

Review

# Palaeo-Tsunami Events on the Coasts of Cyprus

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**Abstract:** Cyprus has a long history of tsunami activity, as described in archaeological and geological records. Although the study area has experienced tsunamis in the past and constitutes an area threatened by this hazard both from the Cyprean arc and from the neighboring Hellenic arc, field research on tsunami evidence on the coastal zone of Cyprus still remains scarce. It is clear from the literature that large boulder accumulations are an important feature along the coasts of Cyprus, testifying to extreme events. A detailed field survey revealed that at various locations cited in the literature as hosting geomorphological evidence of past tsunamis, no such evidence was identified. It is likely that the high touristic activity that has been occurring on the coasts of Cyprus during the last 20 years may have affected tsunami indicators such as boulder accumulations. Tsunamis are unpredictable and infrequent but potentially large-impact natural disasters. The latest strong tsunami that caused damage to the Cypriot coast was centuries ago, when the population and economic growth and development at the Cypriot shoreline did not exist. Today, the coastal zone hosts a higher population as well as increasing touristic activity, highlighting the need for better preparedness, awareness raising and for tsunami-related risk reduction.

**Keywords:** tsunamis; boulders; sediments; eastern Mediterranean; Holocene; hazard



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## 1. Introduction

Coasts located at regions with intense tectonic forces are exposed to high vulnerabilities and hazards. Recent events, such as the Indian Ocean Tsunami in 2004 [1], Hurricane Katrina in 2005 [2] or the 2011 Tohoku-oki tsunami [3], have highlighted how marine and coastal processes can impact coastal populations. During the last few decades, the catastrophic impact of tsunamis has prompted a significant shift in public awareness and research on coastal risks globally [4–9].

Research into palaeo-high-energy events is essential for understanding how coasts respond to tsunami or storm impacts, for identifying tsunami prone areas, but also for coastal hazard mitigation. Long-term geologic records of palaeo-tsunamis allows us to better assess tsunami hazards and further raise society's understanding of this threat so that they are better prepared for the next devastating tsunami. Tsunami deposits may help scientists determine the depth and velocity of past inundations, estimate source locations, and better understand how tsunamis affect coastal ecology and geomorphology. In addition, the chronology of past tsunami deposits allow us to estimate the time and

recurrence intervals of past tsunamis [10]. This type of data can help guide mitigation measures and prevent tsunami losses in the future.

Since the 2004 Indian Ocean tsunami, research efforts have greatly increased not only in terms of identifying palaeotsunami deposits but also with regard to post-tsunami surveys to investigate geological and geomorphological impacts [10]. It is worth noting that since 2004, tsunami-related science has experienced a significant peak, and this has been noted by [11] when researching relevant literature since 1950.

Post-tsunami surveys after recent events included the study of tsunami sedimentation, such as boulders or sediments, inundation mapping, spatial and temporal variations in hydrodynamic parameters, and bathymetric and topographic data sets before and after tsunami events [10,12–16]. Additionally, geodetic observations can offer direct information about offshore fault slip distribution in a much faster way than offshore observations. As a result, the forecasting time is shorter even with short observation periods [17]. The investigation of modern events and the sedimentological characteristics of contemporary tsunami deposits can greatly facilitate palaeo-tsunami studies.

Palaeo-tsunami research is mainly focused on the research of distinct marker horizons in coastal stratigraphy [12,18–20] and boulders that are found on the coastal zone [21–25], displaced from their original location in the intertidal or subtidal zone.

With regard to coastal stratigraphy, several writers have documented the distinctive features and typical sedimentary characteristics of onshore tsunami deposits [26–29]. According to [9], in order to distinguish tsunami deposits from storm deposits, a multiproxy approach is necessary that will incorporate geological, biological, geochemical, geomorphological, archaeological, and anthropological proxies.

Boulder deposits are also a frequent sedimentological proxy used to decipher past tsunami events on the coastal zone. In the case of boulders as well, the identification of the high-energy event that was capable to dislocate them remains controversial [30], and such deposits have been interpreted as both “storm” and “tsunami” deposits, because they often have similar characteristics [31]. The most common approach for their study includes detailed mapping through fieldwork and the use of hydrodynamic equations that have been developed to determine their origin by calculating the wave height and the velocity necessary to transport them [32–37]. Nott et al. [32] was the first to introduce these hydrodynamic equations, taking into consideration the pre-transport location of a coastal boulder, and its shape, size, and density. Different scenarios exist for the possible original location of the displaced boulders; therefore, for their application, their pre-transport location is necessary to be identified. Thus, different equations are used for a possible submerged boulder prior to transportation, when the boulder is moved on the shore by waves, or when a boulder is dislocated from a rocky shore. Following Nott et al. [32], comparable approaches and improved versions of these equations have been used [33–37]. Furthermore, in order to improve nearshore tsunami hydrodynamics, physical experiments have also taken place by simulating different shore types and real boulder shapes [38].

Through the application of such hydrodynamic equations, one may decipher whether the studied boulders have a tsunamigenic origin by comparing the calculated storm wave height with the wave regime of the study area. This is particularly the case for the Mediterranean region, an area of microtidal regime and limited fetch, as the application of such equations is ideal, because storm wave heights are not as large as in other areas where notable storm wave heights may develop [22].

