability value ranges from degree 0 ("very improbable tsunami") to degree 4 ("definite tsunami"), as shown in Table 2. Once the reliability of the event was rated, the tsunami was inserted in the catalogue.

The EMTC reports, for each tsunami, information on the main parameters of the event (date, region, subregion, reliability, tsunami intensity, run-up) and of the generating cause (i.e. geographical coordinates, earthquake magnitude, intensity, focal depth, etc.) as well as detailed descriptions of the tsunami effects in the affected localities. As far as concern the tsunami intensity, for each event the authors, based on the available descriptions, assigned the maximum intensity value according to the 6-degree Sieberg-Ambraseys scale [Ambraseys 1962]. Intensity values on the Papadopoulos-Imamura 12-degree scale were also assigned to the EMTC events, [Papadopoulos and Imamura 2001] it is important to notice that this intensity scale has been calibrated to modern coastal environments, therefore does not provide accurate information when evaluating historical events.

The EMTC gathers events occurred within the EM area, a large region that comprehends countries facing the Mediterranean Basin, the north-eastern Atlantic coast, the North Sea, the Norwegian Sea, the Marmara Sea and the Black Sea coasts. Following the GITEC-TWO and TRANSFER nomenclature, the EM area was divided into seven regions, namely NW (Norwegian Sea), NS (North Sea), AT (Atlantic Ocean), M3 (western Mediterranean), M2 (central Mediterranean), M1 (eastern Mediterranean), BS (Black Sea). Each region was divided into several sub-regions that represent the geographical areas where the events originated (Figure 1).

Reliability	Description	Cause	Tsunami	Sources
4	Definite tsunami	✕	✕	✕
3	Probable tsunami	✕	✕	/
2	Questionable tsunami	✕	/	✕
		/	✕	✕
		□	✕	✕
1	Improbable tsunami	✕	/	/
		/	✕	/
		□	✕	/
0	Very improbable tsunami	/	/	✕
		/	/	/
		□	/	✕
No	No tsunami		All other combinations	

Table 2. Reliability Scale used in the EMTC (from Tinti et al. [2004]). ✕ : fulfilled condition; / :partially fulfilled condition; □ : not fulfilled condition.

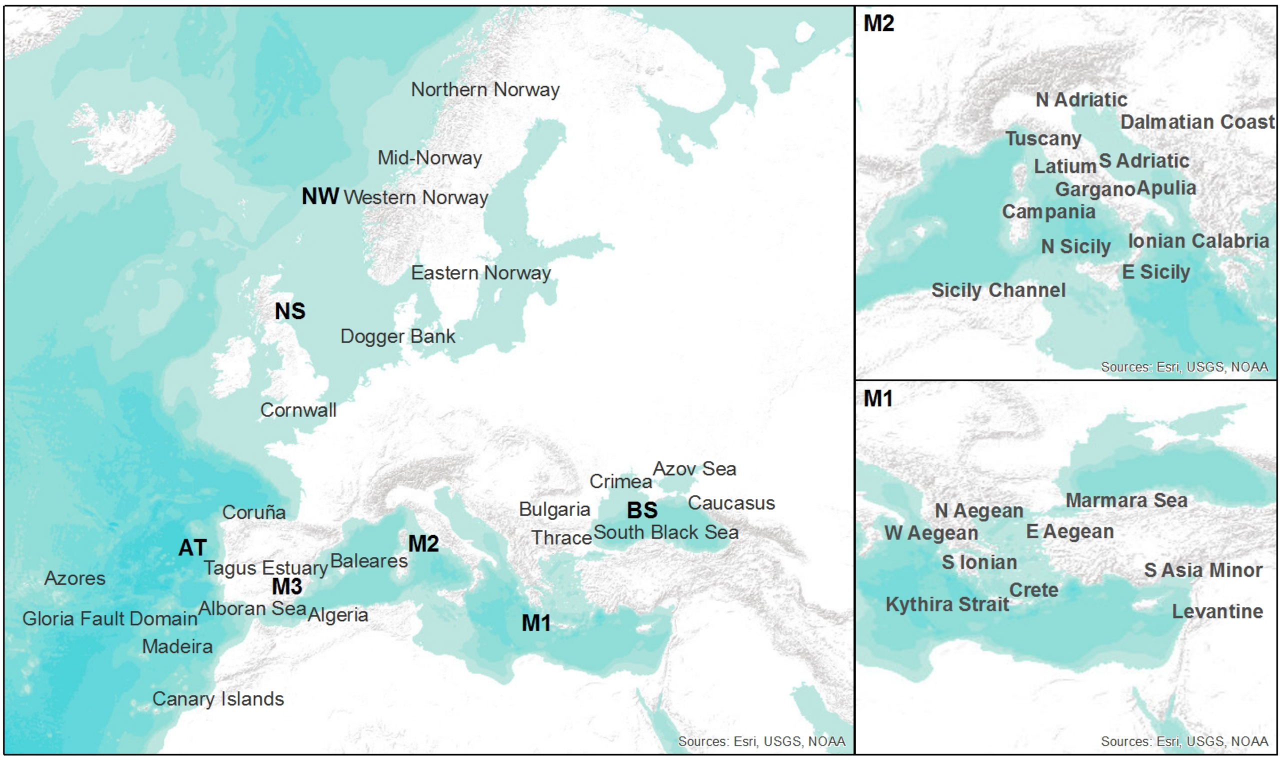

Figure 1. Geographical regions and sub-regions included in the EMTC.

In Appendix 1 the list of tsunamis contained in the EMTC is shown.

Further information, like detailed descriptions of each event, the full list of the bibliographical sources used in EMTC compilation, as well tide-gauge records, maps and pictures (when available) can be consulted at the following website http://roma2.rm.ingv.it/en/facilities/data_bases/52/catalogue_of_the_euro-mediterranean_tsunamis.The EMTC contains 290 tsunamis (Figure 2) occurred since 6150 B.C. (the Storegga event) to present days. The first event that was mentioned in coeval bibliographical sources is the 479 B.C. west Aegean tsunami.

The NW region presents a very low seismic activity and the 18 tsunamis that hit this area were triggered by gravitational phenomena occurred in fjords. Generally speaking, tsunamis generated by landslides usually strike severely local areas but do not propagate regionally, moreover, when they occur in fjords, their effects are amplified by the funnel bathymetry. This is the case

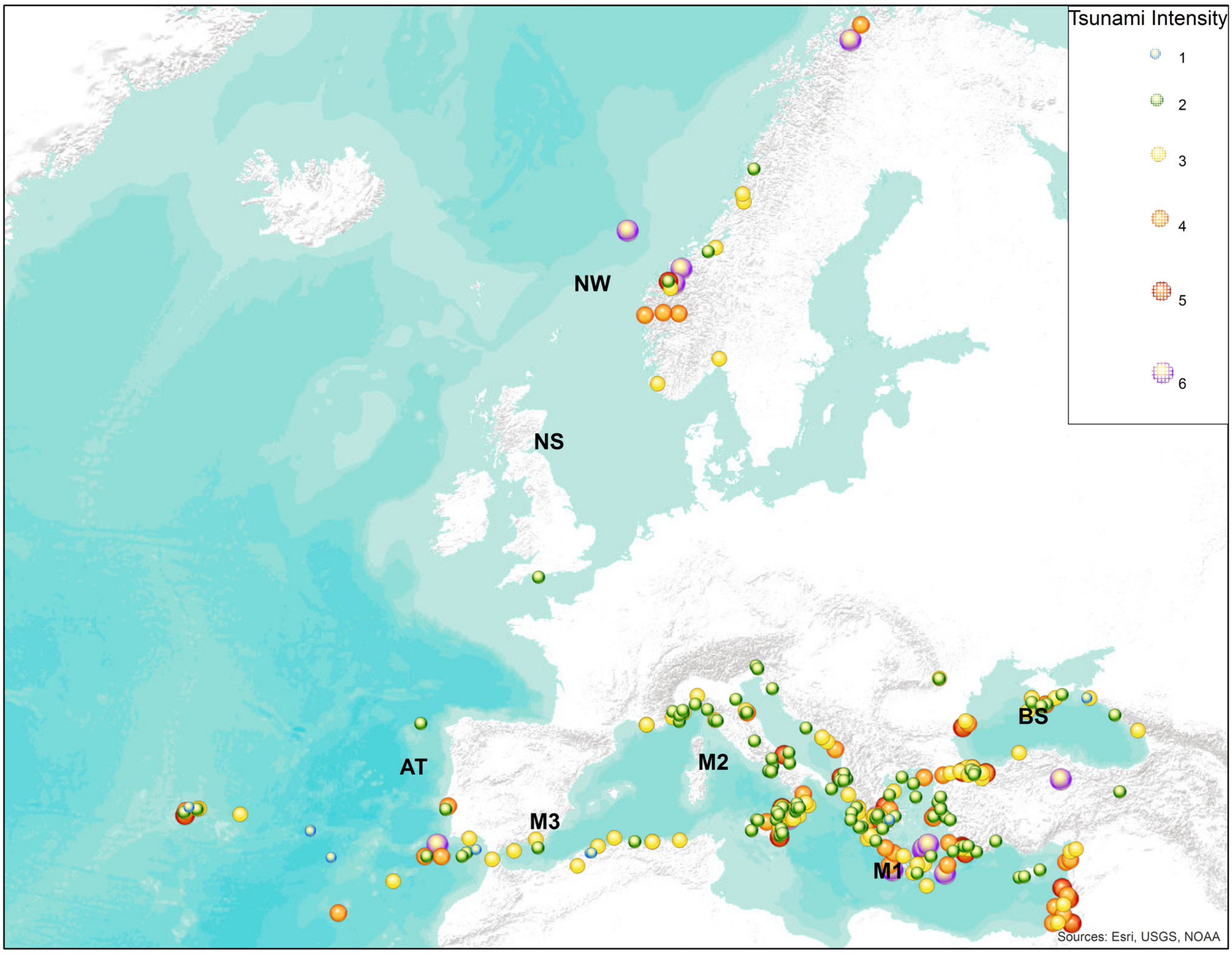

Figure 2. Geographical distribution of tsunamis reported in the EMTC.

of the 1731 tsunami when more than 100,000 cubic meters of rocks sliding down from the mountain Rammerfjell into the fjord Storfjorden. The run-up height was more than 70 m, causing extensive damage and 17 casualties [Jørstad 1968].

