

---

# Defence and Protection of the Marine Coastal Areas and Human Health: A Case Study of Asbestos Cement Contamination (Italy)

---

[Roberta Somma](#)\*, Salvatore Giacobbe, Francesco Paolo La Monica, Maria Letizia Molino, Marina Morabito, [Sebastiano Ettore Spoto](#), Salvatore Zaccaro, Giuseppe Zaffino

Posted Date: 21 February 2024

doi: 10.20944/preprints202402.1185.v1

Keywords: marine coasts; protected areas; defense and conservation; asbestos cement materials; wastes; contamination; human health risk; medical geology



Preprints.org is a free multidiscipline platform providing preprint service that is dedicated to making early versions of research outputs permanently available and citable. Preprints posted at Preprints.org appear in Web of Science, Crossref, Google Scholar, Scilit, Europe PMC.

Copyright: This is an open access article distributed under the Creative Commons Attribution License which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Article

# Defence and Protection of the Marine Coastal Areas and Human Health: A Case Study of Asbestos Cement Contamination (Italy)

Roberta Somma <sup>1,\*</sup>, Salvatore Giacobbe <sup>2</sup>, Francesco Paolo La Monica <sup>3</sup>, Maria Letizia Molino <sup>4</sup>, Marina Morabito <sup>2</sup>, Sebastiano Ettore Spoto <sup>1</sup>, Salvatore Zaccaro <sup>5</sup> and Giuseppe Zaffino <sup>3</sup>

<sup>1</sup> Department of Mathematical and Computer Sciences, Physical Sciences and Earth Sciences, University of Messina, Viale F. Stagno d'Alcontres, 31, Sant'Agata (Messina), 98166, Italy; rsomma@unime.it

<sup>2</sup> Department of Chemical, Biological, Pharmaceutical and Environmental Sciences, University of Messina, Viale F. Stagno d'Alcontres, 31, Sant'Agata (Messina), 98166, Italy; morabitom@unime.it

<sup>3</sup> Ambiente Lab, Granatari (Messina), 4, 98164, Italy; gzaffino@me.com

<sup>4</sup> Metropolitan City of Messina, Palazzo dei Leoni, Corso Cavour, 98122, Italy

<sup>5</sup> pH3 Engineering S.r.l., Via Caio Duilio, 2, Messina, 98123, Italy

\* Correspondence: rsomma@unime.it

**Abstract:** A pivotal environmental geology research was carried out in the protected area of Cape Peloro (Messina, NE Sicily, Italy). Main aims were the ascertainment of the presence of Asbestos Cement Materials (ACMs), their mapping, and consequently the potential risk for human health and marine coastal environments. The beaches surveyed covered 4500 m of coastline. Through high-resolution photographic surveys, over 520 fiber cement fragments were documented on the beaches as well as in the beach deposits. The materials, after microscope, SEM-EDS, and FTIR analyses, resulted to be composed of Portland cement with prevailing fibers of chrysotile and crocidolite. Fragments of ACMs showed typical corrugated forms with centimeter to decimeter sizes and prevailing well-rounded, platy, and sub elongate shapes. In a few localities, tens of fragments resulted to be angular or friable. Furthermore, some fragments found on the beach resulted to be covered by conspicuous encrustations of marine organisms, testifying to their long staying in shallow-water marine environments. Illicit landfills and abandons were identified in natural sections on the coastal plain. Most of the rounded ACMs was characterized by surface textures showing mm-size asbestos fibers exposed on the surface because of significative weathering and abrasion. Noteworthy, new fragments appeared after storms. Significative criticisms related to the ACMs were evidenced, analogously to what reported for other Italian marine beaches. Possible intervention and reclamation activities cannot limit themselves to remove the fragments on the beach, being them immersed in the coastal sediments, at different depths, but also in the marine deposits. At last, it is here underlined as it is proven that any needful asbestos removal and reclamation activities, if not designed and based on a multidisciplinary approach and knowledge of local coastal dynamics and meteo-marine climate is very expensive and ineffective.

**Keywords:** marine coasts; protected areas; defense and conservation; asbestos cement materials; wastes; contamination; human health risk; medical geology

## 1. Introduction

The general term “asbestos” is commonly used for identifying six silicate minerals belonging to the groups of serpentine (chrysotile) and amphiboles (amosite, actinolite, anthophyllite, crocidolite, and tremolite) [1].

Their peculiar chemical-physical properties (fireproof, lightweight, high tensile strength, electrical resistance, durability, and flexibility) were exploited by the industries since the early-mid-19<sup>th</sup> century to produce fiber cements, insulation, and textile materials [2]. Their diffusion in military, industrial, agricultural, and residential structures was essentially due to its low cost and its significative physical properties. The asbestos cement materials (ACMs) were denoted Eternit (a registered trademark) by a famous industry for evidencing its long life. Asbestos minerals were dug

out from quarries worldwide (Canada, USA, South Africa, Russia, and Italy). In the Italian Alps, at Balangero (Tourin), there was one of the largest industrial-scale mines in Europe [3].

Asbestos cement is a lightweight light gray product (specific weight: 1.8 – 2.2 g/cm<sup>3</sup>) composed of a homogenous matrix of cement (Portland cement, CaCO<sub>3</sub>), mixed with a reinforcing grids of asbestos fibers, present in percentages ranging from 10 to 15% by weight. Quarts sands and artificial glass wool may be also added in the mixture. Notwithstanding the grid of asbestos fibers is embedded in the ACM cement matrix and well immobilized, when the matrix degrades, because of long-term weathering, abrasion, and erosion, asbestos fibers may be inevitably released in the atmosphere, hydrosphere, and lithosphere contaminating the natural resources. The most widespread asbestos minerals, mixed in the fiber cement produced in southern Italy, were commonly chrysotile and crocidolite, occurring in mossy aggregates in fibrous and asbestiform habits. Indeed, these minerals are easily crumbled to smaller bundles of fibrils. Chrysotile belongs to the serpentine subgroup of phyllosilicates [Mg<sub>3</sub>Si<sub>2</sub>O<sub>5</sub>(OH)<sub>4</sub>] [4] and shows a white color appearance (known also as white asbestos). Crocidolite is a variety of riebeckite (known also as blue asbestos) [Na<sub>2</sub>(Fe<sup>2+</sup><sub>3</sub>Fe<sup>3+</sup><sub>2</sub>)Si<sub>8</sub>O<sub>22</sub>(OH)<sub>2</sub>] [4] is characterized by a typical cobalt dark blue to lavender color and exhibits waved fibers [5]. As regards their behavior, chrysotile, have lower tensile strength and higher heat resistance than crocidolite [5]. Due to their different colors, aspect, and mm-size, these two fiber minerals may be easily recognized in the ACMs present in the territory by means of the naked eye or 10X magnifying lens.

The most widespread asbestos cement products were the corrugated roofings, mostly still present (and in part protected by special encapsulating paints), the water tanks, and tubes. In particular, the Eternit sheets of the corrugated surfaces were about 1 m wide, from 1.2 to 3.75 m long, and thick from 4 to 20 mm. The number of undulations could be from 5 to 7 with a mean 177 mm wide amplitude of the crests. Mm-sized ornamentations, present on one side of this material, in order to render rough, the surface, were usually made up of honeycomb-like textures (with mark alignments oblique to the crests) or of aligned square marks (similar to “dome and basin like” shapes, aligned parallel and orthogonal to the crests).

ACM continued to be produced and used in Italy until the beginning of the 1990s, before the law n. 257 of the 1992 [6] that definitely banned its production and use, because of its toxicity and consequent high health hazard. The Italian legislation with the ministerial decree of the 1994 [7] ruled the analytical instrumentation and also the removal and remediation activities. After the Italian legislative decree of the 1997 [8], ACMs represented a critical issue to be managed by competent authorities for their removal and remediation in controlled landfills after thermal, chemical, or mechanical processes. In the 1999, the ban was extended also to the rest of the European Union [9].

According to the Italian legislative decree n. 152 of the 2006 [10], the ACMs were classified as dangerous wastes (CER code 17 06 01\* 17 06 05\*). Old corrugated roofings and pipes, are still extensively diffused in the Italian territory. Moreover, after the ACM ban, considered the expensive taxes for the disposal activities, illegal abandons of these wastes in uncontrolled areas of the territory (rivers, streams, slopes, coastal areas) increased determining a diffused criticism in Italy, especially during 1990s [11] but still present.

After the laws above reported, the Italian legislation furtherly evolved conferring to the Regions the competences for the necessary actions to carry out, in order to protect the environment. Already with the law n. 257 [6], the Regions were entrusted to draw up the plans for the environmental protection, decontamination, disposal, and remediation activities, in order to contrast the hazards deriving from human/environment-asbestos interactions.

In particular, at regional scale, the regional law of the 2014 [12], after accepting the national regulatory evolution occurred in the meantime, provided indications for the adoption, on the regional territory, of measures aimed to the prevention and environmental remediation of pollution from asbestos fibres. The coordination of these activities and procedures was assigned to the regional administration, the ARPA (Regional Agency for the Protection of the Environment), the ASP (Provincial Health Company), and the local authorities. Among these, the role of the Municipalities was fundamental for the protection of citizens' health from the risks associated with the exposure to

asbestos. Indeed, the census of the sites or buildings in which the ACMs were present, and their progressive removal were activities to be carried out by the Municipalities. According to the art. 4 c.1 letter b) of the regional law [12], the Municipalities must have a "Municipal asbestos plan"

## 2. Human health and environment risks

Epidemiological studies proved that all the above-mentioned asbestos minerals were classified as carcinogens by the IARC (International Agency for Research on Cancer) [13].

The interaction between geological materials, such as the asbestos minerals, and human, animal, and plant health, is an issue analysed by a recent discipline, the medical geology [14]. These interactions and pathways of direct or indirect exposure may be various. The limit values of concentration for the asbestos fibers in the air, water, and soil are different in the countries and are based on the sources of exposure. The health effects on humans due to the asbestos professional, environmental, and secondary exposure may appear decades after. Indeed, the disease may appear after a mean of 46 years since exposition and at a mean age of 70 years [15].

The most relevant sources of asbestos fibers in the air are anthropogenic [16,17] and may be due to the activities of the asbestos mines around the urban areas or to vehicular traffic intensities. Natural contamination of the waters may be dependent on the natural asbestos minerals present in the rocks, whereas anthropogenic contamination of the drinking waters may be due to the release of fibers from old asbestos-cement pipes or containers. The asbestos fibrous fracture and size (length and diameter) [18] represent the most crucial parameters of their toxicity [19]. These features make these minerals highly carcinogenic and responsible for uncommon dangerous diseases, including asbestosis, lung [20,21], larynx, and ovaries tumors, and mesothelioma, a rare malignancy of the serosal membranes (pleura, pericardium, peritoneum) [15], and serous covering of the testis [22]. The mesothelioma is commonly associated with a prior extensive fiber inhalation of crocidolite [23], tremolite, and amosite, but other fibrous minerals (such as erionite, fluoro-edenite, balangeroite) [24] can be also responsible for this disease. Moreover, the pathogenesis of the malignant peritoneal mesothelioma (abdominal) could be also due to the asbestos fiber ingestion coming from environmental exposition, not only to their inhalation [25].

In Italy, 31,572 cases of mesothelioma were reported in the VII report of the 2021 for the time interval 1993-2018 [15]. According to this registry, the 48.5%, 7.1%, and 13.6% (about a total 70%) of these cases were attributed to certain, probable, and possible professional exposition, respectively. Of the remaining 30%, a number not neglectable, the most important percentage (17.4%) was inferred to unknown exposition. In the Messina, Catania, and Palermo cities, the incidence of unknown / improbable and mesothelioma (calculated on the number of villages) is among the highest affecting the Sicilian population [15]. The ACM health risk will be present for decades. Indeed, the asbestos bans should determine the decrease in the incidence of mesothelioma with an age-standardized rate of 20-40 years [26,27]. Due to the long time to manifest and uncertainty of the causes, the precaution principle on the asbestos issue should not be neglected by public competent authorities for the human health and environmental safety.

## 3. Aim of the research

Human asbestos exposures and health risks should be limited everywhere but especially in the recreational and touristic areas. In particular, considering the high recreational values and touristic uses, the renowned coastal areas facing in the Mediterranean Sea should be healthy environments, regularly managed and controlled for ensuring their usability. Most marine beaches are continuously overrun by dangerous and not dangerous organic and/or inorganic wastes. Indeed, the marine coastal areas and the seas/oceans are the final destinations for wastes, after being illegally abandoned in the soil and transported to the coast by the streams/rivers and wind [28]. The most worldwide man-made organic pollutants present on the beaches, are the highly carcinogenic PCB (polychlorinated biphenyls) and the plastics [29]. These types of wastes, issues of several research, are persistent and may undergo long-term transport, due to their low degradation rates [29-33]. Other inorganic wastes diffused on the beaches, such as glass, bricks, pottery, tiles, mortar, and cement,

including ACMs, arise from building construction and demolition [34]. The ACMs that usually are found in the soils and beaches, mostly consist of entire or fragments of corrugated roofings, but remnants of planar slabs, tanks, pipes, and facade coatings are also present [29]. In such cases, the provenance of the ACMs may be due also to illegal coastal landfills and sea incidents (shipwrecks) [13,29].