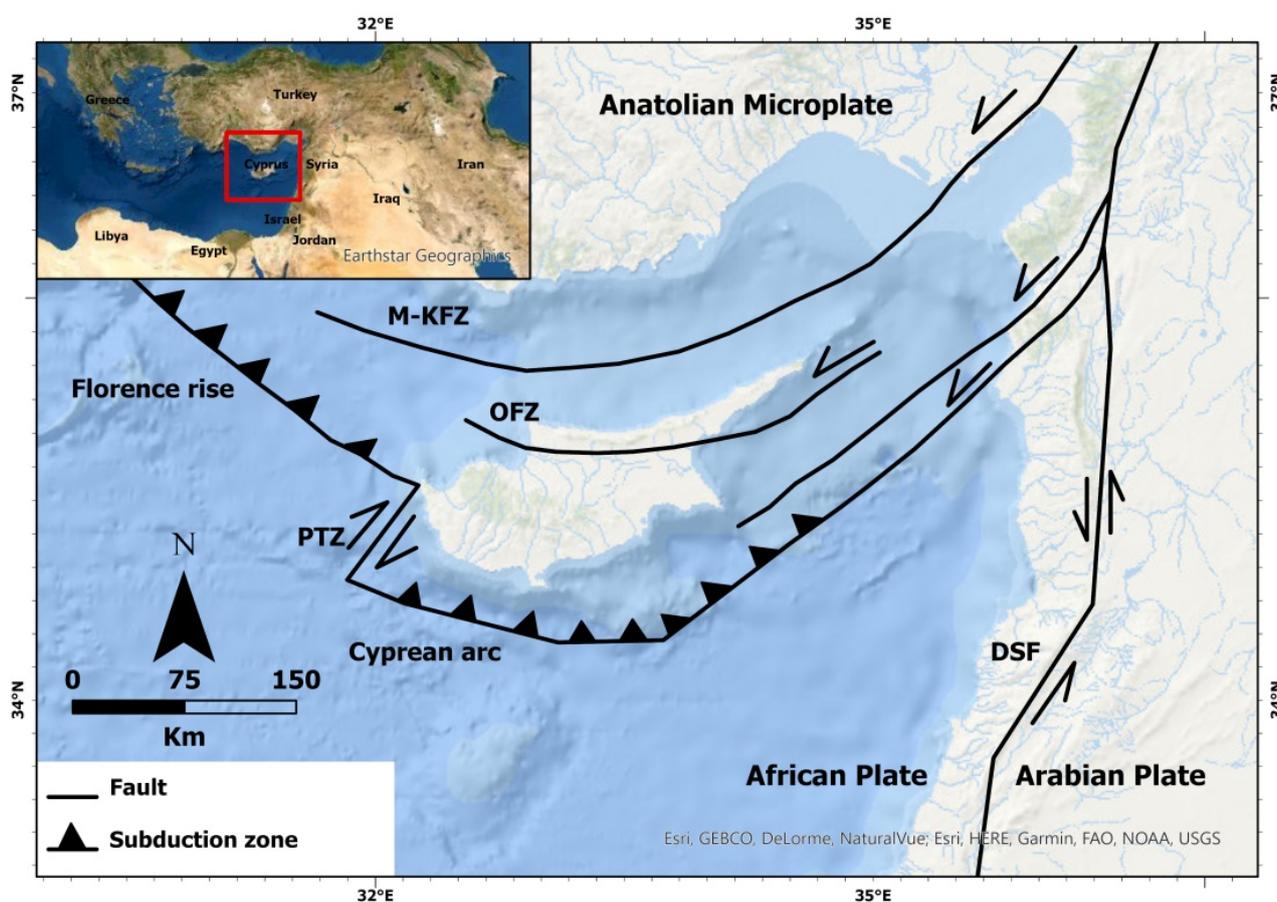
Cyprus has a long history of tsunami activity, as described in archaeological and geological records. The literature related to the occurrence of tsunamis on the eastern Mediterranean has a wealth of historical records [39,40]. Several studies in the coastal areas of Cyprus [25,41,42] have found various geomorphological evidence indicative of past tsunamis. The most frequently noted indicators are boulders, which may be found primarily on the west and southeast coasts of Cyprus.

In this context, this work aims to provide an overview of palaeo-tsunamis and their field evidence on the coastal zone of Cyprus through an extensive literature review and

the discussion of relevant of field data. Through this work, we aim to provide a better understanding of the tsunami hazard in Cyprus as well as to identify research gaps that should be investigated in the future.

## 2. The Geotectonic Setting of Cyprus

The island of Cyprus is located in the southeast part of the Mediterranean Sea (Figure 1). This part of the Mediterranean is dominated by the Cyprean arc and the left-lateral strike-slip Levantine rift. In the Cyprean arc, shallow- and intermediate-depth earthquakes take place primarily in the submarine environment; hence, earthquakes of large magnitudes are expected to cause strong tsunamis [39]. In Cyprus, the relationship between tsunamis and earthquakes is documented through past seismotectonic studies [43–46], along with archaeological [47,48], historical [49,50], and geomorphological studies [42,51].