The NS region, like the NW, is characterized by a scarce seismicity and only one event has been documented with improbable tsunami effects.

In the AT region 27 tsunamis are listed, most of the events are associated with moderate to large earthquakes and among them the strongest and better studied is the Lisbon November 1st, 1755, tsunami. The analysis of historical events in this region highlighted that a large number of tsunamis had local effects but some events propagated regionally and, in certain cases, Atlantic widely. As a matter of fact, those events are associated to strong earthquakes, sometimes exceeding magnitude 8, occurred at the Eurasia-Nubia plate boundary [Baptista and Miranda 2009].

The Mediterranean basin was divided into three large regions: eastern (M1), central (M2) and western (M3).

M1 is definitely the most tsunamigenic region of the EM area, with a total of 127 tsunamis occurred along the coasts of Albania, Greece, Levantine countries and Marmara Sea. Almost all tsunamis were generated by earthquakes and within this region is located the most threatening tsunamigenic source, the Hellenic Arc, capable of triggering powerful basin-wide tsunamis. In 1303 this source generated a very large tsunamigenic earthquake (Me= 8) that ruptured the eastern segment of the Hellenic Arc between Crete and Rhodes islands. Tsunami waves struck the coast of Egypt, Israel and Turkey [Ambraseys et al. 1994, Guidoboni and Comastri 2005, Papadopoulos et al. 2007, Yolsal et al. 2007, Ambraseys 2009]. In the M1 region another relevant tsunamigenic source is the North Anatolian Fault zone, capable of generating destructive earthquakes, like the August 1999 shock (Mw= 7.4) that triggered a damaging tsunami in the Izmit Bay: there was a complicated combination of waves caused by submarine faulting and multiple coastal landslides [Alpar 1999, Yalciner et al. 2000].

The Mediterranean coast of France, the Italian and Croatian coasts are included in the M2 region, with 81 tsunami events mainly concentrated along the Italian coasts. This region is one of the most tsunamigenic in the EM area and the majority of tsunamis were triggered by earthquakes. Generally speaking, tsunamis observed in the M2 region were local and sometimes destructive, like 1627 Gargano (Apulia) event, the 1667 Croatian tsunami, and the 1783 Calabrian tsunamis. In other cases, like the 1693 eastern Sicily and the catastrophic 1908 Messina events, tsunami waves propagated regionally; in 1908 waves propagated northward reaching the Latium coast and southward hitting the coasts of Malta [Platania 1909, Baratta 1910, Camilleri 2006]. In addition, M2 is the only region in which a relevant number of tsunamis are associated with volcanic activity, specifically eruptions and gravitational phenomena related to the Vesuvius and the Aeolian volcanoes (Stromboli and Vulcano), followed by the M1 region, in which the volcanic triggered tsunamis are related to the Thera (Santorini) activity.

The M3 region covers the coasts of Algeria, Baleares islands and the Spanish coasts facing the Alboran Sea. The majority of the 13 events of this region were generated by the Tell-Atlas thrust system, which accommodates a significant portion of the Africa-Europe convergence in the western Mediterranean and is capable of generating strong earthquakes and trigger basin wide tsunamis [Aoudia and Meghraoui 1995, Aoudia et al. 2000, Meghraoui et al. 2004].

The BS region includes the Crimean coasts and the Bulgarian coast facing the Black Sea. In this region all the 23 events were generated by earthquakes. The majority of the tsunamis were very weak, only recorded by tide gauges. The most significant event was the September 1968, triggered by a submarine earthquake, which flooded the coast at Amasra for about 100 m dragging some boats [Lander 1969, Altinok and Ersoy 2000].

3. The online version of the EMTC

Aiming to present a detailed version of the EMTC we also prepared an online interactive map that allowed us to insert for each event a larger number of information, such as detailed descriptions of the tsunami effects in the affected localities, tide-gauge records, pictures and maps for the most relevant events and the full list of the 870 bibliographical sources used during the EMTC compilation. The online version of the EMTC is available at http://roma2.rm.ingv.it/en/facilities/data_bases/52/catalogue_of_the_euro-mediterranean_tsunamis. All the 290 events have been uploaded in a public ESRI map by means of which the user can have access to the data available for each tsunami event.

In Figure 3 an example of a typical screen that the user would find when consulting the online version is reported. The window shows the geographical location of the event, a pop-up with all the available parameters and a link to the detailed description of each event.

4. Discussion

The EMTC contains 290 tsunamis occurred in the EM region. As expected, the majority of the events have seismic origin (83%), mainly triggered by submarine earthquakes and less frequently by earthquakes located in land. A small number of seismic generated tsunamis (17 events) were caused by gravitational phenomena induced by earthquakes (sub aerial or submarine landslides).

Tsunamis caused by mass failures due to mere gravity load account for the 9% of the 290 events and are mainly located in the NW region, associated to

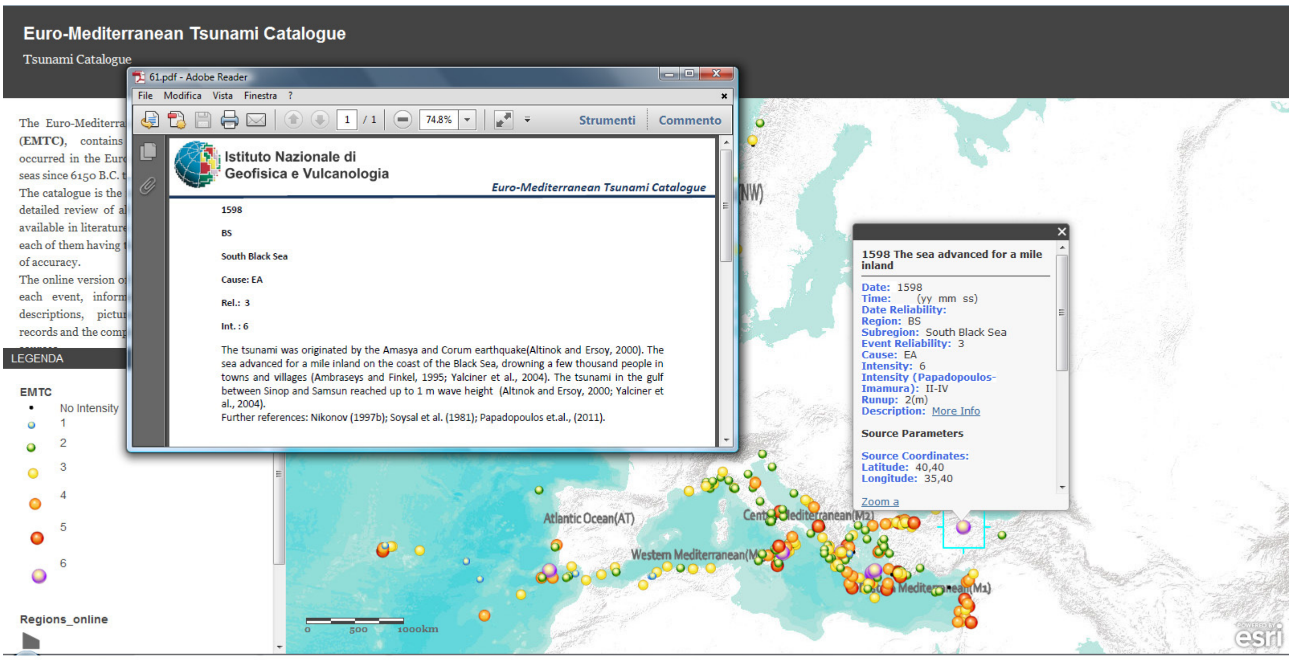

Figure 3. Example of the online version of the EMTC.

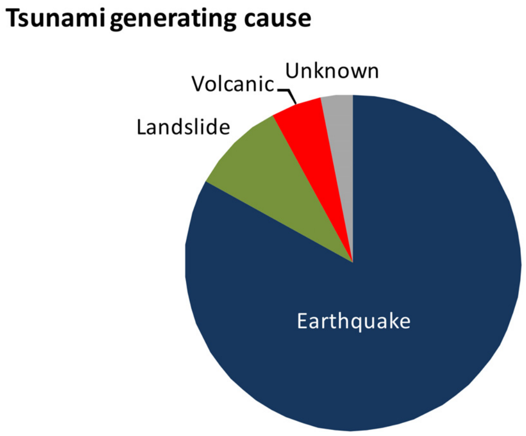

Figure 4. Distribution of the tsunamis in the EMTC by generating cause.

slope instability in fjords. Few tsunamis (less than 5%) are engendered by volcanic activity, for the most part caused by the Vesuvius and Aeolian islands volcanoes in the M2 region. Finally, the generating cause of the 3% of the tsunamis is unknown; in these cases the reported description is typical of a tsunami but the generating mechanism has not been found. In Figure 4 a pie chart showing the tsunamigenic causes is reported.

As mentioned before, the tsunami *reliability* has a key role in the EMTC catalogue because it is an indicator of the quality of the data, so that in one hand it allows the end user to decide how much the data retrieved are trustworthy and on the other hand, it allows the catalogue editor to insert historical tsunamis for which data are quite scarce and the correspondingly uncertainties are many. The former prevents from avoiding loss of historical events which is confirmed by the trend shown in Figure 5, where the number of reliable tsunamis increases in time to the detriment of less reliable events. It can be observed that most entries in the EMTC are "definite" or "probable" tsunamis, having been attributed reliability values of 4 or 3. In addition, the trend of Figure 5 shows that in the last three centuries the total number of entries tends to be stable while prior to 1700 the EMTC is far from being complete.

In order to get a glimpse on the severity of the tsunamis within the EM area, the intensity frequency histogram for each region is shown in Figure 6. According to the Sieberg-Ambraseys [Ambraseys 1962] intensity scale, the intensity 3 represent the threshold for which tsunamis are capable of producing some damage to boats and light coastal structures while strong damage can be observed starting from intensity 4. The total number of tsunamis with intensity I ≥ 4 in the whole EM region is 85 and more than half of these events occurred in M1. Regarding the M3 region, it is interesting to highlight that despite the low intensity tsunamis occurred there, most of them propagated regionally as can be seen in the event descriptions included in the online version of the EMTC.