In recent times, commodity and remote sensing investigations allowed Lisco et al. 2023 [29] to individuate ACMs in the beach of the Marechiaro Bay at Taranto (Italy), and to prove their provenance from illegally and uncontrolled landfills, created in the surrounding areas during the time span 1980-2000. These ACMs, after being eroded by the action of waves, tides, and currents, were transported and redeposited, forming a new anthropogenic beach. The natural consequence of this alarming research was the interdiction to access to the beach, meanwhile, competent authorities were attending for complex remediation activities [29]. Except this research, Italian scientific literature devoted to this criticism is actually very infrequent and main information on this issue mostly derives from media. Indeed, several were the cases reported by environmental associations and media in which soils and beaches contaminated by ACMs were described from northern to southern Italy (Friuli Venezia Giulia, Liguria, Tuscany, Lazio, Marche, Campania, Calabria, Puglia, and Sicily) [35-54].

With this in mind, inspired by the valuable research of Lisco et al. (2023) [29], a pivotal environmental geology research was carried out starting from a protected marine coastal area of Sicily. Main aims of the present research were the ascertainment of the presence of ACMs and, in positive case, the mapping in GIS-based platform. In this respect, evidence of significative criticisms related to the ACMs, involving potential risk for human health and threat for coastal and shallow marine environments, indicated the Cape Peloro area (Messina, NE Sicily, Italy) as profitable case-study, analogously to what reported for other marine beaches in Puglia.

This pivotal research, promoted by the reserve managing body (the Metropolitan City of Messina), and carried out by geologists and biologists of the University of Messina, configured as the first interdisciplinary approach to this alarming item, in Sicily.

#### 4. Study area

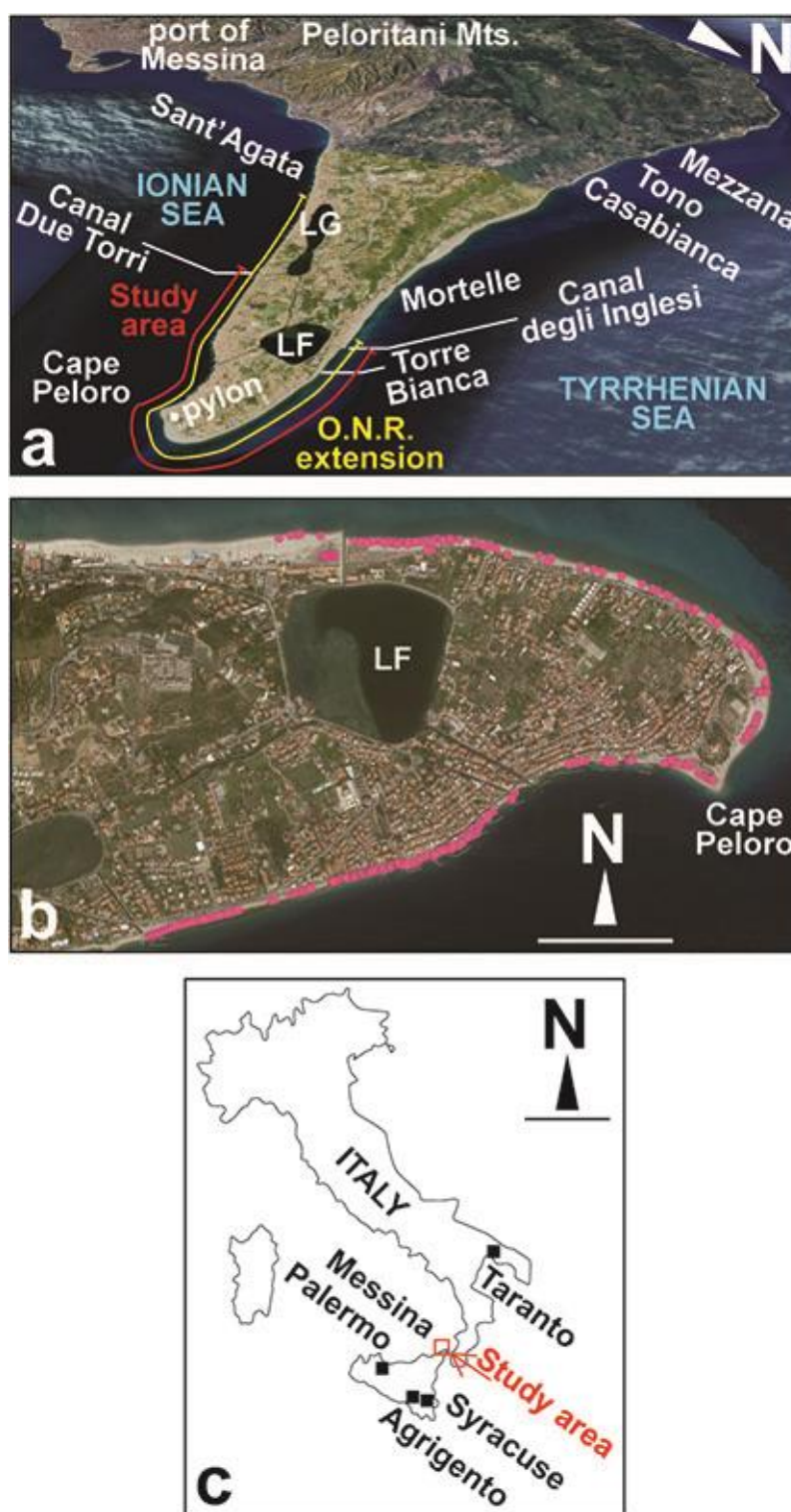
The study area concerns the Holocene coastal area of the Cape Peloro peninsula, extending along the whole Cape Peloro, between the localities Canal degli Inglesi in the Tyrrhenian coast and Canal Due Torri in the Ionian coast (Figure 1a).

The study area, hosting two important lakes (the lakes of Ganzirri and Faro) and wetlands with a rich fauna and flora, is an environmental protected site falling within the Special Protection Zones (SPZs) reported in the Natura 2000 network (SPZ ITA030042 - Monti Peloritani, Dorsale Curcuraci, Antennamare and marine area of the Straits of Messina - 27,993 he, [55] partially overlapping the SPZ ITA030008 - Capo Peloro - Ganzirri Lakes - 60 he [56]) and the Oriented Natural Reserve (O.N.R.) of Cape Peloro.

The SPZs, designated directly by the Member States, belong to the Natura 2000 network. The identification and delimitation of the SPZs is based entirely on scientific criteria and the network is especially aimed to protect the territories most suitable in number and surface for the conservation of sedentary and migrant birds. Indeed, the lakes of Ganzirri and Faro are two of the 38 Italian largest wetlands belonging to the Mediterranean bird flyways for many avian species [57].

The Cape Peloro O.N.R. (Figure 1a), established by the Sicilian region over two decades ago, faces to both the Tyrrhenian and Ionian Sea and includes two zones:

- i. Zone A (reserve), which includes the brackish water coastal lakes of Ganzirri and Faro (Figure 1), classified by the Sicilian Region as Mondial geosites, for their peculiar morphological features.
- ii. Zone B (pre-reserve), which comprises the Ionian and Tyrrhenian marine beaches, four artificial canals (degli Inglesi, Faro, Due Torri, Catuso) connecting the lakes to the sea and one canal (Margi) connecting the lakes to each other (Figure 1).



**Figure 1.** a) Localization of the study area (red line) and the pre-reserve of the O.N.R. (yellow line) reported in the satellite photograph in 3D modality (Google Earth Pro). b) GIS map of the 520 fragments of ACMs (pink circles) (QGIS software). c) In the insert the geographic localization of the study area. The names of the localities cited in the text were also reported. Acronyms: LF: Lake Faro, LG: Lake Ganzirri. Source: Authors.

The beaches of the study area are renowned touristic and recreational areas hosting several beachfront resorts. The surrounding areas offer to tourists and holiday-makers different attractions, such as historical monuments (Torre Bianca or Mazzone, Torre degli Inglesi, and Torre Saracena), cultural foundations, scuba diving and sport centres, resorts, and several restaurants and bars. One

of the most attractiveness present at the Cape Peloro is the “Pylon of Messina” (Figure 1), a 232 m high steel tower, used until 1994 for carrying the power lines from Calabria to Sicily. Moreover, the beauty of the landscape and the clarity of the water, make the Cape Peloro beach the most renowned, traditional, and frequented summer location for swimming and sunbathe. For both adults and children which widely access to the free beach where, lacking equipment and deckchairs, direct contact with the sand is inevitable. The most impacting human activities occurring in the beach are related to fishing, and shelter and maintenance of fishing boats (especially in the Ionian side). Other human activities present in the neighboring areas are represented by the oil refinery of Milazzo (at a distance of about 35 km, along the coast) and the port of Messina (at a distance of about 10 km).

The research area is stretched in continuity from 200 m westward of Canal degli Inglesi to the Canal Due Torri along a belt covering about the 75% of the O.N.R. marine beaches (Figure 1a). The surveys, both in surface and in natural sections, were carried out along 4500 m of coast of the Tyrrhenian and Ionian seas during the winter 2023-2024 (Figure 1).

The beach width, devoid of infrastructures and available for recreational uses, resulted to be variable approximatively from 80 m to few meters. The Torre Bianca beach is from E-W to WNW-ESE oriented and its width is variable approximatively from 80 m (to the W) to 10 m (to the E; Google Earth data, 11 July 2023 satellite photograph) (Figure 1a). The Cape Peloro beach is located between the Tyrrhenian and Ionian Sea and shows coasts from NW-SE to NE-SW oriented (Figure 1a). Analogously, the beach width is variable from about 80 m to 20 m. The study Ionian Sea beach is ENE-WSW oriented, and its width is variable from about 30 m to few meters. Due to the significative coastal erosion, this sector was protected by several breakwater groins.

In the study area of the Sicilian Tyrrhenian coast, the main direction of the sea waves and storms, monitored in the NW Sicilian coast in the last 1.5 years, is from W ( $270^{\circ}\text{N}$ ) and NW ( $285^{\circ}\text{N}$ ), respectively [58,59]. The sea bottom slope, stretched from the shoreline to the 5 m isobath, shows inclinations of 3.6% and marine coastal currents along the shoreline responsible for a potential solid transport, parallel to the coast, from W to E.

In the study area of the Sicilian Ionian coast, the main direction of the sea low-medium waves and storms, monitored in the last 14.5 years, indicates a provenance from E ( $90^{\circ}\text{N}$ ) with wave highs of about 6 m [58,59]. The sea bottom slope, stretched from the shoreline to the 5 m isobath, shows inclinations of 2.8% and marine coastal currents along the shoreline responsible for a potential solid transport parallel to the coast, from SSW to NNE [58,59].

Tide currents in the proximity of the northern edge of the strait are ENE-wards and WSW-wards during the ascending and descending phases, respectively.

In these wave-dominated beaches, significative marine shoreline migration affected the study area including the Cape Peloro. Coastline change may depend on the entity of several contributing local and global scale factors (sediment supply by river/stream transport, urbanization of the coasts, construction of coastal protective structures and ports, frequency and intensity of storms, relative global sea level change connected to the climate change). In particular, the decrease of river sediment supply, mainly due to anthropogenic activities (as the construction of river bridges and cement bottom covering), the expansion of the urbanized coasts, and the increasing frequency and intensity of sea storms may be the leading factors playing an important role in the erosion of the coasts and the regression of the coastline. In the study area, during the last two centuries, beaches resulted to “tend to be naturally stable within the same sector, resulting in a change in shape without any loss in volume” [60]. Notwithstanding, in 2012, some sites underwent a strong erosion responsible for the loss of about 12,000 m<sup>2</sup> of beach, whereas the Pylon beach underwent an accretion of about 5,000 m<sup>2</sup> [60]. The authors moreover ascertained that the winds increased intensities since the 2005 and that the trends for the winds coming from WNW-NW and from NW to NNE increased and decreased, respectively.

The Cape Peloro area is notoriously characterized by high levels of biodiversity, which, however, has been insufficiently investigated. For example, environmental associations gave great emphasis to sedentary and migratory avifauna, but a little scientific literature is available on this regard [61]. Most of the vegetation is not native, except for residual patches of autochthonous

essences, even endemic, which persist in few dunes not yet totally anthropized [62,63]. The beaches do not host relevant biotic communities, also due to their small breadth and intense human attendance. Similarly, the intertidal zone is poorly represented, due to microtidal regime and steep slope of the shoreline.

In the coastal marine environment, some protected habitats are recognizable, as the *Posidonia oceanica* beds, patch distributed from few meters to almost one kilometer off the coastline, at 2-45 m depth [64], and deeper, wide, coralligenous assemblages [65].