**Figure 1.** Location and geotectonic setting of Cyprus (PTZ: Paphos Transform Fault; DSF: Dead Sea Fault; M-KFZ: Misis–Kyrenia Fault Zone; OFZ: Ovgos Fault).

The characteristics and complex structure of the seismic deformation along the Cyprean and Hellenic arc are directly related to the convergence between the Aegean, Anatolian, Eurasian, and eastern Mediterranean lithosphere, which are connected with strike-slip, thrust, and normal faulting [52]. Research suggests that in the lower part of the continental slope, younger tectonic slope failures exist, which are prone to tsunamis along the adjacent coasts of the Mediterranean Sea [52–55]. With regard to the Cyprean arc, tsunami generation can occur in the sea bottom, as seismic activity is identified at offshore seismogenic zones to the W and SW of Cyprus (Figure 1).

According to GPS data, Cyprus is currently forming the upper plate of a subduction zone, hosting the convergence between Eurasia and Africa [56,57]. A 2.5 km deep trench

marks the boundary of the modern plate, where thrust faulting and thrust-related growth strata have been identified through seismic reflection data [57–60].

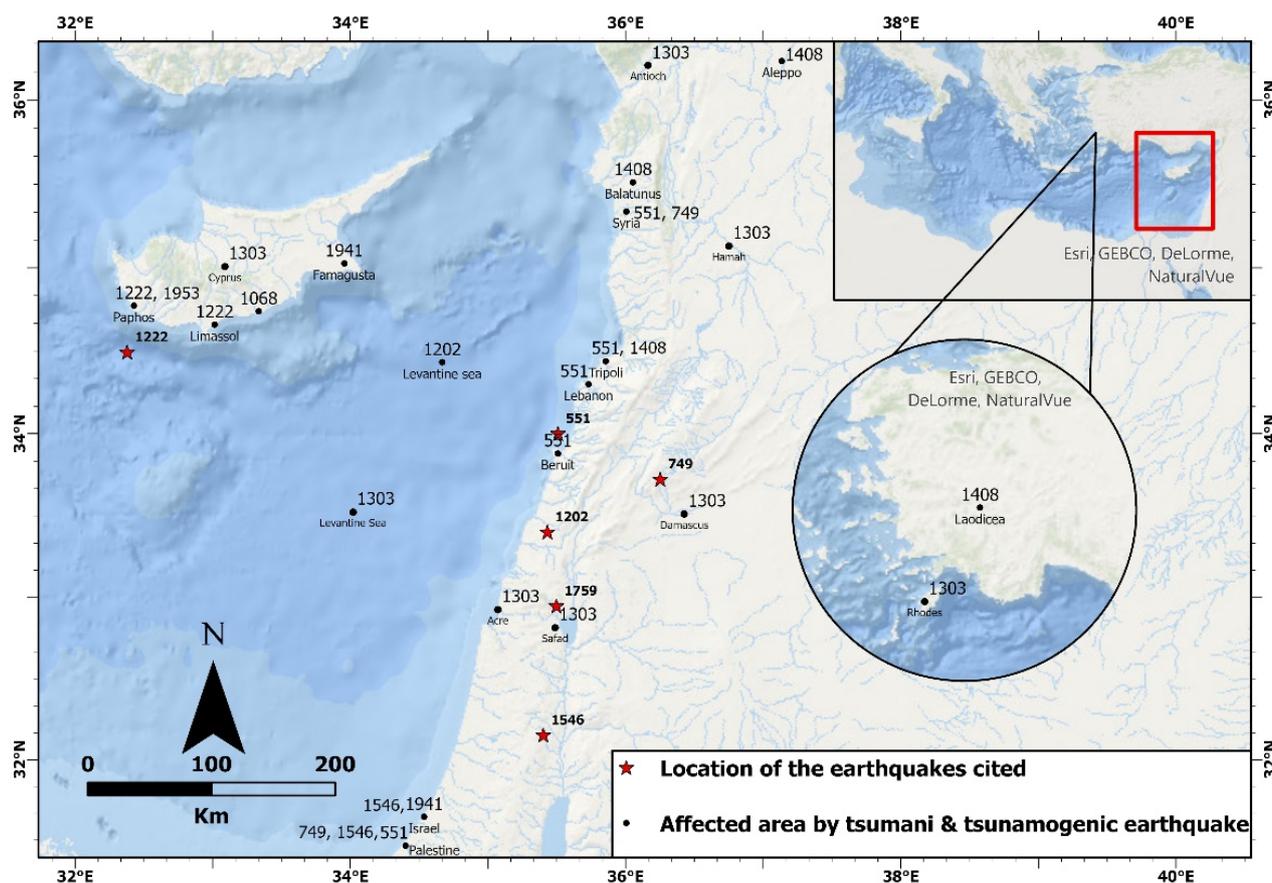
The spatial distribution of tsunamis in the region of Cyprus–Levantine Sea is directly connected with the tectonic setting of the wider region [39]. Two main zones are identified [39]: (i) in south Cyprus, seismic activity takes place along the Cyprean arc, and the generation of tsunamis is favored primarily by seismogenic sources underwater by co-seismic fault dislocations, and (ii) in the Levantine Sea northwards from Gaza, where tsunami-related earthquakes are primarily related to the left-lateral strike-slip fault system of the Levantine rift; in this case, the seismogenic sources are terrestrial and not submarine, and hence, a mechanism that generates tsunamis has yet to be explained.