5. Discarded events

The EMTC is the result of a scrupulous revision of several tsunami catalogues, performed following a series of systematic criteria suggested by Tinti et al. [2004] to evenly rate the events. Those events that did not fulfill the requirements of the revision were discarded and collected in a separate table in order to keep track of them and to explain the reasons of the exclusion. The lack of detailed and reliable description on tsunami effects is the most common cause of event exclusion, followed to a lesser extent by meteorological phenomena, duplication and false events. As far as concern the most common cause, the *No tsunami description* category means that 1) the description available in the consulted sources clearly indicates that the event is a "seaquake" (that is a strong push felt on board ship due to the propagation of seismic P-waves through the sea water) or is related to subsidence/bradyseism and/or 2) the event is not sufficiently documented and needs further investigations.

The total number of discarded events is 248: 164 belong to the *No tsunami description* category and most of them occurred in the M1 region, 26 belong to the *Duplicate* category, 55 can be classified as *Meteorological events* (including storm surges and meteotsunamis) and they are mainly located in the M2 region specifically in Liguria-Côte d'Azur sub-region. Finally, 2 are *False event*. The full list of the discarded events is shown in Appendix 2.

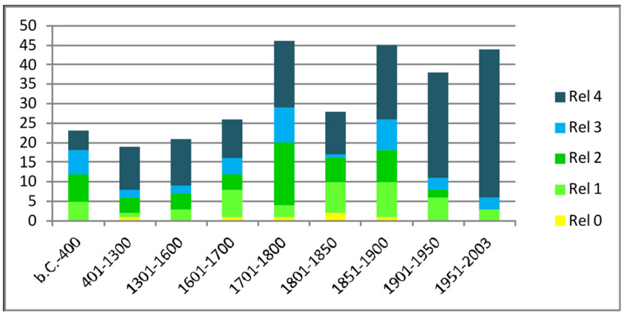

Figure 5. Time distribution of the tsunamis per reliability classes.

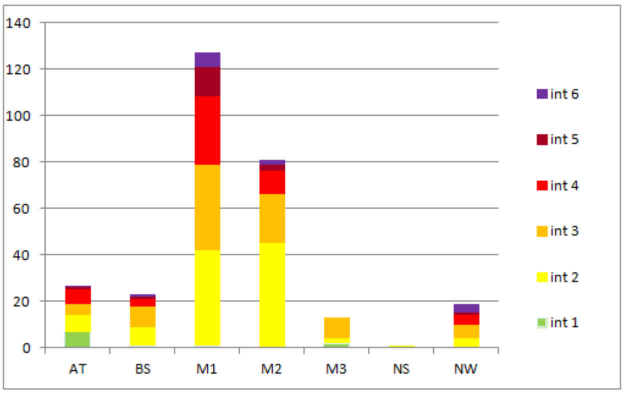

Figure 6. Regional distribution of the tsunamis per intensity classes.

6. Conclusions

The EMTC was created to fulfill the need of having a single tsunami catalogue covering the geographical area of the Euro-Mediterranean region. It is the result of the gathering and systematic revision of several data sets available in literature and its worthiness lie on the fact that for the first time tsunami events occurred in the EM region have been judged with uniform criteria. The EMTC counts 290 tsunamis and spans a time interval ranging from the 6150 B.C. Storegga event to the 2004 Liguria-Côte d'Azur tsunami. About 900 bibliographical sources (including contemporary chronicles, catalogues, historical reports, books, newspapers, specific monograph and scientific articles) support the tsunamis inserted in the EMTC and most of the entries have a high level of reliability (3-4), which indicates the good quality of the available information. Several factors, such as doubtful generating causes, lack of tsunami description and scarcity of bibliographical sources, account for the low reliability value of some events. The reliability value of those events could be improved in case of retrieval of further data. Following the same logic, some of the discarded events could be upgraded to tsunamis and thus inserted in the EMTC.

Finally, the online version of the EMTC provides a geographical context by including interactive maps that allow displaying supplementary information such as detailed descriptions and, when available, tide-gauge records, pictures and photos.

Acknowledgements. The authors thank Prof. Stefano Tinti, Dr. Alberto Armigliato and Dr. Sara Gallazzi (Università di Bologna, Italy) for their valuable contribution. We would also like to thank Dr. Adriano Azzarone (INGV) for providing technical support and finally a special thank to the referees for their suggestions to improve this paper.

References

Alpar, B. (1999). Underwater signatures of the Kocaeli earthquake (August 17th, 1999), Turk. J. Mar. Sci., 5, 111-129.

Altinok, Y., and S. Ersoy (2000). Tsunamis Observed on and Near the Turkish Coast, Nat. Hazards, 21, 185-205.

Altinok, Y., B. Alpar, N. Özer and H. Aykurt (2011). Revision of the tsunami catalogue affecting Turkish coasts and surrounding regions, Nat. Hazards Earth Syst. Sci., 11, 273-291.

Ambraseys, N. (1962). Data for the investigation of the seismic sea waves in the Eastern Mediterranean, B. Seismol. Soc. Am., 52, 895-913.

Ambraseys, N.N., C.P. Melville and R.D. Adam (1994). The seismicity of Egypt, Arabia and Red Sea: A Historical Review, Cambridge, 181 pp.

Ambraseys, N.N. (2009). Earthquakes in the Mediterranean and Middle East. A Multidisciplinary Study of Seismicity up to 1900, Cambridge Univ. Press, Cambridge, UK, xx + 947 pp.

Andrade, C., P. Borges and M.C. Freitas (2006). Historical tsunami in the Azores archipelago (Portugal), J. Volcanol. Geoth. Res., 156 (1-2), 172-185.

Aoudia, A., and M. Meghraoui (1995). Seismotectonics in the Tell Atlas of Algeria: the Cavaignac (Abou El Hassan) earthquake of 25.08.1922 (Ms = 5.9), Tectonophysics, 248 (3-4), 263-276.

Aoudia, A., F. Vaccari, P. Suhadolc and M. Meghraoui (2000). Seismogenic potential and earthquake hazard assessment in the Tell Atlas of Algeria, J. Seismol., 4, 79-98.

Baptista, M.A., and J.M. Miranda (2009). Revision of the Portuguese catalog of tsunamis, Nat. Hazards Earth Syst. Sci., 9, 25-42.

Baratta, M. (1910). La catastrofe sismica calabro-messinese del 28 dicembre 1908, Relazione alla Società Geografica Italiana, 2 voll., 458 pp.

Camilleri, D.H. (2006). Tsunami construction risks in the Mediterranean - outlining Malta's scenario, Disaster Prevention and Management, 15 (1), 146-162.

Fokaefs, A., and G.A. Papadopoulos (2007). Tsunami hazard in the Eastern Mediterranean: strong earthquakes and tsunamis in Cyprus and the Levantine Sea, Nat. Hazards, 40 (3), 503-526.

Guidoboni, E., and A. Comastri (2005). Catalogue of earthquakes and tsunamis in the Mediterranean area from the 11th to the 15th century, INGV-SGA, Bologna, 1037 pp.

IGN (2013). Instituto Géografico National. Catálogo de tsunamis de las costas españolas; http://www.02.ign.es/ign/layoutIn/sismologiaTsunamisCostasEspanolas.do (last access, September 2013).

Jørstad, F.(1968). Waves generated by landslides in Norwegian fjords and lakes, Norwegian Geotechnical Institute publ., 79, 13-31.

Kaabouben, F., M.A. Baptista, A. Iben Brahim, A. El Mouraouah and A. Toto (2009). On the moroccan tsunami catalogue, Nat. Hazards Earth Syst. Sci., 9, 1227-1236.

Lambert, J., and M. Terrier (2011). Historical tsunami database for France and its overseas territories, Nat. Hazards Earth Syst. Sci., 11, 1037-1046.

Lander, J.F. (1969). Seismological Notes - September and October 1968, B. Seismol. Soc. Am., 58, 1023-1030.

Long, D., and C.K. Wilson (2007). A catalogue of tsunamis in the UK. British Geological Survey - Marine, Coastal and Hydrocarbons Programme Commissioned Report CR/07/077, Edinburgh, 28 pp.

Maramai, A., L. Graziani and S. Tinti (2003). Updating and revision of the European tsunami catalogue, Submarine landslides and tsunamis, Proceedings of the NATO Advanced Research Workshop on Underwater, 25-32.

Meghraoui, M., S. Maouche, B. Chemaa, Z. Cakir, A. Aoudia, A. Harbi, P.J. Alasset, A. Ayadi, Y. Bouhadad and F. Benhamouda (2004). Coastal uplift and thrust faulting associated with the Mw = 6.8 Zemmouri (Algeria) earthquake of 21 May, 2003, Geophys. Res. Lett., 31, L19605; doi:10.1029/2004GL020466.

Papadopoulos, G.A., and B.J. Chalkis (1984). Tsunamis observed in Greece and the surrounding area from antiquity up to the present times, Mar. Geol., 56, 309-317.

Papadopoulos, G.A. (2000). Historical Earthquakes and Tsunamis in the Cortinth Rift, Central Greece, National Observatory of Athens, Institute of Geodynamics, publication no. 12, 128 pp.

Papadopoulos, G.A. (2001). Tsunamis in the East Mediterranean: a catalogue for the area of Greece and adjacent seas, Proc. Joint IOC/IUGG International Workshop "Tsunami Risk Assessment beyond 2000: Theory, Practice and Plans", Moscow, Russia.

Papadopoulos, G.A., and F. Imamura (2001). A Proposal for a New Tsunami Intensity Scale, Proceedings of International Tsunami Symposium 2001, Seattle, USA, 569-577.

Papadopoulos, G.A. (2003). Tsunami Hazards in the Eastern Mediterranean: Strong Earthquakes and Tsunamis in the Corinth Gulf, Central Greece, Nat. Hazards, 29, 437-464.