As far as concerns the brackish basins, literature is poor of information about the Lake Ganzirri biodiversity [66], differently than the highly biodiverse Lake Faro, regarding which some faunal and floristic lists have been published [67,68], as well as several data on different biological items (e.g. [69]). Only since the last decade a revised list of the macroalgal flora on molecular bases is in progress [70-73]. At last, of particular interest is the presence of the threatened bivalve *Pinna nobilis* Linnaeus, 1758, originally abundant along the Strait of Messina coasts [74], before the mass mortality event that wiped out the marine populations of the Mediterranean [75], except in a few brackish basins, such as Lake Faro [76].

The study marine beach deposits are composed of Holocene siliciclastic sands and heterometric gravels, and are delimited seawards, by a peculiar belt of bedded siliciclastic conglomerates [77], weakly seawards plunging. They are composed of polygenic deposits with pebbles, cobbles, and boulders floating in arenites. Very hard because pervasively cemented by carbonates, conglomerates contain Serpulid encrustings showing a calibrated AMS (Accelerator Mass Spectrometry) radiocarbon age of about 5.9 Ka [78]. Indeed, the Ganzirri beach rock is characterized by a mixture of benthic assemblages belonging to the upper littoral level or fringe [79]. The beach rock forms a sort of a very shallow marine platform, several decades of meters wide [80], localized from an elevation of 0.70 m to the isobath – 2 m [78] and present for tens of kms partially covered by sands, from Mortelle in the Tyrrhenian coast to the Port of Messina in the Ionian side. These beach rocks exert an important natural defensive action against coastal erosion because they induce the damping of wave energy on the coastal plain.

The Cape Peloro peninsula is delimited onshore by the hills forming the northern edge of the Peloritani Mountains (Figure 1a). These hills are made up of Quaternary siliciclastic deposits with seawards plunging clinofolds (Sands and Gravels of the Messina Formation, Middle Pleistocene), underlying the Holocene deposits and forming the sea bottom of the Cape Peloro peninsula [77,81-83]. The study area [84], as well as the Calabria-Peloritani Arc, is affected by a strong active tectonics, responsible for the high seismic risk of the Straits of Messina [85,86].

## 5. Materials and Methods

A field survey was carried out onshore and offshore in the study area, in order to search for ACMs. The marine backshore and foreshore areas, including the dunes in the Tyrrhenian coast and the cliffs locally present in the Ionian Sea, were investigated. Punctual observations were carried out in the marine shoreface and offshore transition areas, performing snorkeling and scuba diving activities. Punctual observations were also made out the reserve, in two localities, 100 m wide, for comparative purposes.

After alerting the competent authorities on the presence of possible dangerous ACM wastes, University researchers supported by authorized personnel were involved in field activities for collecting samples of these presumed ACMs, in order to ascertain its dangerous and toxic nature. The samples of ACMs were investigated by means of OM (Optical Microscopy), SEM-EDS (Scanning Electron Microscopy coupled to X-ray Energy Dispersive Spectrometer), and FTIR (Fourier Transform InfraRed) spectroscopy techniques.

The OM observations were carried out to characterize, morphological and morphometric features, color, aspect, ornamentations, encrusting organisms, and size of the asbestos fibers of the presumed ACMs. The instrument used was a Zeiss, Stereo Discovery model coupled to a telecamera and workstation. Photomicrographs of selected fibers were documented under stereomicroscope. Fibers were firstly collected, after dissolution of calcareous component of the cement in HCl diluted

at 10% and separation from the fiberglass. Secondly, fibers were posed in a drop of distilled water dispersed on a microscope glass before closing this latter with a glass cover. The OM observations were realized in the laboratories of the University of Messina.

In particular, morphometric analyses were realized to determine the different geometric properties of the particles, describing the outer shape of the particles at the macro-, meso- and microscale and the surface texture [87,88]. The 3D shape of coarse grains/particles (pebbles/boulders) may be expressed by the long axis (L = Long or a), the medium axis (I = Intermediate or b), and the short axis (S = Short or c). The morphology of particles may be expressed by a plethora of shape rates. The I/L ratio (elongation ratio or Aspect Ratio AR) [89,90] (Table 1) and S/I ratio (flatness ratio, Table 1) represent the most important aspects of particle shape [88]. Other two shape parameters very used in sedimentology are the sphericity (Table 1) and roundness. For 2D measurements, the Riley sphericity is expressed by the square root of the diameter of the largest circle inscribed in the particle diameter ( $D_i$ ) divided by the smallest circle circumscribing the particle ( $D_c$ ). Riley sphericity and elongation may be considered different ways to describe the particle shape being based on ratios of their length and width. The roundness consists of the curvature of the corners or surface roughness. It may be obtained by visual comparison with photographic charts or applying some formula. The elongation and flatness ratios may be also plotted in the Zingg diagram, in order to classify the shapes as bladed, oblate (or disc), equant, or prolate.

The LIS dimensions of the ACMs were measured on the field by means of a caliper and analysed by means of dedicated free software useful for morphometric analysis (Image J). For each examined shape parameter, the following statistical data were reported in the box plot: minimum value (Q0); first quartile (Q1); median value (Q2); third quartile (Q3); maximum value (Q4); standard deviation.

**Table 1.** Shape parameters of the ACMs. Source: Authors.

<b>Elongation (I/L)</b>	<b>Classes</b>	<b>Sphericity</b>	<b>Classes</b>
Not elongated	0.80-1.00	Very low	0.00-0.45
Slightly elongated	0.60-0.80	Low	0.45-0.63
Moderately elongated	0.40-0.60	Moderate	0.63-0.78
Very elongated	0.20-0.40	High	0.78-0.89
Extremely elongated	0.00-0.20	Very high	0.89-1.00

The SEM observations were made to characterize morphology and size of the fibers, being SEM able to provide micro to nanoscale morphological information of the sample surface. X-Ray microanalyses were carried out to determine sample composition. The system used was a TermoFisher SEM, Inspect s50 model, working at 10 kV and 1 nA of probe current, coupled to a Bruker Quantex X Flash 6q/60 EDS system.

The FTIR spectroscopy was used to determine the main functional groups of the fibers. The instrument used was a Thermo Scientific spectrophotometer, iS50 ATR model. The scans were performed at a resolution of  $4 \text{ cm}^{-1}$ . Few milligrams of ACM were analysed to ascertain the presence of chrysotile, according to the environmental current legislation. The crocidolite is not usually investigated by this technique because its characteristic peaks are covered by the background signal due to the matrix components.

The SEM and FTIR analyses were carried out in one of the few laboratories in Italy accredited for massive SEM tests on asbestos (Ambiente Lab accredia 1625) and the only one in the Messina province, registered in the Ministry of Health official list of the qualified laboratories authorized to accomplish analyses on asbestos.

For a precautionary principle, considering the presumed hazard of all the study materials, their morphometry and morphology were determined and documented by means of high-resolution photography (using a Nikon telecamera, Z30 Model). Each photography, accompanied by a reference scale, was georeferenced and plotted in a GIS-based platform (Geographic Information System; free software QGIS 3.28.10).

Analytical and sampling procedures were performed according to the criteria reported on the Italian ministerial decree of the 1994 [7] and all investigations were accomplished by specialized analysts using proper personal protective equipment (PPE).

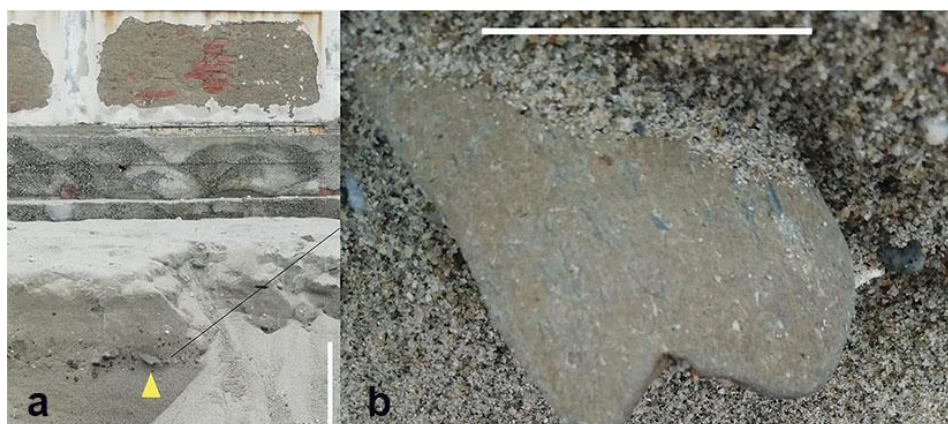
## 6. Results

Over 520 fragments of presumed ACMs were identified, carefully documented, and photographed along a linear belt, about 1 m wide and 4500 m long, along the marine beaches of the study area. The fragments were georeferenced and reported in a GIS map, using QGIS 3.28.10) (Figure 1b). This material was also associated with other anthropogenic inorganic wastes such as thousands of fragments of bricks, tiles, cement, and colored glass.

Onshore, the ACMs were documented not only on surface on the beaches (Figure 2) but also inside the beach deposits, or exposed on natural cliffs due to the marine coastal erosion (Figure 3).



**Figure 2.** Fragments of ACM outcropping in the beaches of the study area. Fragments appear with well-rounded sub elongate shapes and surface ornamentation (b). ACMs are partially covered by sands (a, b, c, d, e, g). h-i) Boot prints on the sand showing the human-environmental interactions. The two fragments of ACM were trampled by humans, enhancing their fracture and transfer of the fibers from the cement to humans and environment. Source: Authors.



**Figure 3.** a) Berm, due to marine erosion, showing beach deposits with a sandy gravel layer containing a fragment of ACM (it is marked by a yellow triangle). The berm is facing the entry of a building today at about 20 m from the Tyrrhenian shoreline (Lat.: 38°16'19.17"N, Long.: 15°38'33.47"E). The scale bar is 0.5 m. b) Detail of Figure 3a showing a rounded elongate shape with evidence of blue and white fibers. The scale bar is 1 m and 10 cm, in Figure 3a and b, respectively. Source: Authors.

The removal of part of the ACMs from the beach, their transfer along the coast, and the surfacing of other ACMs were phenomena observed during the winter cyclic alternations of sea storms and calm sea. Evidence of sediment erosion and deposition were monitored especially in the studied Tyrrhenian beach. The presence of berms, the exposition of old anthropogenic structures (such as wood boats, walls, and palisades contained in the beach deposits), after sea storms, allowed to esteem erosions of at least over 1 m (Figure 4).



**Figure 4.** Evidence of the erosion affecting the beach of Torre Bianca facing the Tyrrhenian sea. a) Beach near the mouth of the Canal degli Inglesi (9.01.2024) (photograph view W-wards). The shape of the wood boat (reported with a black line) shown in b) is drawn for comparative purpose. b)

Erosion makes stand out the remnants of a boat in the same area (a) (18.12.2023) (photograph view E-wards). c) Beach in proximity of ruins and buildings (12.11.2023). d) Same area (c) after erosion and exposure of wood palisades (10.12.2023) (the black dog "Macchia" represents the scale). Source: Authors.

Offshore, the presence of an entire asbestos cement corrugated roofing sheet was ascertained at a depth of 2-3 m, along the study area during scuba diving immersions.

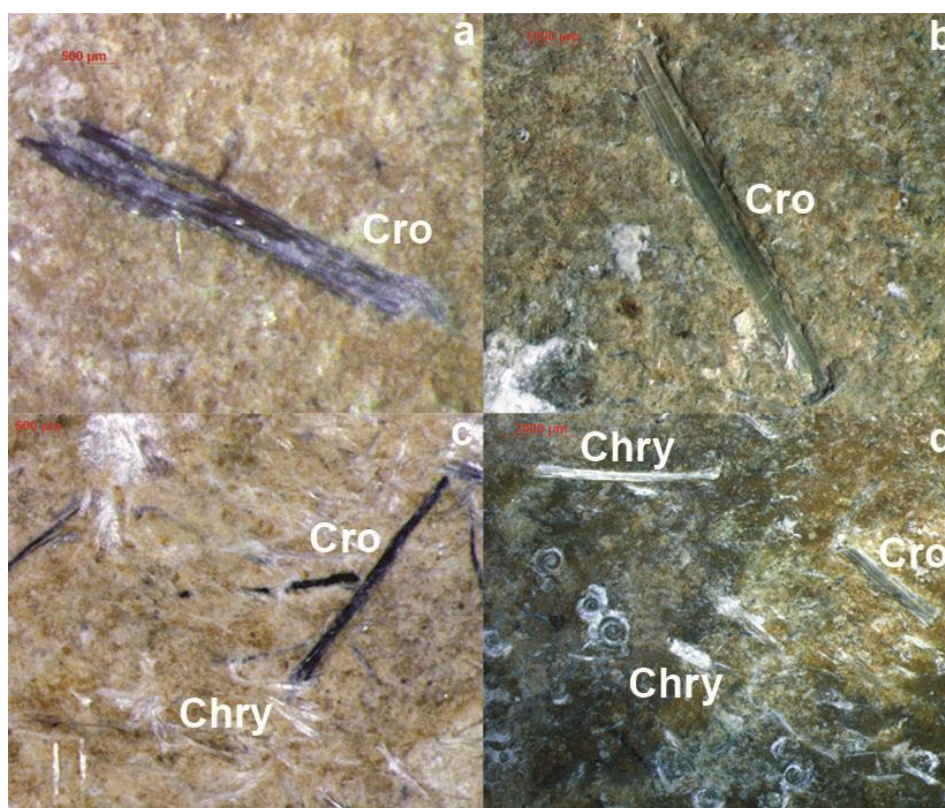
In the complex, analogous criticisms observed onshore were reported in a few of control areas, located out of the O.N.R., in the reserve neighboring area, in the Tyrrhenian beach, and at less than 1 km, along the Ionian coast (Figures 1a and 5).