According to Selva et al. [61], in tectonic settings and small basins, such as the Mediterranean region, atypical sources may represent the majority of potential sources for tsunamis. A significant number of damaging tsunamis were owed to non-subduction earthquakes or non-seismic sources [62–67], which appear to have brought about significant tsunamis according to the available historical record [61,68]. Recent earthquakes that have generated tsunamis with run-up larger than 1 m were owed to crustal seismicity, such as the M6.8 Zemmouri-Boumerdes, the M6.8 Kos-Bodrum in 2017, and the recent M7.0 Samos earthquake in 2020 [61,69]. Hazard analysis, in general, which takes into consideration the source probability and the tsunami potential, has shown that the total tsunami hazard is significant both from crustal sources, but also along coasts near subduction zones, and they may constitute the main origin for various areas in the Mediterranean [46–48,62,70,71].

### 3. Historic Record of Tsunamis in Cyprus

The strongest tsunamis reported in the region of interest are those of 551 AD, 749, 1068, 1202, 1222, 1303, 1408, 1546 [72], and the modern tsunamis of 1941 and 1953, all occurring along the Levantine coast from Gaza northward (Figure 2). According to Salamon [73] and Papadopoulos et al. [74], in 551 AD, a sea retreat of more than a kilometer was recorded while ships were destroyed from the coast of Lebanon, Syria, and Palestine, with many references on the cities of Beirut and Tripoli. In 749 AD, an earthquake event was recorded followed by a tsunami at the coasts of Palestine, Jordan and Syria. The reported tsunami of 1068 has yet to be certified, as many studies have mentioned this event; however, they have not concluded on a specific earthquake source and date [44,45,72,73,75]. These earthquakes may have affected the southern coasts of Cyprus but without any particular record at the time as they may not have caused any disruption to human constructions. Consequently, in 1202 AD, in the Levantine Sea between Cyprus and Syria, a tsunami was recorded and referred to by many scientists [45,46,73,76,77]. Fokaefs and Papadopoulos [39] mentioned that the tsunami had an intensity of 7 and was triggered by an earthquake of M7.6 [75]. A possible cause of the tsunami could have been a submarine landslide following an inland earthquake [74] (Figure 2).

On the other hand, there have been tsunami occurrences far away that did not affect the Cyprus coastline. One of these tsunamis occurred around 1408 AD, and it was generated by a tremendous earthquake in the western part of Syria that caused damage mostly in the areas of Aleppo, Tripoli, Laodicea, Balatunus, and as far as Cyprus [72,73,75,78]. The intensity of the tsunamigenic earthquake was estimated as  $M_s = 7$  by Ambraseys and Barazangi [79] (Figure 2).



**Figure 2.** Location of reported historical earthquakes and areas affected by tsunami or tsunamigenic earthquakes.

In 1546, a sea retreat was recorded in southern Israel. According to studies [44,45,72], the sea withdrew from the coast of Palestine and a tsunami followed. However, there is no evidence of its origin. Probably, this tsunami was caused by a moderate-intensity earthquake  $M_s = 6$  in the Jordan Valley, Israel [44,45,72,80–82]. However, this reported earthquake might not have been strong enough to produce a tsunami (Figure 2).

The latest catastrophic tsunami was in 1222. Waves were many meters high, and the earthquake and tsunami caused severe loss of life and widespread disasters in Paphos and Limassol. The city and the fortress of Paphos were flooded, and many fishes were found in the villages. A relevant description of the event was as follows: “The Paphos port left without water as the coastline moved to the sea” [39] (Figure 2).

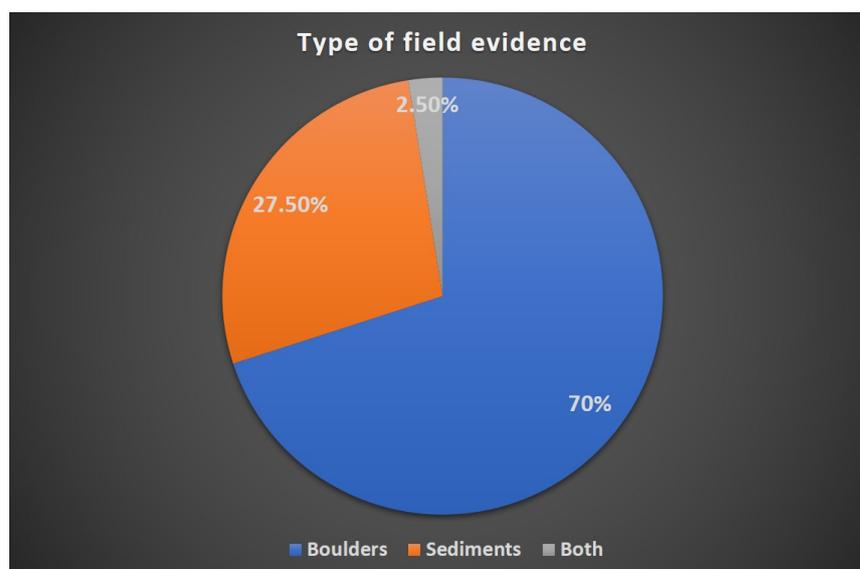
The latest tsunami events in Cyprus were in 1941 and 1953. In 1941, a  $M_s = 6.5$  earthquake in Famagusta (east Cyprus) caused a small earthquake tsunami which was observed off the coast of Israel and did not cause damage (Cyprus Geological Survey Department’s data). A very strong earthquake of  $M_s = 6.3$ , 9.1 km southwest of Paphos on Thursday, 10 September 1953 at 04:06 (GMT) caused tsunami waves around 1 m high. This small tsunami was seen along the coast of Paphos and did not cause any damage [39] (Figure 2).