Papadopoulos, G.A., and A. Fokaefs (2005). Strong tsunamis in the Mediterranean Sea: a re-evaluation, ISET Journal of Earthquake Technology, 42, 159-170.

Papadopoulos, G.A., E. Daskalaki, A. Fokaefs and N. Giraleas (2007). Tsunami hazards in the Eastern Mediterranean: strong earthquakes and tsunamis in the East Hellenic Arc and Trench system, Nat. Hazards Earth Syst. Sci., 7, 57-64.

Papadopoulos, G.A., E. Daskalaki, A. Fokaefs and N. Giraleas (2010). Tsunami hazard in the Eastern Mediterranean Sea: strong earthquakes and tsunamis in the West Hellenic Arc and Trench System, J. Earthq. Tsunami, 4 (3), 145-179.

Papadopoulos, G.A., G. Diakogianni, A. Fokaefs and B. Ranguelov (2011). Tsunami hazards in the Black Sea and the Azov Sea: a new tsunami catalogue, Nat. Hazards Earth Syst. Sci., 11, 945-963.

Platania, G. (1909). Il maremoto dello Stretto di Messina del 28 dicembre 1908, Bollettino della Società Sismologica Italiana, 13, 369-458 .

Salamon, A., T. Rockwell, S.N. Ward, E. Guidoboni and A. Comastri (2007). Tsunami Hazard Evaluation of the Eastern Mediterranean: Historical Analysis and Selected Modeling, B. Seismol. Soc. Am., 97 (3), 705-724; doi:10.1785/0120060147.

Salamon, A., T. Thomas Rockwell, E. Guidoboni and A. Comastri (2011). A critical evaluation of tsunami records reported for the Levant Coast from the second millennium BC to the present, Israel J. Earth Sci., 58, 327-354; doi:10.1560/IJES.58.2-3.327.

Sbeinati, M.R., R. Darawcheh and M. Mouty (2005). The historical earthquakes of Syria: an analysis of large and moderate earthquakes from 1365 B.C. to 1900 A.D., Annals of Geophysics, 48 (3), 347-435.

Soloviev, S.L., O.N. Solovieva, G.N. Go, K.S. Kim and N.A. Shchetnikov (2000). Tsunamis in the Mediterranean Sea 2000 B.C. - 2000 A.D., Advances in Natural and Technological Hazards Research, Kluwer Academic Publishers.

Tinti, S., A. Maramai and L.Graziani (2004). The new catalogue of Italian tsunamis, Nat. Hazards, 33, 439-465.

Yalciner, A.C., Y. Altinok and C. Synolakis (2000). Tsunami waves in Izmit Bay, Earthq. Spectra, 16, Suppl. A, 55-62.

Yalciner, A., E. Pelinovsky, T. Talipova, A. Kurkin, A. Kozelkov and A. Zaitsev (2004). Tsunamis in the Black Sea: Comparison of the historical, instrumental, and numerical data, J. Geophys. Res., 109, C12023; doi:10.1029/2003JC002113.

Yolsal, S., T. Taymaz and A.C. Yalçiner (2007). Understanding tsunamis, potential source regions and tsunami-prone mechanisms in the Eastern Mediterranean, Geol. Soc. Spec. Publ., 291, 201-230; doi:10.1144/SP291.10.

*Corresponding author: Alessandra Maramai,
Istituto Nazionale di Geofisica e Vulcanologia, Sezione Roma 2, Rome, Italy; email: alessandra.maramai@ingv.it.

Appendix 1. List of tsunamis of the EMTC

Date of the event: year, month, day, hour, minute and seconds indicating the initiation time of the event as deduced by the sources. For earthquake- induced tsunamis it corresponds to the earthquake origin time.

Region (Reg.): in the EM area seven tsunamigenic regions were identified: NW (Norwegian Sea), NS (North Sea), AT (Atlantic Ocean), M3 (western Mediterranean), M2 (central Mediterranean), M1 (eastern Mediterranean), BS (Black Sea).

Source subregion (Source_sub): inside each region, several subregions were identified. They are the geographic regions where the tsunamigenic event originated.

Short description: a short description of the most relevant tsunami effects.

Reliability (Rel.): is a parameter indicating the quality of the data. For each event this parameter was assigned based on the trustworthiness of the information related to the generating cause, the tsunami description accuracy and also on the availability of coeval bibliographical sources. It ranges from 0 to 4: 0= very improbable tsunami; 1= improbable tsunami; 2= questionable tsunami; 3= probable tsunami; 4= definite tsunami.

Cause: a two-letters code specifying the cause of the tsunami. When the tsunami is directly or indirectly generated by an earthquake, the letter E is used: ER (submarine earthquake), EA (earthquake in land), EL (earthquake landslide -when the earthquake triggered a landslide), ES (earthquake marine slide - when the earthquake triggered a submarine slide). Analogously, letter V is used when the tsunami is directly or indirectly related to volcanic activity: VO (submarine eruption), VA (volcano associated – when the volcano is close to the coast), VL (volcanic landslide – subaerial avalanches on the volcano flanks), VS (volcanic marine slide – submarine avalanches on the volcano flanks). When the tsunami is caused by a gravitational instability not amenable to earthquakes or volcanic activity, the letter G is used: GL (gravitational landslide), GS (gravitational marine slide), GA (gravitational snow avalanche). The code UN (unknown cause) is used when the tsunami cause is unknown.

Intensity (Int.): the tsunami intensity is attributed on the basis of the six-degree Sieberg-Ambraseys scale [Ambraseys 1962]. 1= very light, 2= light, 3= rather strong, 4= strong, 5= very strong, 6= disastrous.

Year	Month	Day	Hour	Minute	Reg	Source_sub	Short description	Rel	Cause[1]	Int
-6150					NW	Mid-Norway	Huge tsunami in Norwegian North Sea	3	GS	6
-1630					M1	South Aegean	Explosion of Santorini Vulcano	3	VA	6
-1365					M1	Levantine	Tsunami at Ugarit	2	EA	4
-479					M1	West Aegean	Destructive wave at Potidea	2	ER	3
-426	6				M1	Corinthiakos-Patras Gulf	Sea waves in the Gulf of Euboea	4	EA	5
-373					M1	Corinthiakos-Patras Gulf	Destruction of Helike	4	ER	5
-227					M1	Dodecanese Islands	Tsunami at Rhodes	1	ER	5
-218					AT	SWIT	Tsunami in Cadiz	2	ER	2
-141					M1	Levantine	Tsunami between Tyre and Acre	2	ER	4
-60					AT	SWIT	Flooded coasts	3	ER	4
-50					BS	Bulgaria	Flooding of Kavarna and Balchik	1	EA	3
20					BS	Crimea	Submersion of Dioscuria	1	EA	3
66					M1	Crete	Tsunami in Crete	3	ER	3
68					M1	South Asia Minor	Sea wave on the coast of Lycia	2	ER	2
79	8	24			M2	Campania	Sea retreat in the Gulf of Naples	2	VA	2
103					BS	Crimea	Changes of the sea level	3	ER	3
115	12	13			M1	Levantine	Tsunami at Caesarea et Yavne	1	EA	3
120	11	10			M1	Marmara Sea	Tsunami in Cyzicus	2	EA	3
148					M1	Dodecanese Islands	Tsunami in Rhodes	4	ER	3
300					M1	South Asia Minor	Tsunami in Cyprus	1	ER	2
358	8	24			M1	Marmara Sea	Damaging waves at Izmit	4	EL	4
365	7	21			M1	Crete	Waves observed in Eastern Mediterranean	4	ER	6
382					AT	SWIT	Flooding in several islands	3	ER	4
407	4	1			M1	Marmara Sea	Ship wrecking in Istanbul	2	ER	4
447	11	6			M1	Marmara Sea	Sea inundations	4	ER	4

[1] CAUSE CODE: ER submarine earthquake - EA earthquake associated - EL earthquake landslide - ES earthquake marine slide - VO submarine eruption - VA volcano associated - VL volcanic landslide - VS volcanic marine slide - GL gravitational landslide - GS gravitational marine slide - GA gravitational snow avalanche - UN unknown cause.

Year	Month	Day	Hour	Minute	Reg	Source_sub	Short description	Rel	Cause	Int
478	9	25			M1	Marmara Sea	Tsunami in Marmara Sea	4	ER	4
543					BS	Bulgaria	Waves in Varna, Balchik and in Kapidag Peninsula	2	ER	5
551	4				M1	Corinthiakos-Patras Gulf	Sea withdrawal/flooding	4	EA	4
551	7	9			M1	Levantine	Tsunami in Lebanon	4	ER	5
556					M1	Dodecanese Islands	Sea waves at Cos	4	ER	4
740	10	26			M1	Marmara Sea	Sea withdrawal and flooding	4	ER	3
746	1	18			M1	Levantine	Tsunami in the Levantine coast	3	EA	4
800					M1	Kythira Strait	Tsunami at Kythira	1	ER	4
881	6	10			AT	SWIT	Sea retreat in South Spain	3	ER	2
989	10	25			M1	Marmara Sea	Sea waves in Thrace	0	EA	3
1033	12	5			M1	Levantine	Tsunami on the coast of Palestine	4	EA	3
1068	5	29			M1	Levantine	Tsunami in Israel	4	EA	4
1112	6	20			M2	Campania	Sea withdrawal of about 200 steps	2	UN	2
1169	2	4	7		M2	Eastern Sicily	Flood and destruction at Messina	4	EA	4
1202	5	20	2	40	M1	Levantine	Tsunami on Levantine coast	4	EA	5
1222	5	11	6	15	M1	South Asia Minor	Tsunami in Cyprus	4	ER	2
1265	8	11			M1	Marmara Sea	Tsunami in Marmara Island	2	EL	3
1303	8	8	3	30	M1	Dodecanese Islands	Tsunami in Crete	4	ER	6
1329	6	28			M2	Eastern Sicily	Boats carried to the sea	2	VA	3
1343	10	18			M1	Marmara Sea	Tsunami at Istanbul	4	ER	5
1348	1	25	15		M2	North Adriatic	Strong agitation of the canals in Venice	2	EA	2
1389	3	20	12	30	M1	East Aegean	Damaging inundation at Chios	4	ER	4
1402	6				M1	Corinthiakos-Patras Gulf	High wave near Aeghion	4	EA	4
1408	12	29			M1	Levantine	Tsunami in Latakia	4	EA	4
1419	12				M1	Marmara Sea	Sea movement at Istanbul	2	ER	2
1427					BS	Crimea	Villages washed away near Yalta	1	ER	4
1456	12	5	3		M2	Gulf of Naples	Ships damaged in the harbor of Naples	4	EA	2