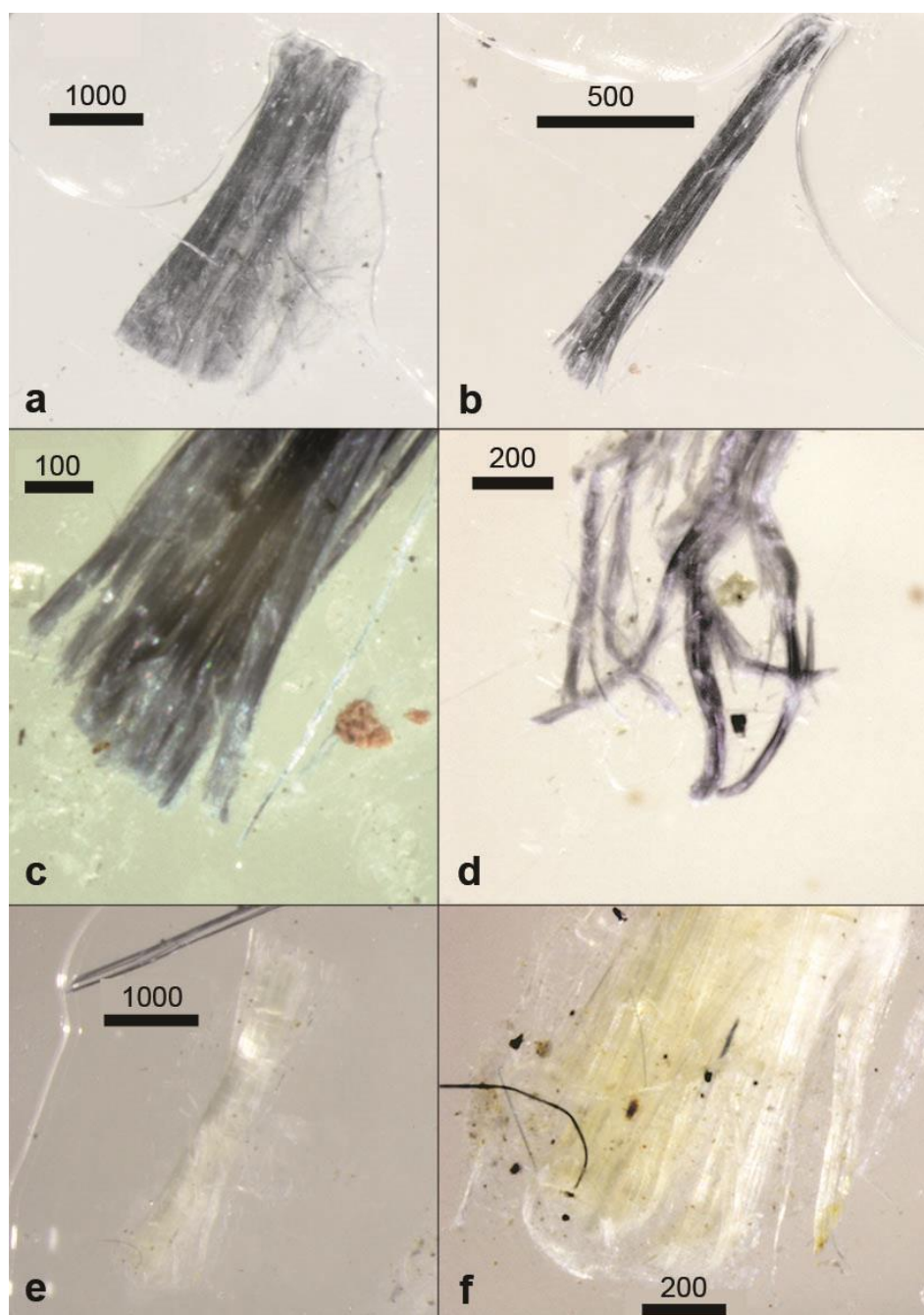
**Figure 5.** Evidence of ACMs in control sites. a-b) A decimeter size and angular fragment of ACM in a resort of the Tyrrhenian coast, neighboring the O.N.R. at Mortelle (Lat.: 38°16'19.44"N, Long.: 15°37'54.42"E). c-g) Well-rounded fragments, in part broken, found in a beach of the Ionian coast, at Sant'Agata (Lat.: 38°15'7.95"N, Long.: 15°35'56.18"E). Source: Authors.

### 6.1. ACMs' morphology and chemical composition

MO observations of the surfaces of the ACMs, by means of stereomicroscope, allowed to recognize bundles of white and blue, fine, fibrous minerals (Figure 6) with needle-like appearance. Bundles, extracted from the ACMs, were also optically observed (Figure 7).

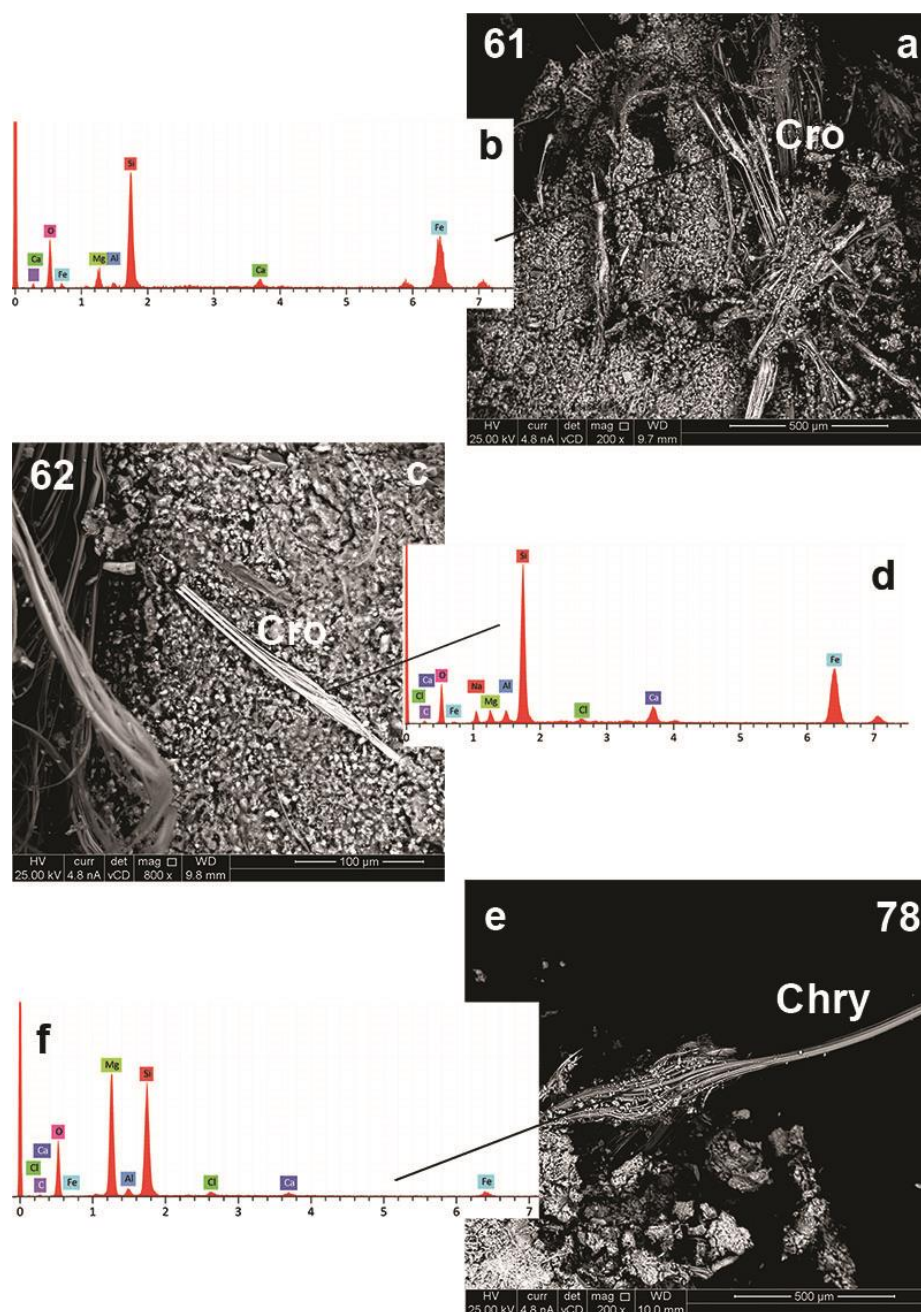


**Figure 6.** Microphotographs of blue and white fibrous minerals observed on the ACMs, under stereomicroscope in reflected light. a,b) Blue fibrous minerals compatible with asbestos type crocidolite (Cro), according to SEM-EDS analyses. c,d) Blue and white fibrous minerals compatible with asbestos type crocidolite (Cro) and chrysotile, according to SEM-EDS analyses (see later). Traces of marine calcareous encrusting organisms appear in Figure 6d. Source: Authors.



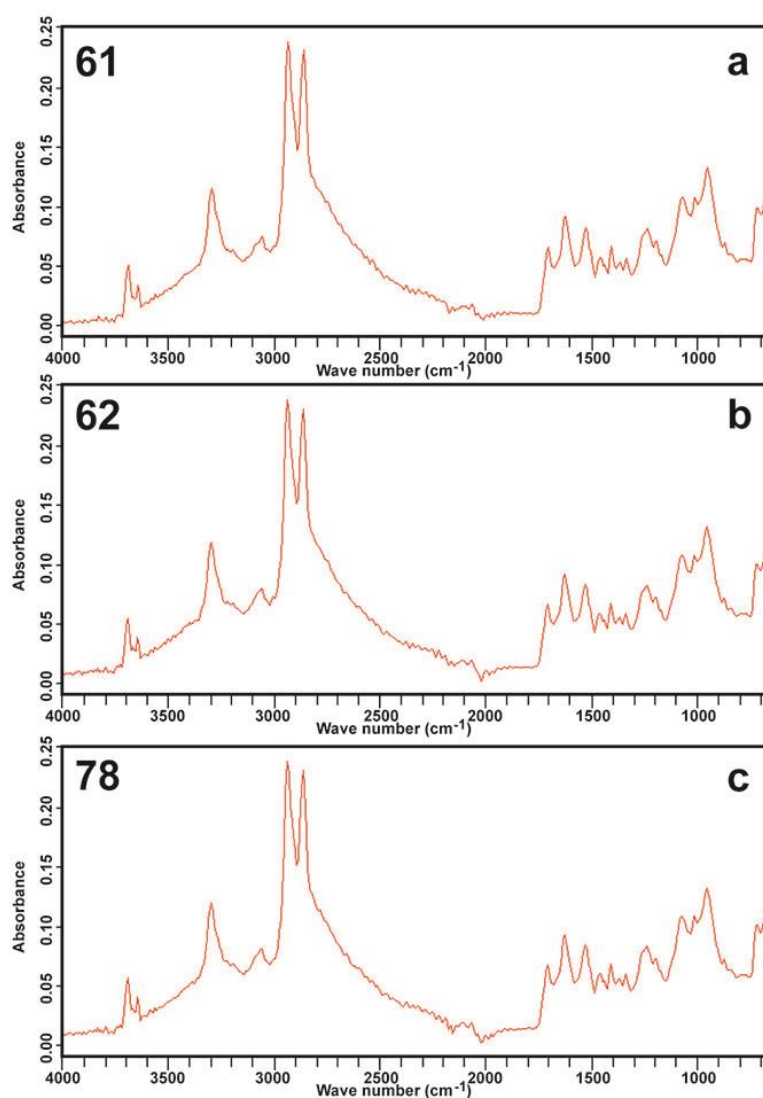
**Figure 7.** Photomicrographs of asbestos fibers of the studied ACMs, under stereomicroscope with reflected light. a,b,c,d) Blue asbestos (crocidolite) according to SEM-EDS analyses. e,f): White asbestos (chrysotile) according to SEM-EDS analyses. Source: Authors.