#### 4. Evidence of Palaeo-Tsunamis on the Coastal Zone of Cyprus

##### 4.1. An Overview of Published Field Evidence

Although the study area has experienced tsunamis in the past and constitutes an area threatened by this hazard both from the Cyprean arc and from the neighboring Hellenic arc, field research on tsunami evidence on the coastal zone of Cyprus still remains scarce. Palaeo-tsunami deposits on the coasts of Cyprus were first reported by Kelletat and Schellmann [41] and Whelan and Kelletat [42] in 2002. Both studies reported field evidence from the west

and southeast coasts of Cyprus in the form of boulders (Figure 3) and in the form of bands parallel to the coastline that were striped by soil or vegetation [41,42]. According to radiocarbon dating of marine organisms on dislocated boulders as well as relocated wood and charcoal from the west coasts [41], the coast of Cyprus were impacted by strong tsunamis around 1700–1750 AD. The aforementioned field data were later supplemented by Noller et al. [83], who provide further sites with field evidence of past tsunamis also from the north, northeast, south, and southeast coasts of the island; however, this evidence does not have any age constrains. A detailed field investigation on the southeast coast of Cyprus at Cape Greko by Evelpidou et al. [25] confirmed the existence of large, dislocated boulders, and radiocarbon dating on marine organisms revealed that the area was affected by the 1303 tsunami event but also by other extreme events that remain to be updated.



**Figure 3.** An overview of published work on palaeo-tsunamis in Cyprus shows that the main indicators used are boulders, while sediments have been reported less frequently.

It is clear from the literature that large boulder accumulations are an important feature along the coasts of Cyprus, testifying to extreme events (see Supplementary Material). Although there is an abundance of field evidence, geochronological constrains are still scarce in the study area. In some coastal areas, the lithology of the boulders, i.e., calcarenites, makes the discovery of any datable material for radiocarbon difficult, such as the case of Cape Greko [25]. Recent attempts by Brill et al. [84] to use optically stimulated luminescence rock surface exposure dating (OSL-RSED) to estimate cliff-detachment ages of wave-transported coastal boulders of calcarenitic composition were also found to be unreliable due to low amounts of sensitive quartz and feldspar. Calcarenites are carbonate-dominated and/or carbonate-cemented sandstones which are predominantly >50% composed of carbonate grains. They can contain up to 50% non-carbonate grains such as quartz and feldspar, but they are not studied in depth with regard to occurrences on the Cyprus coastline. Additionally, waves and bio-erosion on boulder surfaces may affect the accuracy of the geochronological method applied [84].

#### 4.2. Survey Overview of Available Field Data

A detailed field survey was conducted by the authors during 2020. They visited and investigated sites that were reported in the available literature [6,42,81] for high-energy event deposits along the south coastline of Cyprus. The field survey was conducted in 19 coastal areas: Akamas Peninsula, Lara coast, Agios Georgios, Maniki coast, Kissonerga, Kato Paphos, Paphos Airport, Kouklia, Petra toy Romiou, Avdimou, Episkopi, Zygi-

Maroni, Larnaka, Pyla cape, Ormidia, Xylophagou, Liopetri, Ayia Napa, and Protaras (see Supplementary Material for locations).

Through the survey, the authors were unable to identify any clear boulder accumulation or movement by tsunami in most of the aforementioned areas. On the rocky south coast of Cyprus, there was evidence of wave impact. However, most aforementioned sites were characterized by the absence of tsunami indicators. A possible explanation is that the high touristic activity that has been occurring on the coasts of Cyprus during the last 20 years may have affected tsunami indicators such as boulder accumulations. Nowadays, it is very difficult to have free access to the coast, as many locations are private.