Year	Month	Day	Hour	Minute	Reg	Source_sub	Short description	Rel	Cause	Int
1481	5	3			M1	Dodecanese Islands	Tsunami in Rhodes	4	ER	5
1489					M1	Dodecanese Islands	Tsunami in Adalia	1	ER	2
1494	7	1	10	10	M1	Crete	Big waves in Heraklion	4	ER	3
1509	9	10	22		M1	Marmara Sea	Large inundation in Costantinople	4	ER	3
1511	3	26	14	30	M2	North Adriatic	Large sea level rise at Trieste	2	EA	2
1522	9	22	8		M3	Alboran Sea	Tsunami in Almeria and Badès	3	EA	3
1531	1	26	4	30	AT	TE	Flooding of Lisbon	4	ER	4
1546	1	14			M1	Levantine	Sea withdrawal in the coast of Palestine	4	EA	5
1564	7	20			M2	Liguria Cote d'Azur	Sea inundation in Antibes	4	EA	2
1577	7	17	18		M1	Marmara Sea	Sea waves at Istanbul	1	ER	3
1598					BS	South Black Sea	The sea advanced for a mile inland	3	EA	6
1609	4				M1	Dodecanese Islands	Destructive waves in Rhodes	1	ER	5
1612	11	8			M1	Crete	Many shipwrecks in Crete	2	ER	4
1613	8	25			M2	Northern Sicily	Sea flooding at Naso	1	EA	2
1614	5	24			AT	Azores	Sea retreat and rising in Terceira	3	EL	3
1615	6	5			BS	Crimea	Sea recession at Feodosia	0	ER	2
1624	3	19	19	45	M2	North Adriatic	Strong sea agitation	4	EA	2
1627	7	30	10	50	M2	Gargano	Large sea withdrawal and flooding	4	EA	5
1630	3	9			M1	Kythira Strait	Tsunami in Kythira	4	ER	3
1631	12	17	9		M2	Campania	Sea withdrawal in the Gulf of Naples	4	VA	2
1633	11	5			M1	Ionian Sea	Cliff collapsed in the sea at Zante	3	ER	3
1638	3	27	15	5	M2	Tyrrhenian Calabria	Sea retreat at Pizzo Calabro	2	EA	2
1641	12	21	12		AT	Azores	Inundation and damage in S.Jorge island	3	ER	5
1646	4	5			M2	Tuscany	Sea rise in Livorno	4	EA	3
1646	4	5			M1	Marmara Sea	Ships destroyed at Istanbul	3	ER	4
1649	1				M2	Messina Straits	Shipwrecks in the Messina harbor	1	ER	3

Year	Month	Day	Hour	Minute	Reg	Source_sub	Short description	Rel	Cause	Int
1650	9	29			M1	South Aegean	Destructive waves at Thera	4	VO	6
1650					BS	Crimea	Flooding at Sivash	1	ER	3
1667	4	6	7	10	M2	Dalmatian coasts	Sea withdrawal at Dubrovnik	4	ER	3
1672	4	14	15	45	M2	Central Adriatic	Sea withdrawal-flooding at Rimini	4	EA	2
1676					AT	Azores	Damage in the island of Terceira	1	UN	3
1680	10	9	7		M3	Alboran Sea	Sea rise (5 m) in Malaga harbor	4	ER	3
1688	7	10	11	45	M1	East Aegean	Weak tsunami at Smyrna	1	ER	2
1691	7	26			AT	Azores	Sea disturbance	1	ER	2
1693	1	9	21		M2	Eastern Sicily	Anomalous sea movement	2	ER	2
1693	1	11	13	30	M2	Eastern Sicily	Large sea withdrawal and flooding	4	ER	5
1698	5	14	10		M2	Campania	Sea oscillations in the Gulf of Naples	2	VA	2
1703	2	2	11	5	M2	Latium	at the Tiber mouth	0	EA	2
1703	7	2	1		M2	Liguria-Côte d'Azur	Sea withdrawal in Genoa	2	ER	2
1706	5	5			AT	Canary Islands	Sea retreat/flooding at Garachico	3	VO	4
1722	12	27	17	30	AT	SWIT	River water withdrawal	4	ER	3
1723	2	18	2		M1	Ionian Sea	Sea inundation at Leukas	2	ER	3
1725	6	4	18		M3	Algeria	Sea retreat at Annaba (Bonne)	2	UN	3
1725	6	29	20		M2	Liguria-Côte d'Azur	Sea retreat/flooding in the Marseille harbor	2	UN	3
1726	9	1	21	55	M2	Northern Sicily	Sea withdrawal at Palermo	4	ER	2
1727	7	4			M2	Sicily Channel	Sea withdrawal at Sciacca	2	ER	2
1731	1	8			NW	Western Norway	Giant wave, Stranda	3	GL	5
1731	3	20	3		M2	Apulia	Sea rise at Siponto and Barletta	4	EA	2
1741	1	31	1	15	M1	Dodecanese Islands	Sea retreat/flooding in Rhodes	3	ER	5
1741	2				M1	Crete	Tsunami in Heraklion	2	ER	3
1742	1	19	16	30	M2	Tuscany	Sea oscillations in Livorno harbour	4	EA	2
1743	2	20	16	30	M2	Apulia	Sea withdrawal Brindisi	2	ER	2

Year	Month	Day	Hour	Minute	Reg	Source_sub	Short description	Rel	Cause	Int
1743	3	14			M1	South Asia Minor	Sea retreat in Antalya	1	EA	2
1748	5	25			M1	Corinthiakos-Patras Gulf	Damaging inundation at Aeghion	3	ER	5
1754	9	2	21	45	M1	Marmara Sea	Sea receded in Izmit Gulf	1	ER	2
1755	11	1	9	40	AT	SWIT	Catastrophic tsunami	4	ER	6
1755	11	16	15	30	AT	Coruña	Sea flux/reflux at La Coruña	2	ER	2
1756	2				NW	Western Norway	3 waves, severe turbulence, Tjelle	4	GL	6
1756	3	29			AT	TE	Tagus level rise	2	ER	2
1757	7	9			AT	Azores	Sea rise at St.Jorge, Pico	3	ER	2
1759	10	30	3	45	M1	Levantine	Tsunami at Acre and Tripoli	4	EA	3
1759	11	25	19	23	M1	Levantine	Tsunami in Acre	4	EA	4
1760	6	16	15		M2	Campania	Sea withdrawal in Portici	2	ER	2
1761	3	31	12	1	AT	SWIT	Oscillations and sea rise	4	ER	3
1766	5	22	5	30	M1	Marmara Sea	Inundation and damage in the Bosphorus	4	ER	3
1769					M1	Corinthiakos-Patras Gulf	Sea retreat in Desfina (Corinth Gulf)	3	EA	2
1772	11	24	7	45	M1	East Aegean	Tsunami in Chios	1	ER	2
1773	5	6	10		M3	Alboran Sea	Tsunami in Tangiers and Algiers	2	ER	3
1780	9	21			M2	Dalmatian coast	Sea withdrawal in Kotor	4	ER	3
1783	2	5	8		M2	Ionian Calabria	At Capo Rizzuto inundations	2	EA	3
1783	2	5	12		M2	Tyrrhenian Calabria	Withdrawals and inundations	4	EA	4
1783	2	6	0	20	M2	Messina Straits	More than 1500 victims at Scilla	4	EL	6
1783	2	7	13	10	M2	Tyrrhenian Calabria	Sea rise at Stilo	2	EA	2
1783	3	1	1	40	M2	Tyrrhenian Calabria	Sea flooding at Tropea	3	EA	2
1783	3	24	12		M2	Messina Straits	Capsizing of a boat 1 man killed	4	GL	3
1783	3	28	18	55	M2	Tyrrhenian Calabria	Sea flooding at Bagnara	3	EA	2
1784	1	7			M2	Ionian Calabria	Sea flooding at Roccella	4	ER	3
1784	1	9	2	0	M2	Tyrrhenian Calabria	At Bivona a ship broke its moorings	2	ER	3

Year	Month	Day	Hour	Minute	Reg	Source_sub	Short description	Rel	Cause	Int
1784	1	19			M2	Messina Straits	Sea flooding at Faro and Catona	4	ER	4
1790	10	9		1	M3	Algeria	Flooding of Spain-North-Africa coasts	3	EA	3
1791	11	2			M1	Ionian Sea	Sea movement at Zakyntos	2	ER	3
1794	6	11			M1	Corinthiakos-Patras Gulf	Tsunami in the Gulf of Corinth	4	EL	3
1800	6	2	20	17	AT	Azores	3 sea waves at Terceira	2	ER	3
1802	8	10			NS	SW England	Sea rise/fall at Teignmouth	2	UN	2
1802	10	26			BS	Bulgaria	Waves in Evpotoria	0	EA	2
1804	1	13	17	45	M3	Alboran Sea	Sea retreat in Almerìa province	4	EA	2
1804	6	8	3		M1	Corinthiakos-Patras Gulf	Tsunami in Patras	1	ER	3
1805	7	26	21		M2	Campania	Sea rise in the Gulf of Naples	4	EA	2
1809	7	3	1		M2	Liguria-Côte d'Azur	1 meter sea rising at La Spezia	2	UN	2
1810	2	17			M1	Crete	Sea waves in Alexandria	1	ER	2
1810					NW	Northern Norway	3 waves in Lyngsfjord	4	GL	6
1813	5	17			M2	Campania	Sea withdrawal in the Gulf of Naples	1	VA	2
1817	1	14	14	30	M2	Sicily Channel	Sea oscillations at Sciacca	1	ER	2
1817	8	23	8		M1	Corinthiakos-Patras Gulf	Sea retreat/inundation in Aeghion	4	ER	6
1818	2	20	18	15	M2	Eastern Sicily	Withdrawal/inundation at Catania	4	EA	2
1818	2	23	18	10	M2	Liguria-Côte d'Azur	Violent sea waves at Antibes	2	EA	2
1821	1	6			M1	Ionian Sea	Tsunami in Patras	3	EA	4
1821	11	17			BS	Bulgaria	Sea rising in Odessa	1	EA	2
1823	3	5	16	37	M2	Northern Sicily	Boats carried and damaged at Cefalù	4	ER	4
1825	1	19	11	45	M1	Ionian Sea	Tsunami at Leukada	1	EA	3
1828	10	9	2	20	M2	Liguria-Côte d'Azur	Shipwreck in Genoa harbour	4	EA	3
1831	5	26	10	30	M2	Liguria-Côte d'Azur	Sea withdrawal in Sanremo	2	ER	2
1832	3	8	18	30	M2	Ionian Calabria	Sea flooding at Magliacane Crotone	4	EA	3
1833	1	19			M1	Albania-North Ionian	Tsunami at Valona	1	EA	2