The SEM analyses and EDS spectra of fibers of three specimens (61, 62, 78) showed images and chemical contents compatible with asbestos type crocidolite and chrysotile, respectively. Crocidolite fibers in the SEM images appeared light in color, with a curved morphology, whereas the EDS spectra indicated Na presence and high Fe contents. Analogously, chrysotile fibers appeared dark, with a straight morphology, and with high and low contents, respectively, in Mg and Fe (Figure 8). The cement matrix resulted to be composed of significantly weathered carbonates.



**Figure 8.** a,c,e) SEM images of the asbestos fibers of specimens 61, 62, and 78 (see Figure 13). b,d,f) EDS spectra related to specimens 61, 62, 78.

The FTIR spectra of the asbestos fibers from the same three specimens 61, 62, and 78 (see Figure 13) showed the inner surface Mg-OH stretch at  $3686\text{ cm}^{-1}$  and  $3644\text{ cm}^{-1}$ , typical of the absorbances of the chrysotile (Figure 9).



**Figure 9.** FTIR spectra of the asbestos fibers present in the ACMs' specimens 61 (a), 62 (b), and 78 (c) (see Figure 13) in the interval of wave number 4000-700  $\text{cm}^{-1}$ .

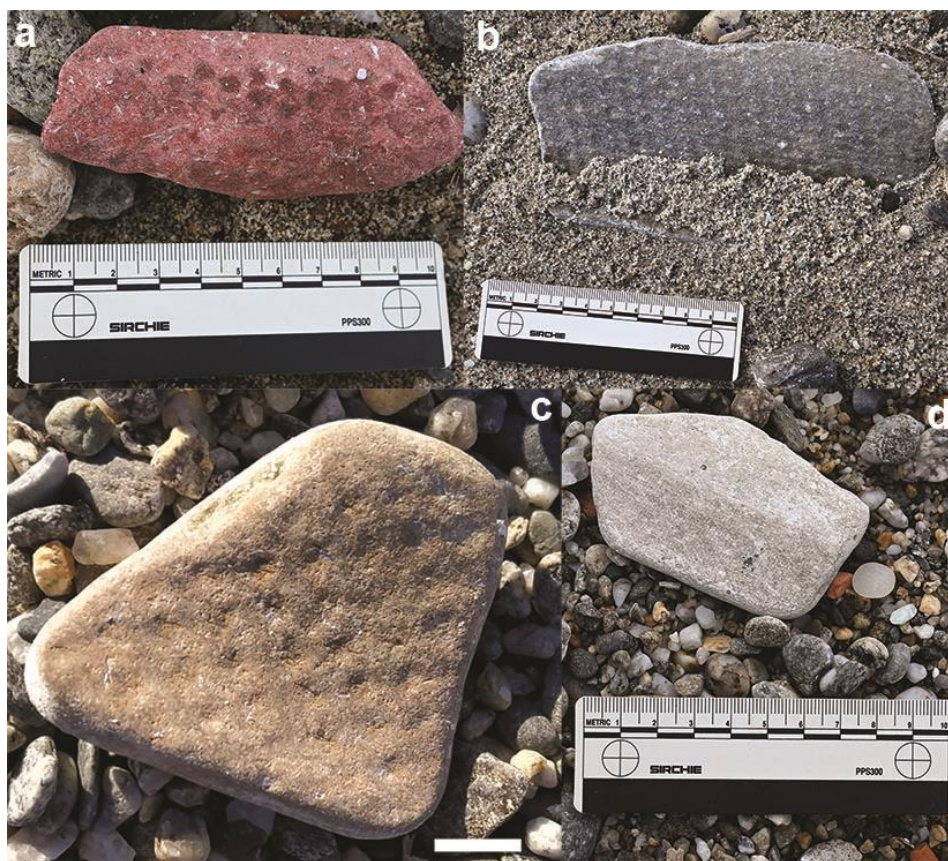
### 6.2. ACMs' characteristics

Several types of ACMs were reported in the study area. These were differentiated on the base of the following parameters and features:

- i. Color,
- ii. Face aspect,
- iii. Marine organism encrustations,
- iv. Degree of surface erosion,
- v. Shape.

The color of the ACMs' surfaces resulted to be mostly light grey, i.e. similar to the original color of the asbestos cement. A beige to orangish color (Figure 10), probably due to weathering, was also recognized in tens of fragments. Rare dark fragments and rare dark red color were also observed (Figure 10a). This latter was presumably the evidence of the typical red asbestos encapsulation paint usually used to protect the corrugated asbestos sheets by the fiber dispersion.

The face aspect of the ACMs, mostly rough and abraded, was characterized by white and blue minerals, with the first ones prevailing on the second ones (Figure 6). Two different surface ornamentations (honeycomb-like, Figure 10a-b-c, and dome-basin-like, Figure 10d) in tens of fragments were observed.



**Figure 10.** Colors and rough face aspect of the studied ACMs. a) Fragment with rare dark red color of the asbestos encapsulation paint on honeycomb-like ornamentation. b) Fragment with typical light gray color showing honeycomb-like ornamentation. c) Fragment with beige to orangish color showing honeycomb-like ornamentation. Scale bar: 2 cm. d) Fragment with typical light gray color showing dome-basin like ornamentation, probably due to weathering. Source: Authors.

MO of the surfaces of the ACMs, by means of stereomicroscope, allowed to recognize also marine organism encrustations in a few fragments. These, present also on both sides of the ACM, were mainly formed by a complex stratification of lichens covered by calcareous red algae (*Corallinaceae*), bryozoan, and sessil gastropods (*Vermetidae*) (Figure 11).



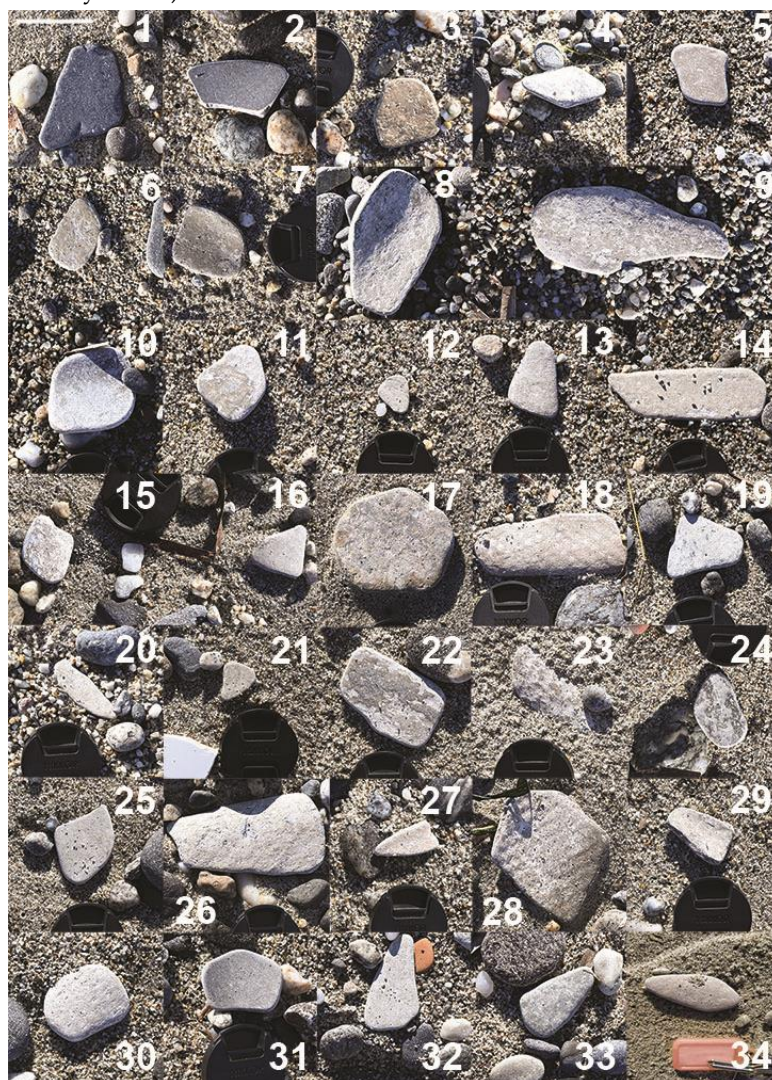
**Figure 11.** a) Field photograph and b) microphotograph of encrusting marine organisms, growth on the surface of the ACM, under stereoscope with reflected light. Bryozoans, red algae (*Corallinaceae*), and sessile gastropods (*Vermetidae*). Source: Authors.

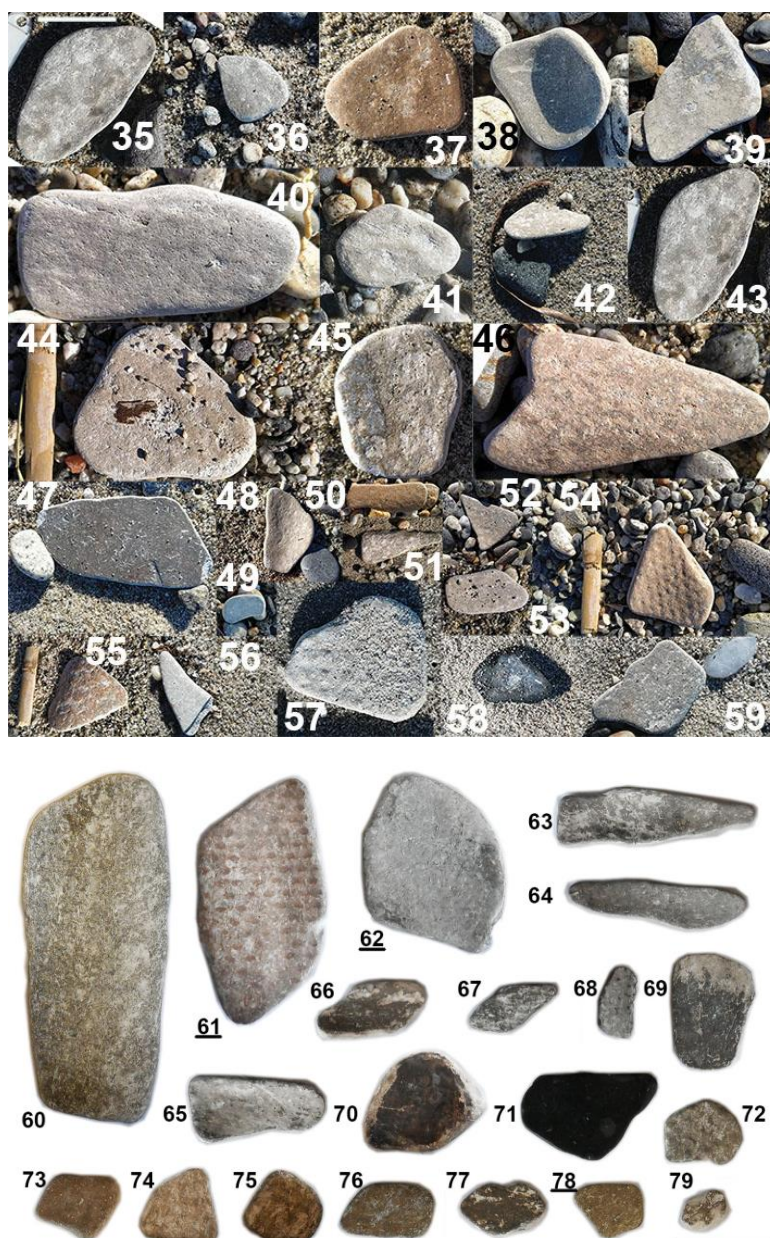
The surface erosion of the ACMs was significant and the degree variable from low to high. In the same fragment, homogenous or heterogenous degrees of erosion were observed. The low degree was ascertained in fragments preserving the original ornamentalations and showing thickness, similar to that of the original industrial product. The high degree was evidenced by the lower thickness, the absence of ornamentalations, and the erosion of the encrusted fragments (living some relict traces). Erosion/abrasion of the ACMs mostly produced extensively exposure of asbestos fibers on well-rounded surfaces and borders (Figure 12). Systems of incipient joints were also present. A few samples found in the beach resulted to be poorly weathered and with angular shapes and fresh fractures. But most of the angular shapes prevailed in sites of abandon near the main roads.



**Figure 12.** Photomicrographs showing the asbestos fibers exposed on the ACM's surface along the borders due to erosion/abrasion, seen under stereomicroscope with reflected light. a) Wisps of sub-mm long blue asbestos fibers (crocidolite). b) Mm long white asbestos fibers (chrysotile) showing typical wool effect. Source: Authors.

Most of the ACMs showed several cm-long, well rounded, and weathered corrugated (40-50%) and planar (50-60%) shapes, corresponding to parts of the crests and sides of the corrugate sheets, respectively (Figure 13). Some decimeter long specimens, showing a complete typical crest shape, were also identified (8, 28, 31, 38, 50, 54, 55, 60, 61, 62, 63, 64, 65, 66, 79 in Figure 13). Morphological and morphometric analyses allowed to characterize the ACMs shape (calculating elongation and flatness ratios, sphericity index).