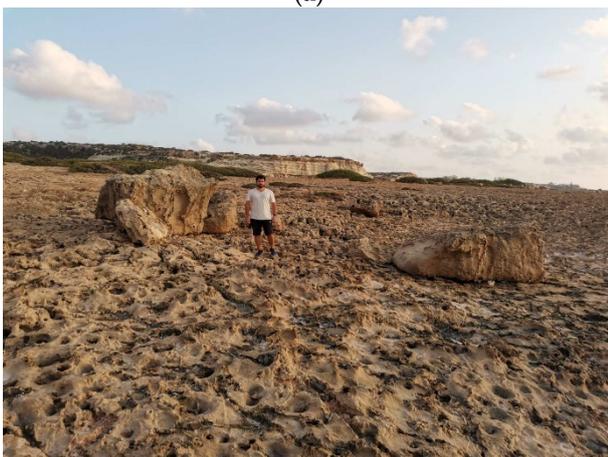
On the other hand, on the west coast of Cyprus, one site of boulder accumulation was identified [42]. The site is located at the north-west Agios Georgios, Paphos (Figures 4c,d and 5). The boulders have a maximum size of 1.5 m<sup>3</sup>. The rocky coast of Agios Georgios is characterized by a gentle seaward dip, highly erosional features (creep lines and karrens), and it is scraped of soil. Taking into account the geomorphology of the rocky coast and the fact that the area is highly affected by large waves, it is possible that these small boulder accumulations were dislocated because of a storm event.



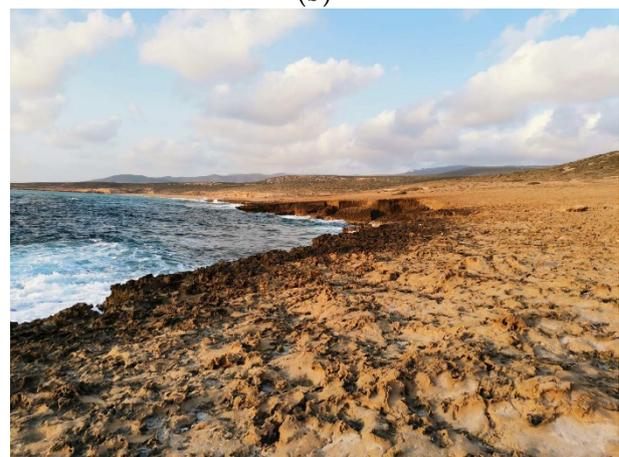
(a)



(b)



(c)

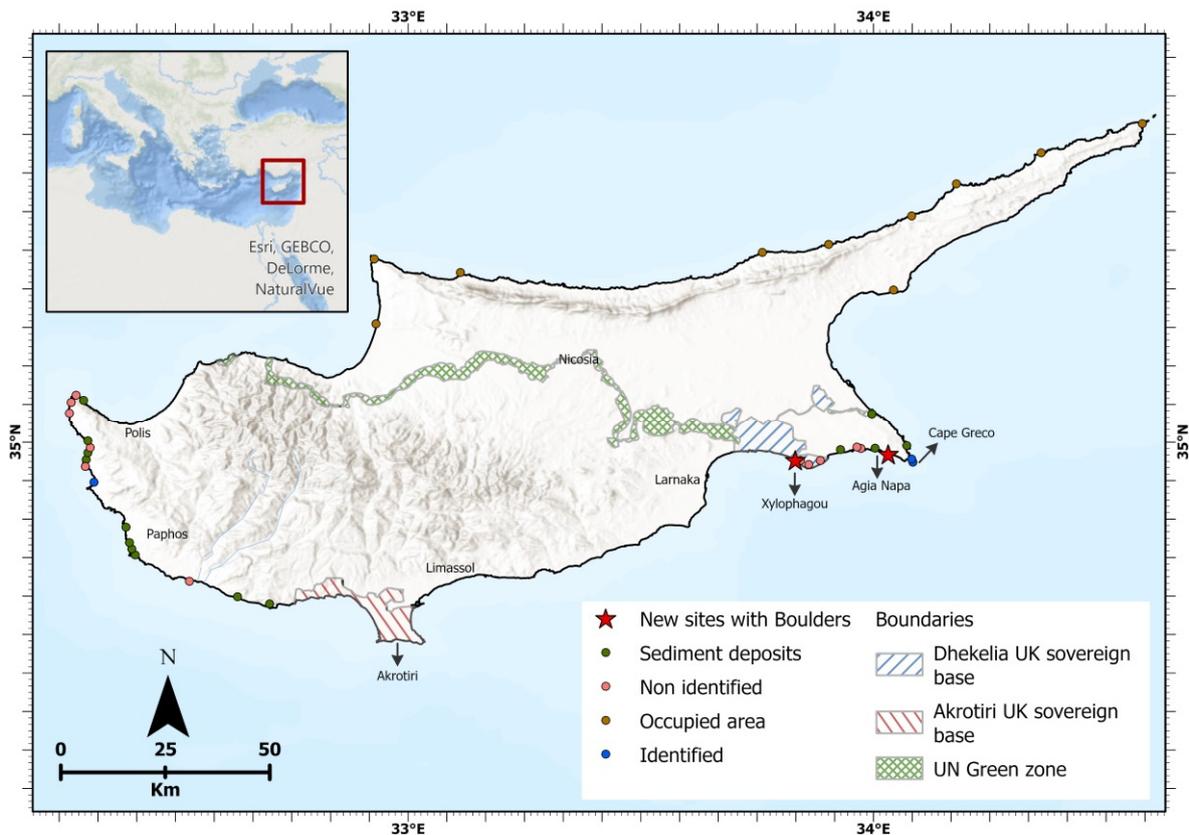


(d)