Year	Month	Day	Hour	Minute	Reg	Source_sub	Short description	Rel	Cause	Int
1836	4	25	0	20	M2	Ionian Calabria	Sea retreat/flooding. Boats damaged	4	EA	4
1838	1	23			BS	Bulgaria	Sea swell in Odessa harbor	1	EA	3
1838	8	10			M2	North Adriatic	Sea oscillations at Fiume	2	ER	2
1843	10	18			M1	Crete	Tsunami at Chalki	2	ER	2
1845	8	16	16	38	M2	Dalmatian coasts	Sea level raising at Gruz	4	ER	3
1846	8	14	12		M2	Tuscany	Sea rising one yard at Livorno	4	EA	2
1847	8	26			M2	Campania	Sea level lowering in Naples	0	UN	2
1851	2	28	15		M1	Dodecanese Islands	Tsunami at Makri (Rhodes)	2	ER	2
1851	4	3	17		M1	Dodecanese Islands	Sea wave in Fethiye	4	ER	3
1851	10	12	7		M1	Albania-North Ionian	Sea level rise at Valona	4	EA	2
1852	9	8	22	30	M1	East Aegean	Tsunami at Izmir	2	EA	2
1853	8	18	8	30	M1	Corinthiakos-Patras Gulf	Tsunami in the Gulf of Eubea	1	EA	2
1856	11	13			M1	East Aegean	Tsunami at Chios	3	ER	4
1856	8	21	21	45	M3	Algeria	Tsunami along the Algerian coast and Baleares	4	EA	3
1856	8	22	11	40	M3	Algeria	Tsunami along the Algerian coast	4	EA	3
1861	12	26	6	30	M1	Corinthiakos-Patras Gulf	Destructive waves and ships damaged	4	EL	4
1866	1	2			M1	Albania-North Ionian	Tsunami at Valona and Kanina	3	EA	2
1866	1	19			M1	East Aegean	Sea level oscillation in the Cesme straits	1	ER	4
1866	2	6			M1	Crete	Damaging waves at Kithyra	4	ER	4
1866	3	3			M1	Albania-North Ionian	Tsunami at Valona	1	EA	3
1867	3	7			M1	East Aegean	Sea rising in Mitilini	4	ER	2
1867	5	7	10		NW	Western Norway	Withdrawal of sea and oscillations	4	EA	3
1867	9	20	5	44	M1	Ionian Sea	Strong tsunami in the coast of Gulf of Gythion	4	ER	4
1869	10	11	13		BS	Crimea	Sea rising in harbors in Crimea	2	ER	3
1869	12	28			M1	Ionian Sea	Tsunami waves at Valona	2	ER	3
1870	6	24	17		M1	Crete	Inundation in Alexandria	3	ER	2

Year	Month	Day	Hour	Minute	Reg	Source_sub	Short description	Rel	Cause	Int
1872	4	3	7	40	M1	Levantine	Flooding near Antakya (Antioch)	3	EA	3
1875	3	17	23	51	M2	Central Adriatic	Sea flooding at Rimini and Cervia	4	ER	3
1875	7	25			BS	Crimea	Sea agitated on the western coast of Crimea	1	ER	2
1878	4	19			M1	Marmara Sea	Sea waves in the Gulf of Izmit	1	EA	3
1880	4	14			NW	Western Norway	Boathouses destroyed at Sunnylven	2	GL	3
1881	4	3	11	50	M1	East Aegean	Tsunami in Chios	2	EA	2
1883	6	27	10		M1	Ionian Sea	Sudden withdrawal at St.Georges	3	ER	3
1885	1	29	7	30	M3	Algeria	Sea level change in Algerian coasts	1	EA	2
1886	8	27	21	30	M1	Ionian Sea	Boats carried on land in Pylos	4	ER	3
1887	2	23	5	21	M2	Liguria-Côte d'Azur	Extended sea retreat. Boats damaged.	4	EA	3
1887	10	3	22	53	M1	Corinthiakos-Patras Gulf	20 m inundatin in Galaxidi	3	ER	2
1888	4	23			NW	Mid-Norway	Flood wave in Trondheim harbor	1	GS	3
1888	7	30			M2	Liguria-Côte d'Azur	2 sea retreats at Pietra Lunga	2	ER	2
1888	9	9			M1	Corinthiakos-Patras Gulf	Small tsunami in Galaxidi	3	ES	2
1889	12	8			M2	Gargano	Sea agitation	2	EA	2
1891	1	15	4		M3	Algeria	Sea withdrawal-flooding at the Algerian coast	4	EA	3
1893	2	9	18		M1	North Aegean	Damaging wave at Agistron	4	ER	4
1893	4	17			M1	Ionian Sea	Sea withdrawal at Zakynthos	4	ER	2
1893	6	14	7	30	M1	Albania-North Ionian	Tsunami at Valona	1	EA	2
1894	4	27	19	42	M1	Corinthiakos-Patras Gulf	3m high wave in Atalanti	3	EA	4
1894	7	10	12	33	M1	Marmara Sea	Sea retreat/inundation at Istanbul	4	ER	3
1894	11	16	17	52	M2	Tyrrhenian Calabria	Vessel carried landward in Reggio Calabria.	4	EA	3
1898	6	2			M1	Corinthiakos-Patras Gulf	Flooding in the southern coast of Corinth Gulf	1	EA	2
1898	12	3	5	50	M1	Ionian Sea	Small tsunami at Zakyntos	4	EA	2
1899	1	22	7	56	M1	Ionian Sea	Tsunami at Messenia	4	ES	3
1899	2	3			AT	Azores	Damage at Terceira and S.Jorge islands	0	UN	4
1901	3	31	7	12	BS	Bulgaria	At Balchik boats uplifted	4	ER	4

Year	Month	Day	Hour	Minute	Reg	Source_sub	Short description	Rel	Cause	Int
1905	9	8	1	43	M2	Tyrrhenian Calabria	Extended flooding. Boats affected.	4	EA	4
1905	10	4	22	29	BS	North Caucasus	Sea rising at Anapa harbor	3	ER	3
1906	4	4	4		M2	Campania	Sea oscillations in Naples Gulf	4	VA	2
1907	10	23	20	28	M2	Ionian Calabria	Sea flooding at Capo Bruzzano	4	EA	3
1908	12	28	4	20	M2	Messina Straits	Destructions, hundreds of victims	4	ER	6
1909	4	8			BS	Crimea	Three waves near Sochi-Tuapse	1	ER	3
1912	8	9	1	29	M1	Marmara Sea	Tsunami waves along the Marmara Sea coast	4	ES	4
1914	11	27	14	39	M1	Ionian Sea	Strong local wave at Leukada	1	EL	2
1915	8	7	15	4	M1	Ionian Sea	Two tsunamis in the Ionian islands	1	ER	3
1916	7	3	23	21	M2	Aeolian Islands	Withdrawal/inundation at Stromboli	4	ER	2
1916	8	16	7	6	M2	Central Adriatic	At Tavollo tsunami waves observed	4	ER	2
1919	5	22	17	45	M2	Aeolian Islands	Sea retreat/flooding at Stromboli	4	VO	3
1920	12	18	2	1	M1	Albania-North Ionian	Tsunami at Saseno Island	4	EA	5
1926	8	17	1	42	M2	Aeolian Islands	Anomalous sea retreat at Salina	2	ER	2
1927	6	26	11	20	BS	Crimea	Sea retreat/rise in North Black Sea	4	ER	2
1927	9	11	22	15	BS	Crimea	2 houses destroyed in Balaklava	4	ER	4
1927	9	16	8	21	BS	Crimea	Sea receded at Balaklava	1	ER	2
1928	3	31	0	29	M1	East Aegean	Tsunami at Smyrna	1	EA	2
1929	11	18	20	32	AT	GB	Tide gauge records in Ponta Delgada and Leixoes	4	GS	1
1930	3	4	18	3	AT	MAD	Enormous wave at Vigario beach	4	GL	4
1930	5	2			NW	Mid-Norway	Large flood wave, Orkdalsfjorden	3	GS	2
1930	9	11	9	52	M2	Aeolian Island	Strong sea retreat/flood at Stromboli	4	VO	4
1930	10	30	7	13	M2	Central Adriatic	Sudden high tide at Ancona	4	EA	4
1932	9	26	19	20	M1	North Aegean	Tsunami at Chalkidiki	4	ER	2
1934	4	7	3		NW	Western Norway	Giant waves in Tafjord	4	GL	6
1938	3				NW	Western Norway	3 waves, Stranda	1	GL	2
1939	5	8	1	46	AT	Azores	Recorded on tide gauges	4	ER	1