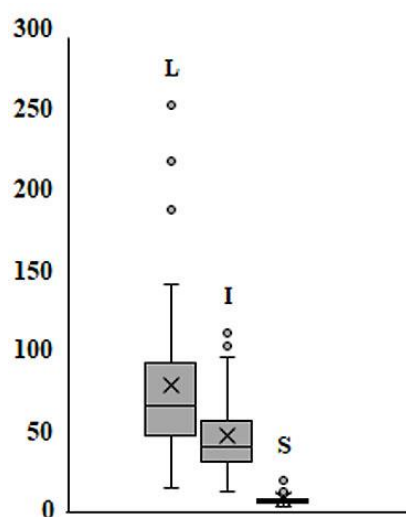
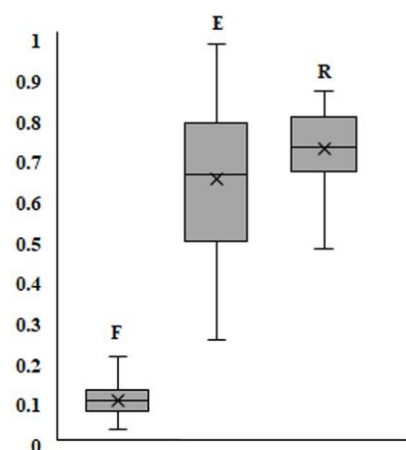


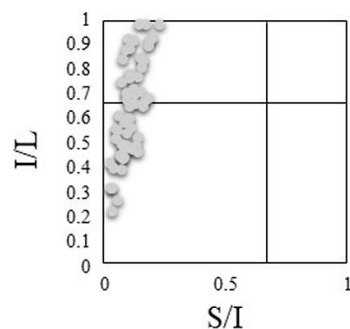
**Figure 13.** Representative assemblage of the main aspects and shapes of the ACMs (N. 80), selected on over 520 photographs taken in the study area. For better evidencing the aspect, images (60-79) were cut out from the sediment background by using free image software. Scale bar: 5 cm. The underlined numbers indicate the analysed samples by SEM-EDS and FTIR. Source: Authors.

The 3D dimensions (LIS, Figure 14) and shape parameters (F, E, R, Figure 15) were measured and calculated on 58 and 43 specimens of ACMs, respectively, and synthesized in Table 2. The LIS dimensions resulted to be very heterogenous. The L and I distributions were characterized by a dextral asymmetry, whereas the S distribution was symmetric (Figure 14). The F distribution was symmetric with very low values typical of flatted material as the asbestos sheets (Figure 15). The E distribution was weakly right asymmetric with elongation values ranging from very elongate to very equant with a sub-elongate mean (Figure 15). The Riley sphericity distribution was characterized by a dextral asymmetry with values ranging from intermediate to very equant with an equant mean (Figure 15). The Zingg diagram, based on elongation and flatness ratios, showed 3D shapes shifted on the left zone of the diagram, being flatness ratio very low, with forms variable from bladed ( $S < I < L$ ) to oblate/disc ( $S < I = L$ ) (Figure 16).

**Table 2.** Shape parameters of the ACMs. Source: Authors.

Parameter	Q <sub>0</sub>	Q <sub>1</sub>	Q <sub>2</sub>	Q <sub>3</sub>	Q <sub>4</sub>	St d
L (mm)	135.00	45.75	65.00	92.00	251.00	48.00
I (mm)	11.50	30.00	39.00	56.00	110.00	24.00
S (mm)	2.00	5.00	6.00	6.75	19.00	2.65
F	0.02	0.07	0.10	0.13	0.21	0.03
E	0.25	0.50	0.66	0.81	1.00	0.19
R	0.48	0.68	0.74	0.82	0.89	0.09

**Figure 14.** The 3D dimensions of the LIS orthogonal axes in the studied ACMs: L: Long dimension; I: Intermediate dimension; S: Small dimension. The measure unit (ordinate axis) was expressed in mm. Source: Authors.**Figure 15.** Shape parameters of the studied ACMs: Flatness ratio (F: S/I); Elongation ratio (E: I/L); Sphericity - Riley sphericity (R). Source: Authors.



**Figure 16.** Zingg diagram ( $S \leq I \leq L$ ) of the studied ACMs, showing elongation and flatness ratios in the ordinate and abscissa axes, respectively. Source: Authors.

### 6.3. Abandons of ACMs and landfills

Surveys allowed to individuate different illegal abandons and landfills in the study area.

Onshore, a site showing tens cm-long, fresh, devoid of superficial vegetal growths (lichens and mosses), and angular fragments of ACMs, partially covered by brushwood, was documented in a several m<sup>2</sup> wide area (Figure 17).



**Figure 17.** Illegal abandon of ACMs, located back of the sand dunes exposed on the left side of the Canal degli Inglesi (Lat.: 38°16'18.96"N, Long.: 15°38'8.98"E). Source: Authors.

An illegal landfill of construction and building demolition wastes (mostly bricks) containing angular fragments of ACMs was individuated along the Ionian coast (Figure 18a,b,c). The presence of the landfill was evidenced by the exposure of their wastes in the cliff (Figure 18a), a few meters high, facing to the Ionian beach (Figure 18d,e,f) and eroded by the energy of the marine waves, currents, and storms. Actually, commercial activities, parking areas, and asphalted streets cover these wastes.



**Figure 18.** Ionian coast. a,b,c) Landfill with fragments of ACMs (Lat.: 38°15'37.87"N, Long.: 15°37'47.19"E). d,e,f) Beach deposits mostly made up of fragments of bricks, cement, and ACMs. The yellow arrows evidence the ACMs. Source: Authors.

## 7. Discussion and Conclusions

The main results of the pivotal research carried out in the protected area of Cape Peloro may be synthesized as follows:

- i. The suspect material investigated resulted to be ACM with asbestos fibers compatible with chrysotile and crocidolite (SEM-EDS and FTIR).
- ii. A high number of ACM fragments (over 520) was recorded. Found ACM fragments likely presumably represent an underestimation of the actual number dispersed in the environment.
- iii. The ACMs were observed on the top of the beach, inside the beach deposits, inside the illegal landfill deposits, exposed on natural cliffs due to the marine erosion. A corrugated sheet of ACM was detected on the sea bottom at 2-3 m depth.
- iv. During the winter sea storm and calm sea cycles, part of the ACMs resulted transported away or transferred along the coast and other ACMs appeared on the beach.
- v. Peculiar ACM fragments were found on the beaches, being covered by complex stratifications of lichens encrusted by calcareous red algae (*Corallinaceae*), bryozoan, and sessil gastropods (*Vermetidae*). The age of these laminated materials is under study.

- vi. The prevailing ACM shapes found on the beach and in the beach deposits were platy with bladed and oblate forms, and typically well rounded. Angular shapes were detected in the beach but they were especially recognized in landfills and abandon sites.
- vii. The surface aspect of the ACM was characterized by an extensively exposure of asbestos fibers especially on the well-rounded shapes.
- viii. The well-rounded ACM fragments testify a significative transport and long staying of these wastes on the beaches.

The high number of ACMS fragments (11-12 fragments each 100 m long linear area) and their inequal distribution between the Ionian and Tyrrhenian coasts (74% and 26%, respectively) agree with the respective grade of anthropization. Significative and higher concentrations, for example, were reported in the eastern side of the canal Due Torri and in some of the very strict beaches distributed on the strongly urbanized area of the Torre Faro coast. Analogous criticisms were reported also in a few of control areas (Sant'Agata, Mortelle, Figures 1a and 5).

The provenance of the ACMs and the related environmental contamination may be related to illegal landfills of construction and building wastes and onsite abandons, but it cannot be excluded that these wastes, mostly well-rounded, underwent a significative transport due to the coastal dynamics, characterized by prevalent E- and NNE-ward directions of the currents, in the Tyrrhenian and Ionian Sea, respectively. Analogously, it is possible that illegal landfills and abandons of ACMS in the streams may have significantly contributed to the anthropogenic stream sediment supply, transferred from the Tyrrhenian and Ionian Messina valleys towards the seaside areas. Significative evidence of this phenomenon was testified by the release of asbestos bearing materials in the Ionian coastal area, after the Scaletta Zanclea-Giampileri flood disaster of the 1 October 2009 and the subsequent demolition activities of damaged buildings [91].

Another significative issue to be considered in this case, concerns the changing shoreline, significantly affecting the Tyrrhenian coast. In the western surrounding areas the reserve, especially in the Acqualadroni-Mezzana-Mulinello-Casabianca coastal area (Figure 1a), geomatic observations may evidence a shoreline landwards retreat esteemed up to about 75 m in the time span 2001-2023. It is noteworthy, that since 1969, the Tyrrhenian shoreline retreat reached over 250 m in the most exposed coasts. Really, in the Mezzana beach, some buildings were definitively submerged by the sea. Notwithstanding, the neighboring Tyrrhenian coast of the reserve, despite affected by opposite land- and seawards shoreline migrations, erosion and accretion phenomena, it cannot be excluded that the ACM individuated on the sea bottom could belong to previous barracks (of the fishers or farmers of "Zibibbo" vineyards) drowned by the sea for its land-wards advance.

The light weight and platy shape of the ACMs, the strong energy of the sea storms, tides, and currents, occurring in the Ionian and Tyrrhenian seas, facilitated the removal of the ACMs from the local coastal landfills and abandons, and the transport and deposition along the coast and shallow sea. It must be underlined that the particles with original platy shapes are usually facilitated in their staying in the coastal areas, because of their better adherence to the substrate. In the case of the studied ACMs, their platy shapes, facilitated the long staying of this material in the marine coastal and shallow environments, after their provenance from direct abandons on the beach or ACM bearing stream sediment supply.

The study wastes, being subject to a continuous transport and wind corrasion, became friable and object of a strong abrasion due to their significative impact with the sedimentary particles. Most of the fragments observed testified a strong weathering of the material determining the exposition of the asbestos fibers on the external surfaces of the fragments, especially in the borders. The significative degradation of the ACMs is prodrome of an easier release of the asbestos fibers in the environmental matrices. Moreover, considering that beaches of the reserve, especially at Cape Peloro, during the summer are crowded with bathers whose bodies, bath towels, and clothing are in contact with the sand, it is evident that a criticism exists, and needs to be considered. Consequently, an evaluation of the potential risk for both human health and coastal marine environment should be carried out.

The marine encrustations observed on part of the ACMs, and the findings of ACM sheets in the sea bottom suggested that a continuous transfer of this material actually occurs from the shallow sea

to the beach and vice versa. In this regard, the evidence of a long staying of the study material also in the marine shallow environment contributes to increase the complexity of the removal activities and consequent remediation. Consequently, removal activities must be planned after having considered a fully developed conceptual model, based on all the factors influencing the transfer mechanisms of the ACMs into the coasts and shallow marine areas.

Similar critical conditions have recently been reported in other areas of the Italian territory [29]. Possible intervention and reclamation activities cannot limit themselves to remove the fragments on the beach, being them immersed in the coastal sediments, at different depths, but also in the sea deposits. Any appropriate asbestos reclamation activities, if not designed and based on a multidisciplinary approach and knowledge of local coastal dynamics and meteo-marine climate, would prove to be very expensive and ineffective, as occurred in the Sardinia beaches [41].

Italian marine beaches fall down in the maritime state property of the State and represent an inalienable and inextinguishable georesource devoted to serve the needs of the community. The ACM contamination reported in the Cape Peloro area, involving a possible wanting of healthiness, as well as elsewhere in our country, represents a criticism which needs to be promptly addressed and solved. On the base of the above and of the reports related to other Italian sites, it cannot be excluded that the evidenced contamination could represent only the “tip of the iceberg”, being its presumable extension much wider. Indeed, it cannot be excluded that the illegal landfill reported in the Ionian coast of the reserve forms an extensive (perhaps uneven) anthropogenic coastal plain extending landward and along the coast. This eventuality, which considers the widespread use of asbestos cement in private, civil, and military building in the town of Messina, is an alert signal of a “submerged criticism” affecting most of the Messina metropolitan city underground, an area at high seismic risk, over urbanized, and coming soon exposed to the construction of extensive infrastructures.

**Author Contributions:** “Conceptualization, R.S. and S.E.S.; methodology, R.S., S.G., M.M. and S.E.S.; software, R.S. and F.P.L.M.; validation, R.S., S.G., M.M. and S.E.S.; formal analysis, R.S., S.G., F.P.L.M. and M.M.; investigation, R.S., S.G. and M.M.; resources, R.S., S.G., M.M. and G.Z.; data curation, R.S., S.G. and M.M.; writing—original draft preparation, R.S.; writing—review and editing, R.S., S.G. and M.M.; visualization R.S., S.G., F.P.L.M., M.L.M., M.M., S.E.S., S.Z. and G.Z.; supervision, R.S. All authors have read and agreed to the published version of the manuscript.”