**Figure 4.** *Cont.*



**Figure 4.** Example of sites of south Cyprus. In most cases, there is an absence of evidence of high-energy event deposits as mentioned in the literature: (a) Paphos airport area with a beachrock formation. Beachrocks may create flattened boulders as they break from the wave action; (b) Lara coast with no high-energy event deposits available. Confirmed evidence of high-energy event: (c) 4 identified boulder deposits at Agios Georgios, Pathos; (d) general view of Agios Georgios, Pathos rocky coast. (e,f) Boulders at Cape Greco, Cyprus, lying at about 4.5 m above sea level. According to Evelpidou et al. [25], their geomorphic characteristics suggest that their current location is owed to at least one tsunami event.



**Figure 5.** Map of Cyprus with all possible tsunami occurrences in the literature. Boulder deposits and sediment deposits cases are mentioned. The red stars indicate the newly identified areas, identified by the authors. The data presented in this map are available at <https://arcg.is/1eyXLO> (accessed on 26 November 2020).

Another identified boulder accumulation that indicates a high-energy wave event is located at Cape Greco, Ayia Napa (Figures 4e,f and 5) [25]. The area is characterized by quite evident geomorphological features related to at least one tsunami event: a calcarenitic, rocky coast, scraped from soil, boulder deposits, two eroded platforms, boulder detachment zones, and karrens on the rocky coast. At that site, 272 boulders of various sizes were reported (Figure 4e,f) with a maximum volume of 24.7 m<sup>3</sup> and a maximum height of 4 m a.m.s.l. [25].

As mentioned before, all the sites with boulder accumulation share similar geomorphological features: the deposition of boulders, imbricated clusters, detachment zones, eroded platforms, and rock shear zones. These features were not found at sites with non-identified boulders. This indicates a close relationship between the morphology of the coast and the accumulation of boulders (Figure 4). During the survey, the authors were unable to confirm tsunami sediment deposits reported by previous studies, e.g., tsunami deposits of 20 cm thickness located 3–4 km at the west of Petra tou Romiou [41,51,81]. The sediment deposit sites are indicated in the map of Figure 5 along with the unidentified boulder cases, as noted in the literature [6,42,81].

#### 4.3. An Overview of New Field Data

The recent survey investigation conducted by the authors revealed two additional areas which have been affected by high-energy wave events, possibly tsunamis. The areas Xylophagou and Agia Napa are located on the southeastern part of Cyprus (Figure 5). Additionally, the authors conducted underwater photography and video in the Cape Greco area using a submarine drone in order to identify morphological features on the seabed, which can indicate a tsunami impact. In the submarine area south to Cape Greco, the seafloor is scraped of sediments and the vegetation is limited. Below the coastal platform, the seabed has a smooth inclination, which is abruptly interrupted by a vertical rocky step with a rectangle shape. The walls of the submerged rocks are also vertical with signs of intense wave carving. Moving deeper, in a distance of 20 m from the coastal platform, a second rocky vertical step was observed, which had evidence of an in situ boulder that has been detached from its main rock mass, but it was not moved from its initial place. Piloting the submarine drone towards the coast, drag lines were also visible. These lines indicate the movement of rock masses from/towards the coast.

The Xylophagou site shares similar geomorphological features to the Cape Greco site, with dislocated boulder accumulations lying on the coast. Six (6) boulders were identified, possibly originating from the subaerial platform (Figure 6). The boulders are located on the rocky coast at an altitude of 4 m above mean sea level (a.m.s.l.). During the investigation of the site, a layer of cemented pebbles was identified at a high elevation, above the aeolianite and the boulder deposits. This cemented layer may correspond to a palaeo-shoreline, suggesting an uplift of the area.

At the Ayia Napa site, ten (10) boulders were identified, whose original location is likely from the coastal platform (Figure 7). The site has similar features to the Cape Greco area. The boulders are located approximately 5 m a.m.s.l. on a high vertical cliff of aeolianite composition. They are located on the landward part of a wide eroded surface.



**Figure 6.** Boulders at Xylophagou, Cyprus. Their characteristics indicate that their current location is owed to at least one tsunami event. (a) Two boulders lying at about 4 m a.m.s.l. with a mean size of  $0.6 \text{ m}^3$ . (b) A boulder sized  $2 \text{ m}^3$  lying at about 0.5 m a.m.s.l. on a wavecut plateau.



**Figure 7.** Boulders at Ayia Napa lying at about 5 m a.m.s.l. on a coastal cliff. Their geomorphological characteristics indicate that their present location is also owed to at least one tsunami event. (a) Boulder clusters with a mean size of  $0.5 \text{ m}^3$ ; (b) a 4 m high vertical cliff at Ayia Napa site.