Year	Month	Day	Hour	Minute	Reg	Source_sub	Short description	Rel	Cause	Int
1939	12	26	23	57	BS	South Black Sea	Sea withdrawal at Fatsa bay	4	EA	2
1940	1	15	13	19	M2	Northern Sicily	Sea waves in Gulf of Palermo	2	EA	2
1940	8	31	7		NW	Northern Norway	Impressive wave in Finnvika	4	GL	2
1941	11	25	18	4	AT	GFD	Recorded on tide gauges	4	ER	1
1944	10	6	2	34	M1	East Aegean	200 m inundation at Ayvalik (Edremit Gulf)	3	ER	2
1944	8	20	6	30	M2	Aeolian Islands	Sea flooding. One house destroyed	4	VO	4
1947	10	6	19	55	M1	South Ionian	Local wave at Methoni	4	ES	2
1948	2	9	12	58	M1	Dodecanese Islands	Sea inundation at Karpathos island	4	ER	4
1948	4	22	10	42	M1	Ionian Sea	Tsunami at Leukada	4	ER	2
1949	7	23	15	3	M1	East Aegean	Strong wave at Chios	4	ER	2
1952	1	9	8		NW	Mid-Norway	1-2 m high wave in Follafjorden	4	GL	2
1953	9	10	4	6	M1	South Asia Minor	Waves in Cyprus	3	EA	2
1954	2	2			M2	Aeolian Islands	Slight tsunami at Stomboli	4	VO	3
1954	9	9	1	4	M3	Algeria	Recorded by tide-gauges	4	ES	1
1956	7	9	3	11	M1	South Aegean	Destructive waves in Cyclades	4	ER	6
1956	11	2	16	4	M1	North Aegean	Sea rising at Volos	1	EA	2
1959	5	7			NW	Northern Norway	Tsunami at Sokkelvik, Nordreisa	4	GS	4
1961	5	23	2	45	M1	Dodecanese Islands	Weak wave in the Gulf of Izmir	1	ER	2
1962	1	11	5	5	M2	Dalmatian coasts	Sea level oscillation at Split	4	ER	2
1963	2	7	19	28	M1	Corinthiakos-Patras Gulf	Destructive wave. 2 victims	4	GS	4
1963	9	18	16	58	M1	Marmara Sea	Sea waves at Bandirma	4	ER	3
1965	7	6	3	18	M1	Corinthiakos-Patras Gulf	Local wave at Galaxidi	4	EL	4
1966	5	8			NW	Eastern Norway	2 flood waves, Oslofjorden	4	GS	3
1966	7	12	18	53	BS	North Caucasus	Recorded on tide gauges	4	ER	1
1968	2	19	22	45	M1	North Aegean	Tsunami at Lemnos	4	ER	2
1968	4	18	19	38	M2	Liguria-Côte d'Azur	Sea withdrawal-flooding at Alassio	4	EA	2
1968	9	3	8	19	BS	South Black Sea	Sea withdrawal and rising at Amasra	4	ER	3

Year	Month	Day	Hour	Minute	Reg	Source_sub	Short description	Rel	Cause	Int
1969	2	28	2	40	AT	SWIT	Recorded on tide gauges	4	ER	2
1969	7	17	5	0	AT	Unknown	Recorded on tide gauges	4	UN	1
1970	12	4	1	59	BS	Caucasus	Sea oscillations near Sochi	3	ER	2
1975	5	26	9	11	AT	GFD	Recorded on tide gauges	4	ER	1
1978	8	14	14	17	AT	SWIT	Recorded on one tide gauge in Spain	4	ER	1
1979	4	15	6	19	M2	Dalmatian coasts	Damaging wave at Kotor Bay	4	EA	4
1979	10	6			NW	Northern Norway	2 m run-up at island Ĭksningen	4	GL	3
1979	10	16	13	57	M2	Liguria-Côte d'Azur	3m high waves at Antibes	4	GS	3
1980	1	1	16	42	AT	Azores	Recorded on one tide gauge	4	ER	1
1980	10	10	12	24	M3	Algeria	Recorded on tide gauges	4	ES	1
1981	2	24	20	53	M1	Corinthiakos-Patras Gulf	Recorded in one tide gauge	4	ER	1
1983	1	17			M1	Ionian Sea	Sea retreat at Zakynthos	4	ES	2
1983	8	6	15	43	M1	North Aegean	Tsunami in Lemnos	1	ER	2
1983	8	18	9		NW	Western Norway	5-7 m run-up at Årdalstangen	4	GL	4
1984	2	11	8	2	M1	Corinthiakos-Patras Gulf	Local wave at Sergoula	4	EL	3
1988	4	20	5	30	M2	Aeolian Islands	Small waves in Vulcano and Lipari	4	GL	2
1990	12	13	0	14	M2	Eastern Sicily	Anomalous wave at Augusta	4	ER	2
1994	4	28	11	30	NW	Western Norway	4 m high wave in fjord, Balestrand	4	GA	4
1995	6	15	0	15	M1	Corinthiakos-Patras Gulf	Small tsunami at Eratini	4	ER	2
1996	1	1			M1	Corinthiakos-Patras Gulf	Strong sea-waves at Aeghion	4	GS	3
1998	3	19	18	30	NW	Western Norway	Damage to boat houses	4	GL	4
1999	8	17	0	11	M1	Marmara Sea	Destruction/victims in Izmit Bay	4	EA	5
2000	4	5	4	36	M1	Crete	Sea oscillations in Heraklio	4	ES	3
2002	3	24			M1	Dodecanese Islands	3-4 m high waves in Rhodes	4	GS	3
2002	12	30	13	15	M2	Aeolian Islands	Heavy damage at Stromboli	4	VL	5
2003	5	21	18	44	M3	Algeria	Damaging waves in Balearic islands, Sea retreat in Algiers region	4	ER	3
2004	8	24			M2	Liguria-Côte d'Azur	Sea retreat in Marseille	3	GL	3

Appendix 2. List of discarded events

Codes used in the column *Bibliographical sources* are the acronyms of the datasets reported in Table 1 (*ID code*).

	Year	Month	Day	Region	Elimination cause	Bibliographical sources
1	-1300			M1	No tsunami description	A11
2	-760			M1	No tsunami description	S00
3	-590			M1	No tsunami description	SA11, S00
4	-525			M1	No tsunami description	A11, S00
5	-330			M1	No tsunami description	A11, S00
6	-223	10		M1	No tsunami description	P01
7	-210			AT	No tsunami description	IGN
8	-197			M1	No tsunami description	P01, S00
9	-138			M1	No tsunami description	S00
10	-92	2	28	M1	False event	A11, S11
11	-58			M1	No tsunami description	S00
12	-23			M1	No tsunami description	FP07, A11
13	46			M1	No tsunami description	A11
14	76			M1	No tsunami description	A11, S00
15	177			M2	No tsunami description	S00
16	258			M2	No tsunami description	S00
17	262			M1	No tsunami description	P07, A11, S00
18	303	4	2	M1	No tsunami description	A11, Y07
19	342			M1	No tsunami description	A11, S00
20	344			M1	No tsunami description	A11
21	348			M1	No tsunami description	A11, Y07, S00
22	368			M1	No tsunami description	P01
23	426			M1	No tsunami description	S00
24	488	9	26	M1	Duplicate of the 478/9/26	A11
25	524			M1	Duplicate of the 543/9/6	A11
26	542			M1	Duplicate of the 543/9/6	A11
27	549			M1	No tsunami description	A11
28	552	5		M1	Duplicate of the 551/4	P01
29	555	8	15	BS	Duplicate of the 556 in M1	A11, S00, Y04
30	557	12	14	M1	No tsunami description	A11, S00
31	792/793			M2	No tsunami description	S00
32	803	12	19	M1	No tsunami description	A11
33	803	6	26	M1	No tsunami description	SA11
34	859	12	30	M1	No tsunami description	A11, S00
35	881/882			M1	No tsunami description	S00
36	975			M1	No tsunami description	S00
37	986	10	26	M1	Duplicate of the 989/10/25	P01
38	991	4	5	M1	No tsunami description	A11

	Year	Month	Day	Region	Elimination cause	Bibliographical sources
39	1036/1037			M1	No tsunami description	A11, SA11, Y07
40	1039	2	2	M1	No tsunami description	A11, S00
41	1050			M1	No tsunami description	S00
42	1064			M1	No tsunami description	A11, S00
43	1068	3	18	M1	Duplicate of the 1068/5/29	Y07, S00
44	1106	3		M2	False event	S00
45	1114	8-Nov	10	M1	No tsunami description	A11
46	1157	8	12	M1	No tsunami description	A11
47	1169	2	11	M2	Duplicate of the 1169/2/4	S00
48	1170	6	29	M1	No tsunami description	A11
49	1172			M2	No tsunami description	S00
50	1185			BS	Meteorological event (storm)	P11
51	1231	3	11	M1	No tsunami description	P01
52	1270	3		M1	No tsunami description	P01
53	1273	9		M2	No tsunami description	S00
54	1321			M2	Meteorological event ('acqua alta')	S00
55	1332	2	12	M2	Meteorological event (storm)	A11, S00
56	1341			BS	Duplicate of the 1343/10/18 in M1	P11
57	1343	10	20	M1	Duplicate of the 1343/10/18	P01
58	1343	11	25	M2	Meteorological event (storm)	S00
59	1365	1	2-Apr	M3	No tsunami description	S00, GC05
60	1403	11	16	M1	Duplicate of the 1402/6	A11, S00
61	1404	2	20	M1	Duplicate of the 1402/6	A11, Y07
62	1437	11	28	M1	No tsunami description	P01
63	1508	5	29	M1	No tsunami description	S00
64	1520	5	17	M2	No tsunami description	P01
65	1534			M1	No tsunami description	S00
66	1538	9	26	M2	No tsunami description (bradyseism)	S00
67	1562	10	20	M2	No tsunami description	S00
68	1570			M1	No tsunami description	P07
69	1571	7	17	M1	No tsunami description	P01
70	1571	7		AT	No tsunami description	AN06
71	1591	7	26	AT	No tsunami description	AN06
72	1594			M2	No tsunami description (bradyseism)	S00
73	1601			M1	No tsunami description	S00
74	1629	3	7	M1	No tsunami description	S00
75	1636	9	30	M1	No tsunami description	S00
76	1653			AT	Meteorological event (storm)	AN06
77	1659	2	17	M1	No tsunami description	P01
78	1661	3	22	M2	No tsunami description	S00
79	1667	11	30	M1	No tsunami description	A11, S00
80	1668	11	23	AT	No cause, no tsunami description	AN06