**Funding:** “This research received no external funding”.

**Conflicts of Interest:** “The authors declare no conflict of interest.”

## References

1. Directive (EU) 2023/2668 of the European Parliament and of the Council of 22 November 2023 amending Directive 2009/148/EC on the protection of workers from the risks related to exposure to asbestos at work.
2. McCulloch, J.; Tweedale G. *Defending the Indefensible. The Global Asbestos Industry and its Fight for Survival*; Editor Oxford University Press, UK, **2008**, pp. 1–344.
3. Silvestri, S.; Magnani, C.; Calisti, R.; Bruno, C. The experience of the Balangero chrysotile asbestos mine in Italy: Health effects among workers mining and milling asbestos and the health experience of persons living nearby. *Canad. Mineral.* **2001**, *5*, 177–186.
4. CAS. A division of the American Chemical Society. Available online: <https://www.cas.org/cas-data/cas-registry> (Accessed online the 14 December 2023)
5. Deer, W. A.; Howie, R.A.; Zussman, J. *An introduction to the rock-forming minerals*. 3rd ed. The Mineralogical Society, London UK, **2013**, pp. 1–498.
6. Law 257/1992. Available online: [https://www.salute.gov.it/resources/static/primopiano/amianto/normativa/Legge\\_27\\_marzo\\_1992.pdf](https://www.salute.gov.it/resources/static/primopiano/amianto/normativa/Legge_27_marzo_1992.pdf). (Accessed online the 15 December 2023).
7. Ministerial decree n. of 6 September 1994. Available online: <https://www.gazzettaufficiale.it/eli/id/1994/09/20/094A5917/sg> (Accessed online the 16 December 2023).
8. Italian legislative decree n. 22 of the 5 February 1997 Available online: [https://www.mase.gov.it/sites/default/files/dlgs\\_05\\_02\\_1997\\_22.pdf](https://www.mase.gov.it/sites/default/files/dlgs_05_02_1997_22.pdf) (Accessed online the 16 December 2023).
9. Directive 1999/77/EC of 26 July 1999 adapting to technical progress for the sixth time Annex I to Council Directive 76/769/EEC on the approximation of the laws, regulations and administrative provisions of the Member States relating to restrictions on the marketing and use of certain dangerous substances and preparations (asbestos).

10. Law 152/2006. Available online: <https://www.normattiva.it/uri-res/N2Ls?urn:nir:stato:decreto.legislativo:2006-04-03;152>. (Accessed online the 16 December 2023).
11. Liu, Y.; Kong, F.; Santibanez Gonzalez, E.D.R. Dumping, waste management and ecological security: evidence from England. *J. Clean. Prod.* **2017**, *167*, 1425–1437. DOI: 10.1016/j.jclepro.2016.12.097
12. Sicilian regional law n. 10 29 April 2014. Rules for the protection of health and the territory from the risks deriving from asbestos. Available online: <http://www.gurs.regione.sicilia.it/Gazzette/g14-19o/g14-19o.pdf> (Accessed online the 18 December 2023).
13. Paglietti, F.; Malinconico, S.; Della Staffa, B.C.; Bellagamba, S.; De Simone, P. Classification and management of asbestos-containing waste: European legislation and the Italian experience. *Waste Manag. Res.* **2016**, *50*, 130–150. DOI: 10.1016/j.wasman.2016.02.014
14. Bunnell, J.E.; Finkelman, R.B.; Centeno, J.A.; Selinus, O. Medical Geology: a globally emerging discipline. *Geol. Acta* **2007**, *5*(3), 273–281.
15. VII Rapporto del Registro nazionale dei mesoteliomi (ReNaM), Italia, 2021. Accessed online: <https://www.inail.it/cs/internet/comunicazione/pubblicazioni/catalogo-generale/pubbl-il-registro-nazionale-mesoteliomi-settimo-rapporto.html> (Accessed online the 7 January 2024).
16. Kakooei, H.; Marioryad, H. Evaluation of exposure to the airborne asbestos in an automobile brake and clutch manufacturing industry in Iran. *J. Pharmacol. Toxicol.* **2010**, *56*(2), 143–147. DOI: 10.1016/j.yrtph.2009.09.005
17. Ramos-Bonilla, J.P.; Cely-García, M.F.; Giraldo, M.; Comba, P.; Terracini, B.; Pasetto, R.; Silva, Y.A. An asbestos contaminated town in the vicinity of an asbestos-cement facility: The case study of Sibaté, Colombia. *Environ. Res. J.* **2019**, *176*, 108464. DOI: 10.1016/j.envres.2019.04.031
18. Platek S.F.; Riley R.D.; Simon S.D. The classification of asbestos fibres by scanning electron microscopy and computer-digitizing tablet. *Ann. Occup. Hyg.* **1992**, *36*(2), 155–171. DOI: 10.1093/annhyg/36.2.155. PMID: 1326908
19. Huuskonen, O.; Kivisaari, L.; Zitting, A.; Taskinen, K.; Tossavainen, A.; Vehmas, T. High-resolution computed tomography classification of lung fibrosis for patients with asbestos-related disease. *Scand. J. Work Environ. Health* **2001**, *27*(2), 106–112. DOI: 10.5271/sjweh.596
20. Serio, G.; Vimercati, L.; Pennella, A.; Gentile, M.; Cavone, D.; Buonadonna, A.L.; Scattoni, A.; Fortarezza, F.; De Palma, A.; Marzullo, A. Genomic changes of chromosomes 8p23.1 and 1q21: Novel mutations in malignant mesothelioma. *Lung Cancer* **2018**, *126*, 106–111. DOI: 10.1016/j.lungcan.2018.10.012
21. Klebe, S.; Leigh, J.; Henderson, D.W.; Nurminen, M. Asbestos, smoking and lung cancer: an update. *IJERPH* **2020**, *17*(1), 258, 1–23. DOI: 10.3390/ijerph17010258
22. Hocking, A.J.; Thomas, E.M.; Prabhakaran, S.; Jolley, A.; Woods, S.L.; Soeberg, M.J.; Klebe, S. Molecular Characterization of Testicular Mesothelioma and the Role of Asbestos as a Causative Factor. *Arch. Pathol. Lab. Med.* **2023**, *147*(12), 1446–1450. DOI: 10.5858/arpa.2022-0283-OA
23. Wagner, J.C. The discovery of the association between blue asbestos and mesotheliomas and the aftermath. *JOEM* **1991**, *48* (6), 399–403. DOI:10.1136/oem.48.6.399
24. Attanoos, R.L.; Churg, A.; Galateau-Salle, F.; Gibbs, A.R.; Roggli, V.L. Malignant mesothelioma and its non-asbestos causes. *Arch. Pathol. Lab. Med.* **2018**, *142*(6), 753–760. DOI: 10.5858/arpa.2017-0365-RA
25. Kindler, H.L. Peritoneal mesothelioma: the site of origin matters. *ASCO* **2013**, *33*(1), 182–188. DOI: 10.14694/EdBook\_AM.2013.33.182
26. Zhai, Z.; Ruan, J.; Zheng, Y.; Xiang, D.; Li, N.; Hu, J.; Dai, Z. Assessment of global trends in the diagnosis of mesothelioma from 1990 to 2017. *JAMA Netw. Open* **2021**, *4*(8), e2120360-e2120360. DOI: 10.1001/jamanetworkopen.2021.20360
27. Walker-Bone, K.; Benke, G.; MacFarlane, E.; Klebe, S.; Takahashi, K.; Brims, F.; Sim, M.R.; Driscoll, T.R. Incidence and mortality from malignant mesothelioma 1982–2020 and relationship with asbestos exposure: the Australian Mesothelioma Registry. *Occup. Environ. Med.* **2023**, *80*, 186–191.
28. Ambrose, K.K.; Box, C.; Boxall, J.; Brooks, A.; Eriksen, M.; Fabres, J.; Fylakis, G.; Walker, T.R. Spatial trends and drivers of marine debris accumulation on shorelines in South Eleuthera, the Bahamas using citizen science. *Mar. Pollut. Bull.* **2019**, *142*, 145–154. DOI: 10.1016/j.marpolbul.2019.03.036
29. Lisco, S.; Lapietra, I.; Laviano, R.; Mastronuzzi, G.; Fracchiolla, T.; Moretti, M. Sedimentological features of asbestos cement fragments in coastal environments (Taranto, southern Italy). *Mar. Pollut. Bull.* **2023**, *187*, 114469. DOI: 10.1016/j.marpolbul.2022.114469
30. Tolosa, I.; Readman, J.W.; Fowler, S.W.; Villeneuve, J.P.; Dachs, J.; Bayona, J.M.; Albaiges, J. PCBs in the western Mediterranean. Temporal trends and mass balance assessment. *Deep Sea Res. Part II Top. Stud. Oceanogr. DEEP-SEA RES PT II* **1997**, *44*(3-4), 907–928. DOI: 10.1016/S0967-0645(96)00104-X
31. El Nemr, A.; El-Sadaawy, M.M. Polychlorinated biphenyl and organochlorine pesticide residues in surface sediments from the Mediterranean Sea (Egypt). *Int. J. Sediment Res.* **2016**, *31*, 44–52. DOI: 10.1016/j.ijsrc.2013.03.001

32. Ragab, S.; El Sikaily, A.; El Nemr, A. Concentrations and sources of pesticides and PCBs in surficial sediments of the Red Sea coast, Egypt. *Egypt. J. Aquat. Res.* 2016, 42(4), 365–374. DOI: 10.1016/j.ejar.2016.09.007
33. Reinold, S.; Herrera, A.; Hernández-González, C.; Gómez, M. Plastic pollution on eight beaches of Tenerife (Canary Islands, Spain): an annual study. *Mar. Pollut. Bull.* 2020, 151, 110847. DOI: 10.1016/j.marpolbul.2019.110847
34. Noor, T.; Javid, A.; Hussain, A.; Bukhari, S.M.; Ali, W.; Muhammad Akmal, M.; Hussain, S.M. Types, sources and management of urban wastes. In *Urban Ecology*, Verma, P., Singh, P., Singh, R., Raghubanshi, A.S., Eds., Elsevier, Issy-les-Moulineaux, France, 2020, pp. 239–263.
35. Legambiente. Available online: <https://www.legambiente.it/rapporti-e-osservatori/liberi-dallamianto/> (accessed on 2 December 2023).
36. Osservatorio Nazionale Amianto (ONA). Available online: <https://onanotiziarioamianto.it/amianto-spiagge-necessario-effettuare-bonifica/> (accessed on 2 December 2023).
37. Il Secolo XIX. Available online: <https://www.ilsecoloxix.it/imperia/2013/05/09/news/amianto-emergenza-in-spiaggia-1.32312548> (accessed on 2 December 2023).
38. Gruppo d'Intervento Giuridico (GrIG). Associazione ecologista. Available online: <https://gruppodinterventogiuridicoweb.com/2022/05/15/cagliari-bonificata-dai-detriti-di-amianto-la-spiaggia-del-poetto/> (accessed on 2 December 2023).
39. La Nuova Venezia di Venezia e Mestre. Available online: <https://nuovavenezia.gelocal.it/veneziana/cronaca/2010/01/21/news/veneziana-quintali-di-eternit-nella-cittadella-davenezia-1.1337278> (accessed on 3 December 2023).
40. GalluraOggi.it. Available online: <https://www.galluraoggi.it/cronaca/eternit-marina-maria-bonifiche-spiaggia-2-aprile-2023/> (accessed on 3 December 2023).
41. LinkOristano.it. Available online: <https://www.linkoristano.it/2020/06/11/bene-la-pulizia-della-spiaggia-ad-abarossa-ce-ancora-amianto/> (accessed on 3 December 2023).
42. RomaToday.it. Available online: <https://www.romatoday.it/cronaca/amianto-via-del-pesce-luna-fiumicino.html> (accessed on 3 December 2023).
43. FondiNotizie.net. Available online: [https://www.fondinotizie.net/notizie/territorio/52/una-spiaggia-fatta-di-amianto#google\\_vignette](https://www.fondinotizie.net/notizie/territorio/52/una-spiaggia-fatta-di-amianto#google_vignette) (accessed on 3 December 2023).
44. La Nazione. Available online: <https://www.lanazione.it/viareggio/cronaca/eternit-spiaggia-libera-c9217e92> (accessed on 5 December 2023).
45. Il Tirreno. Available online: <https://www.iltirreno.it/piombino/cronaca/2018/04/23/news/eternit-sulla-spiaggia-della-sterpaia-1.16748868> (accessed on 5 December 2023).
46. LaRegione. Available online: <https://www.laregione.ch/estero/estero/1602113/lastre-eternit-lucca-viareggio-ambiente> (accessed on 5 December 2023).
47. QuiCosenza.it. Available online: <https://www.quicosenza.it/news/provincia/42898-ancora-amianto-sul-litorale-di-san-lucido-spiagge-sotto-sequestro> (accessed on 5 December 2023).
48. BrindisiReport.it. Available online: <https://www.brindisireport.it/cronaca/frammenti-di-Eternit-abbandonati-da-anni-su-spiaggia-di-Specchiolla.html> (accessed on 5 December 2023).
49. OsservatorioOggi.it. Available online: <http://www.osservatoriooggi.it/notizie/attualita/5694-amianto-torre-cane-spiaggia-bambini-turisti-fasano> (accessed on 15 February 2024).
50. Ilnuovoamico.it. Available online: <https://www.ilnuovoamico.it/2018/07/amianto-pericolo-a-ridosso-della-spiaggia-di-pesaro/> (accessed on 15 February 2024).
51. Livesicilia.it. Available online: <https://livesicilia.it/amianto-seppellito-sotto-la-sabbia-bonifica-alla-spiaggia-numero-3/> (accessed on 15 February 2024).
52. Normanno.com. Available online: <https://normanno.com/attualita/lastre-amianto-due-passi-dal-mare-biancuzzo-vanno-rimosse-subito/> (accessed on 15 February 2024).
53. Tempostretto.it. Available online: <https://www.tempostretto.it/news/inquinamento-sabbia-eternit-tanto-mare-sant-agata-mortelle.html> (accessed on 15 February 2024).
54. Messinatoday.it. Available online: <https://www.messinatoday.it/cronaca/indagini-spiaggia-mili-marina-rifiuti-amianto-.html> (accessed on 15 February 2024).
55. Regione Sicilia. Available online: <https://www.regione.sicilia.it/sites/default/files/2024-01/Format%20ITA030042-%20Monti%20Peloritani%2C%20Dorsale%20Curcuraci%2C%20Antennamare%20e%20area%20marina%20dello%20stretto%20di%20Messina.pdf>
56. Regione Sicilia. Available online: <https://www.regione.sicilia.it/sites/default/files/2024-01/Format%20ITA030008%20-%20Capo%20Peloro%20-%20Laghi%20di%20Ganzirri.pdf> (accessed on 15 February 2024).
57. Ferrarini, A.; Celada, C.; Gustin, M. Preserving the Mediterranean bird flyways: Assessment and prioritization of 38 main wetlands under human and climate threats in Sardinia and Sicily (Italy). *Sci. Total Environ.* 2021, 751, 141556. DOI: 10.1016/j.scitotenv.2020.141556