### 5. Warning System and Tsunami Risk for Cyprus Coasts

Within the Mediterranean, the tsunami hazards of Greece and Italy are ranked among the highest based on the tsunami records in contrast with the Cyprus–Levantine region, which is classified at the lowest level. Within this area, the Levantine coast is at much higher risk than Cyprus [39]. However, some of the damaging historical events highlight the need to evaluate tsunami hazards by all available means. Furthermore, remote tsunamigenic sources, such as those of 1303 with an earthquake epicenter in southern Cyprus [44,73,75] or 1481 in the eastern Hellenic arc, can pose a threat for the coastal zone of the Cyprus–Levantine area; hence, even these regional tsunamis should be considered in the evaluation of the tsunami risk of the region [39].

The average tsunami recurrence in the Cyprus–Levantine Sea region has been estimated to be around 30 years, 120 years, and 375 years for moderate (intensity > III), strong (intensity > V), and very strong (intensity > VIII) events, respectively [51,81]. The rate of tsunami occurrence equals  $0.033$ ,  $8.3 \times 10^{-3}$  and  $2.7 \times 10^{-3}$  events/year for intensity higher than III, V, and VIII, respectively [82].

The tsunami risk in Cyprus can come from three different sources:

1. Local, strong, submarine and surface earthquakes in the central part of the Cyprus arc (e.g., the earthquakes of 1222 and 1953). The Cyprian arc is subjected to subduction, collision, and transcurrent tectonic processes.
2. Submarine landslides on the Levantine coast, which are caused by strong earthquakes in the rift of the Dead Sea (e.g., the earthquake of 1202). Near the Levantine coast, the bottom is characterized by a steep slope, as well as east of Rhodes Island and south of the Cypriot shoreline, south from Paphos city.
3. Regional, strong, submarine and surface earthquakes in the Hellenic arc (e.g., the earthquakes of 1303 and 365). The tsunami potential in the Hellenic arc is the highest in the Mediterranean.

The latest strong tsunami that caused damage to the Cypriot coast was centuries ago, when the population and economic growth and development at the Cypriot shoreline did not exist. Today, the population of the coastal cities is more than 250,000, and the tourism in Cyprus reaches almost 4,000,000 visitors per year (according to the official Cyprus Government's data). According to the above, the impacts of a probable tsunami are maximized.

Although tsunamis are infrequent and they remain unpredictable, they are amongst the natural hazards with potential significant impact. Probabilistic hazard and risk analysis methods have been developed to aid in the preparation, mitigation, and prevention of potential losses from this natural hazard [71].

Most countries in the region have systems and procedures in place to warn residents in the case of a natural disaster. National systems commonly link to regional multi-hazard networks. Since 1965, the UNESCO Intergovernmental Oceanographic Commission (IOC) has been responsible for coordinating the Pacific Tsunami Warning System (PTWS). In June 2005, following the 26 December 2004 tsunami in the Indian Ocean, it was decided to set up three similar warning systems in the Indian Ocean, the Caribbean, and the North Atlantic and Mediterranean regions.

The Tsunami Service Providers (TSPs) of European countries for the Mediterranean region are: France, Turkey, Greece, Italy, and Portugal. These Service Providers may issue public messages for an ocean basin but only with a generic tsunami threat statement to avoid potential conflict and public confusion with the tsunami warnings issued by the National Tsunami Warning Centers (NTWCs). For this purpose, TSPs are continuously used throughout the year [16].

On 25 November 2016, the Council of Ministers approved the establishment of the Cyprus National Committee for NEAMTWS, coordinated from the Department of Geological Survey, members of the Civil Defense, and the Oceanographic Center of Cyprus University.

In Cyprus, as part of the operation of the NEAMTWS System, the Seismological Network of the Department of Geological Survey provides, in real time, continuous seismic data to the National Seismic Wave Warning Center of the Geodynamic Institute of the National Observatory of Athens and the Italian Center for Geophysics and Volcanology (INGV). In the case of a tsunami being detected, automatic warnings are sent to the Member States of the system. These alerts are received from local authorization centers (Civil Defense services for Cyprus), which activate national disaster response plans.

## 6. Concluding Remarks

An overview of bibliographically available information regarding tsunami evidence in Cyprus coastline is presented in this paper. New data were derived from extensive field work, which revealed additional locations of boulder accumulations that can be studied in detail in order to provide more data for palaeo-tsunami events in the Mediterranean. The source of the events in the region of the eastern Mediterranean appears to be connected mainly with strong local and regional surface and submarine earthquakes. The average tsunami recurrence in the Cyprus–Levantine Sea region appears to be around 30 years for moderate events, 120 years for strong events, and 375 years for very strong events.

From the recorded historical events, it is clear that this region of the Mediterranean has been constantly and continuously affected by tsunamis in the past. From the investigation and detailed study of past events, it is possible to obtain more data regarding the source of these events, to calculate the intensity, and provide a better estimation of the hazard, which will lead to the development of coastal management plans which will be focused on natural hazards.

**Supplementary Materials:** The data presented in Figure 5 are available at <https://arcg.is/1eyXLO> (accessed on 25 November 2021). A dashboard including a map along with statistics of the type of evidence may be found in the following link <https://www.arcgis.com/apps/dashboards/3aca7dc81d604e2ab7171eb35cf9a9fa> (accessed on 25 November 2021).

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