	Year	Month	Day	Region	Elimination cause	Bibliographical sources
81	1672	2	14	M1	No tsunami description (subsidence)	P07, A11, S00
82	1672			M1	No tsunami description	P01
83	1681	2	10	M1	No tsunami description	P01
84	1682	8	12	M2	No tsunami description	S00
85	1690	2	3	M2	No tsunami description	S00
86	1694	9	8	M2	No tsunami description	S00
87	1699			M2	Duplicate of the 1693/1/11	S00
88	1707	5		M1	No tsunami description	S00
89	1707	7	20	M2	Meteorological event (low tide)	S00
90	1714	6	30	M2	Meteorological event (low tide)	S00
91	1721	3	24	M3	No tsunami description	S00
92	1723	3	28	M2	Meteorological event	S00
93	1732	2	12	M1	Meteorological event (storm)	P01
94	1732	11		M1	Meteorological event (storm)	S00
95	1742	2	21	M1	Meteorological event (high tide)	P03
96	1750	12	27	M2	No tsunami description	S00
97	1751	8	15	M1	Meteorological event (storm)	A11
98	1751	11	21	M2	No tsunami description	S00
99	1752	7	21	M1	No tsunami description	FP07, A11,S00
100	1754	9	16	M1	Duplicate of the 1754/9/2	P01
101	1756	1	1	AT	No tsunami description	IGN
102	1756	10	22	M2	No tsunami description	S00
103	1758	5		M1	No tsunami description	P01
104	1774	7	24	M1	No tsunami description	S00
105	1774	9	24	M2	No tsunami description	S00
106	1778	6	16	M1	No tsunami description	P01
107	1787			AT	No tsunami description	AN06
108	1792	1	23	AT	No tsunami description	AN06
109	1802	1	4	M2	Meteorological event (storm)	S00
110	1802	11	7	M3	No tsunami description	S00
111	1804	7	31	M2	No tsunami description (bradyseism)	S00
112	1806	8	26	M2	No tsunami description	S00
113	1808	4	2	M2	Meteorological event (storm)	LT11, S00
114	1812	6	27	M2	Meteorological event (storm)	LT11, BRGM13
115	1817	1	1	M1	No tsunami description	P01
116	1817	7	5	M2	Meteorological event (storm)	LT11, BRGM13
117	1818	1		M1	No tsunami description	S00
118	1818	12	9	M2	No tsunami description	S00
119	1819	1	8	M2	No tsunami description	S00
120	1820	3	17	M1	No tsunami description	S00
121	1820	7	23	M2	No tsunami description	S00
122	1820	12	29	M1	Meteorological event (storm)	P10

	Year	Month	Day	Region	Elimination cause	Bibliographical sources
123	1822	8	13	M1	No tsunami description	A11, S00
124	1823	8	20-Jul	M2	No tsunami description (seaquake)	S00
125	1823	10		M2	No tsunami description (seaquake)	S00
126	1826	3	18	M2	No tsunami description	S00
127	1829	5	23	M1	No tsunami description	A11, S00
128	1829	5	23	M2	Meteorological event	LT1, BRGM13
129	1831	7	2	M2	No tsunami description	S00
130	1835	7	12	M1	No tsunami description	S00
131	1837	1	1	M2	No tsunami description	FP07, A11, SB05
132	1841	7	14	M2	Meteorological event	LT11, BRGM13
133	1841	7	17	M2	Meteorological event	LT11, BRGM13
134	1843	2	27	M2	Meteorological event	LT11, BRGM13
135	1844	3	3	M2	Meteorological event	S00
136	1844	3	22	M2	Meteorological event	S00
137	1845	6	18	M2	No tsunami description	S00
138	1846	7	25	M1	No tsunami description	A11
139	1846	12		M2	No tsunami description	S00
140	1847	5	23	NS	No tsunami description	LW07
141	1850	1-Apr		M2	No tsunami description	S00
142	1850	5	16	M2	Meteorological event	S00
143	1850	10	20	M2	Meteorological event	S00
144	1851	5	23	M1	Duplicate of the 1851/4/3	A11
145	1851	7	28	M2	No tsunami description	S00
146	1852	2/6/7/		M2	Meteorological event	S00
147	1852	5	12	M1	Meteorological event	A11, S00
148	1852	9	22	M1	No tsunami description	S00
149	1853	4	8	M2	No tsunami description	S00
150	1853	12	11	M2	No tsunami description (subsidence)	S00
151	1854	2	29	M2	No tsunami description	S00
152	1854	12	31	M2	No tsunami description	S00
153	1855			AT	No tsunami description	AN06
154	1855	2	13	M1	No tsunami description	P07, A11
155	1855	5	18	M2	No tsunami description	S00
156	1856	1	6	AT	Meteorological event (storm)	AN06
157	1856	8	21	M3	Duplicate of the 1856/8/21 at 21:45	S00
158	1856	10	12	M1	No tsunami description	A11, S00
159	1857	5	23	M3	No tsunami description	S00
160	1857	9	17	M1	No tsunami description (subsidence)	A11, S00
161	1858	2	21	M1	No tsunami description	P01
162	1859	8	21	M1	No tsunami description	A11
163	1859	10	20	M1	No tsunami description	S00
164	1860	1	6	M3	No tsunami description	S00

	Year	Month	Day	Region	Elimination cause	Bibliographical sources
165	1860	9	3	M1	Meteorological event	BRGM13
166	1862	1	1	M1	Duplicate of the 1861/12/26	S00
167	1862	3	18	M2	Meteorological event	S00
168	1863	3	22	M1	Meteorological event (storm)	A11, S00
169	1865	7	16	M3	No tsunami description	S00
170	1866	1	6	M2	Duplicate of the 1866/1/6	S00
171	1866	1	28	M1	No tsunami description	S00
172	1866	1	31	M1	No tsunami description	A11
173	1866	2	2	M1	Duplicate of the 1866/1/19	S00
174	1866	3	6	M1	Duplicate of the 1866/3/3	P01, S00
175	1866	3	13	M1	Duplicate of the 1866/3/3	P01, S00
176	1866	10		M1	No tsunami description	S00
177	1867	2	4	M1	No tsunami description	P01, S00
178	1867	4	10	M1	No tsunami description	S00
179	1867	10	4	M1	No tsunami description	S00
180	1867	11	19	M1	No tsunami description	S00
181	1868	9	5	M2	No tsunami description	S00
182	1869	9	9	M1	No tsunami description	S00
183	1870	7	29	M2	No tsunami description	S00
184	1870	8	1	M1	No tsunami description	S00
185	1870	8	6	M2	Meteorological event	S00
186	1870	10	28	M2	Meteorological event (storm)	S00
187	1870	11	12	M2	Meteorological event (storm)	S00
188	1871	1	17	M2	Meteorological event (storm	S00
189	1871	10	5	M1	No tsunami description	S00
190	1873	10	25	M1	No tsunami description	S00
191	1876	12	23	M2	Meteorological event	S00
192	1880	9	2	M1	No tsunami description	S00
193	1881	4	11	M1	Duplicate of the 1881/4/3	P01
194	1881	12		M1	No tsunami description	S00
195	1885	1	16	M2	Meteorological event	S00
196	1890	8	20	M2	Meteorological event	BRGM13
197	1892	8	11	M2	Meteorological event	BRGM13
198	1892	11	15	M2	No tsunami description	S00
199	1894	6	6	M2	Meteorological event	BRGM13
200	1894	12	27	M2	No tsunami description	S00
201	1894			M3	No tsunami description	S00
202	1895	11	1	M2	No tsunami description	S00
203	1896	10	16	M2	No tsunami description	S00
204	1896	11	5	M1	No tsunami description	P10
205	1897	6	30	M2	Meteorological event (storm)	BRGM13
206	1897	12		M1	Duplicate of the 1898/12/3	P01, S00

	Year	Month	Day	Region	Elimination cause	Bibliographical sources
207	1899	7	24	M2	Meteorological event	BRGM13
208	1902	7	5	M1	No tsunami description	S00
209	1903	5	13	M2	No tsunami description	S00
210	1905			M3	No tsunami description	S00
211	1905	1	20	M1	No tsunami description	P01
212	1909	6	15	M2	Meteorological event	BRGM13
213	1911	2	18	M1	No tsunami description	P01
214	1912	1	24	M1	No tsunami description	P01
215	1914	1	15	M2	Meteorological event	S00
216	1915	1	27	M1	No tsunami description	P01
217	1919	10	22	M2	No tsunami description	S00
218	1920	11	26	M1	Duplicate of the 1920/12/18	P01
219	1925	5	11-Dec	M2	Meteorological event	S00
220	1926	8	31	AT	No tsunami description	AN06
221	1926	12	18	AT	No tsunami description	BM09
222	1928	4	22	M1	Meteorological event	S00
223	1928	4	24/25	M1	Meteorological event	S00
224	1928	5	2	M1	No tsunami description	S00
225	1929	3	25/27	M1	Duplicate of the 1928/3/31	S00
226	1931	8	31	AT	No tsunami description	AN06
227	1932	5	7	M2	Meteorological event	S00
228	1933	4	23	M1	No tsunami description	A11, S00
229	1935	1	4	M1	No tsunami description	A11
230	1937	7	20	M2	Meteorological event	S00
231	1939	1	27	M2	No tsunami description	S00
232	1941	1	20	M1	No tsunami description	SA11
233	1941	3	16	M2	No tsunami description	S00
234	1949	6	18	M1	No tsunami description	FP07
235	1950	10	8	NW	No tsunami description	J68
236	1953	8	9-Dec	M1	No tsunami description	P01, S00
237	1959	2	23	M1	Meteorological event	S00
238	1961	6	6	M1	Meteorological event	S00
239	1962	5	28	M1	No tsunami description	PF05
240	1963	9	2	M3	No tsunami description	S00
241	1978	6	20		Meteotsunami	P01
242	1978	6	22		Duplicate of the 1978/6/22	S00
243	1979	5	15	M1	Meteorological event	S00
244	1989	10	29	M3	No tsunami description	S00
245	1990	8	2	BS	No tsunami description	P11
246	1991	1	4	M1	Meteorological event	A11, S00
247	1991	5	7	M1	Meteorological event	S00
248	2007	5	7	BS	Meteorological event	P11