58. Ispra Ambiente. [https://www.isprambiente.gov.it/files/pubblicazioni/statoambiente/tematiche2011/05\\_%20Mare\\_e\\_ambiente\\_costiero\\_2011.pdf](https://www.isprambiente.gov.it/files/pubblicazioni/statoambiente/tematiche2011/05_%20Mare_e_ambiente_costiero_2011.pdf) (accessed on 15 February 2024).
59. Ispra Ambiente. <https://www.isprambiente.gov.it/it/servizi/stato-delle-coste/atlante-delle-coste> (accessed on 15 February 2024).
60. Randazzo, G.; Cigala, C.; Crupi, A.; Lanza, S. The natural causes of shoreline evolution of Capo Peloro, the northernmost point of Sicily (Italy). *J. Coast. Res.* 2014, *70*, 199–204. DOI: 10.2112/SI70-034.1
61. Ferrarini, A.; Celada, C.; Gustin, M. Anthropogenic Pressure and Climate Change Could Severely Hamper the Avian Metacommunity of the Sicilian Wetlands 2022. *Diversity*, *14*(9), 696. DOI: 10.3390/d14090696
62. Marcenò, C.; Romano, S. La vegetazione psammofila della Sicilia settentrionale. *Informatore Botanico Italiano* 2010, *42*(1) 91–98.
63. Roma-Marzio, F.; Liguori, P.; Meneguzzo, E.; Banfi, E.; Busnardo, G.; Galasso, G.; Kleih, M., Lasem, B.; Wallnöfer, B.; Bolpagni, R.; Gianguzzi, O.; Caldarella, O.; Mereu, G.; Giardini, M. Nuove segnalazioni floristiche italiane 6. Flora vascolare. *Notiziario Della Società Botanica Italiana* 2019, *3*(1), 47–53.
64. Giacobbe, S.; Spanò, N.; Manganaro, A. Le praterie di Posidonia oceanica (L.) Delile nello Stretto di Messina: Stato delle conoscenze e prospettive. Posidonia oceanica meadows, conservation and experiences. In *A.M.P. "Capo Rizzuto"* pubbl., Infantino E. ed, Le castella (Crotone), Italy, 2004, 57–66.
65. Di Geronimo, I.; Giacobbe, S. Cartes des biocenoses de Détroit de Messine. In: Bionomie des peuplements benthiques des substrats meubles et rocheaux plio-quatérnaires du Détroit de Messine. *Doc. et Trav. IGAL* 1987, *11*, 153–169.
66. Bottari, A.; Bottari, C.; Carveni, P.; Giacobbe, S.; Spanò, N. Genesis and geomorphologic and ecological evolution of the Ganzirri salt marsh (Messina, Italy). *Quat. Int.* 2005, *140141* (VII, 1), 150–158. DOI: 10.1016/j.quaint.2005.07.001
67. Giacobbe, S. Biodiversity loss in Sicilian transitional waters: the molluscs of Faro Lake. *Biodivers. J.* 2012, *3*(4), 501–510.
68. Vitale, D.; Giacobbe, S.; Spinelli, A.; De Matteo, S.; Cervera, J.L. "Opisthobranch" (mollusks) inventory of the Faro Lake: a Sicilian biodiversity hot spot. *Ital. J. Zool.* 2016, *83*, 4, 524–530. DOI: 10.1080/11250003.2016.1236843
69. Furfaro, G.; Renda, W.; Nardi, G.; Giacobbe, S. Integrative taxonomy of the bubble snails (Cephalaspidea, Heterobranchia) inhabiting a promising study area: the coastal sicilian Faro Lake (Southern Italy). *Water* 2023, *15*(14), 2504, 1–18. DOI: 10.3390/w15142504
70. Manghisi, A.; Morabito, M.; Bertuccio, C.; Le Gall, L.; Couloux, A.; Cruaud, C.; Genovese, G. Is routine DNA barcoding an efficient tool to reveal introductions of alien macroalgae? A case study of *Agardhiella subulata* (Solieriaceae, Rhodophyta) in Cape Peloro lagoon (Sicily, Italy). *Cryptogam. Algal.* 2010, *31*(4), 423–433.
71. Bertuccio, C.; Genovese, G.; Manghisi, A.; Cruaud, C.; Couloux, A.; Le Gall, L.; Morabito, M. Changes in the benthic algal flora of Lake Ganzirri, North-Eastern Sicily (Italy). *Cambiamenti della flora bentonica del Lago di Ganzirri, Sicilia nord orientale (Italia)*. *Natura Rerum* 2014, *3*, 79–91.
72. Miladi, R.; Manghisi, A.; Armeli Minicante, S.; Genovese, G.; Abdelkafi, S.; Morabito, M. A DNA barcoding survey of *Ulva* (Chlorophyta) in Tunisia and Italy reveals the presence of the overlooked alien *U. ohnoi*. *Cryptogam. Algal.* 2018, *39*, 85–107. DOI: 10.7872/crya/v39.iss1.2018.85
73. Manghisi, A.; Miladi, R.; Minicante, S.A.; Genovese, G.; Gall, L.L.; Abdelkafi, S.; Saunders, G.W.; Morabito, M. DNA barcoding sheds light on novel records in the Tunisian red algal flora. *Cryptogam. Algal.* 2019, *40*(3), 13–34. DOI: 10.5252/cryptogamie-algologie2019v40a3
74. Giacobbe, S.; Leonardi, M. Les fonds à Pinna du Détroit de Messine. *Doc. et Trav. IGAL* 1987, *11*, 253–254.
75. Cabanellas-Reboredo, M.; Vázquez-Luis, M.; Moure, B.; Álvarez, E.; Deudero, S.; Amores, A.; Addis, P.; Ballesteros, E.; Barrajón, A.; Coppa, S.; García-March, J.R.; Giacobbe, S.; Giménez Casalduero, F.; Hadjoannou, L.; Jiménez-Gutiérrez, S.V.; Katsanevakis, S.; Kersting, D.; Mačić, V.; Mavrič, B.; Patti, F.P.; Planes, S.; Prado, P.; Sánchez, J.; Tena-Medialdea, J.; De Vaugelas, J.; Vicente, N.; Belkhamssa, F.Z.; Zupan, Z.; Hendriks, I.E. Tracking a mass mortality outbreak of pen shell *Pinna nobilis* populations: A collaborative effort of scientists and citizens. *Sci. Rep.* 2019, *9*, 13355. DOI: 10.1038/s41598-019-49808-4
76. Donato, G.; Lunetta, A.; Spinelli, A.; Catanese, G.; Giacobbe, S. Sanctuaries are not inviolable: Haplosporidium pinnae as responsible for the collapse of the *Pinna nobilis* population in Lake Faro (central Mediterranean). *J. Invertebr. Pathol.* 2023 *201*, 108014. DOI: 10.1016/j.jip.2023.108014
77. Bonfiglio L.; Violanti D. Prima segnalazione di Tirreniano ed evoluzione pleistocenica di Capo Peloro (Sicilia nord-orientale). *Geogr. Fis. Dinam. Quat.* 1983, *6*, 3–15.
78. Antonioli, F.; Ferranti, L.; Lambeck, K.; Kershaw, S.; Verrubbi, V.; Dai Pra, G. Late Pleistocene to Holocene record of changing uplift rates in southern Calabria and northeastern Sicily (southern Italy, Central Mediterranean Sea), *Tectonophysics* 2006, *422*(1–4), 23–40.
79. Cosentino, A.; Giacobbe, S. Mollusc assemblages of hard bottom subtidal fringe: a comparison between two coastal typologies. *Biodivers. J.* 2015, *6*(1), 353–364.

80. Bottari, A.; Bottari, C.; Carveni, P. Tectonic genesis of the salt marshes on the Sicilian coast of the Straits of Messina (Sicily). *Alp. Mediterr. Quat.* 2005, *18*(2), 113–122.
81. Jacobacci, A.; Malatesta, A.; Motta S. Piano di studi sullo Stretto di Messina per il collegamento della Sicilia con la Calabria: ricerche geologiche. Regione siciliana, IRES 1961, Palermo, Italy, pp. 1–66.
82. Selli, R. Geologia e sismotettonica dello Stretto di Messina. Convegno su: L'attraversamento dello Stretto di Messina e la sua fattibilità, *Att. Acc. Naz. Lincei* 1978, *43*, 119–154.
83. Lombardo, G. Stratigrafia dei depositi pleistocenici della Sicilia nord-orientale. *Att. Acc. Gioenia Sc. Nat. Catania* 1980, *12*, 84–113.
84. Guarnieri, P.; Pirrotta, C. The response of drainage basins to the late Quaternary tectonics in the Sicilian side of the Messina Strait (NE Sicily). *Geomorphology* 2008, *95*(3-4), 260–273. DOI: 10.1016/j.geomorph.2007.06.013
85. Presti, D.; Billi, A.; Orecchio, B.; Totaro, C.; Faccenna, C.; Neri, G. Earthquake focal mechanisms, seismogenic stress, and seismotectonics of the Calabrian Arc, Italy. *Tectonophysics* 2013, *602*, 153–175. DOI: 10.1016/j.tecto.2013.01.030
86. Neri, G.; Orecchio, B.; Presti, D.; Scolaro, S.; Totaro, C. Recent seismicity in the area of the major, 1908 Messina Straits earthquake, south Italy. *Front. Earth Sci.* 2021, *9*, 667501. DOI: 10.3389/feart.2021.667501
87. Krumbein, W.C.; Pettijohn, F.J. Manual of Sedimentary Petrography. XIV + 549 pp., 8:0, 265 fig. New York and London 1938, (1939). D. Appleton — Century Company. 8 6.50 (30 s.), *Geol. fören. Stockh. förh.* 1939, *61*(2), 225–227. DOI: 10.1080/11035893909452786
88. Blott, S.J.; Pye, K. Particle shape: a review and new methods of characterization and classification. *Sedimentology* 2008, *55*(1), 31–63. DOI: 10.1111/j.1365-3091.2007.00892.x
89. Dapples, E.C.; Rominger J. F. Orientation analysis of fine-grained clastic sediments: a report of progress. *J. Geol.* 1945, *53*(4), 246–261.
90. Folk, R.L. *Petrology of sedimentary rocks*. Hemphill Publishing Company, Austin, Texas, 1980, pp. 1–184.
91. Tempostretto.it. Available online: <https://www.tempostretto.it/news/cronaca-post-alluvione-cittadini-scaletta-chiedono-sicurezza-salute-dopo-demolizioni-amianto-dappertutto.html> (accessed on 16 February 2024).

**Disclaimer/Publisher's Note:** The statements, opinions and data contained in all publications are solely those of the individual author(s) and contributor(s) and not of MDPI and/or the editor(s). MDPI and/or the editor(s) disclaim responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.