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Article

Terrestrial and Marine Landforms along the Cilento Coastland (Southern Italy): A Framework for Landslide Hazard Assessment and Environmental Conservation

Domenico Guida [1] and Alessio Valente [2,*]

[1] Department of Civil Engineering, University of Salerno, 84084 Fisciano (SA), Italy; dguida@unisa.it
[2] Department of Sciences and Technologies, University of Sannio, 82100 Benevento, Italy
* Correspondence: valente@unisannio.it; Tel.: +39-0824-305-188

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Abstract: This study shows the terrestrial and marine landforms present along the Cilento coast in the southern part of the Campania region (Italy). This coast is characterized by the alternation of bays, small beaches, and rocky headlands. In the adjacent submerged areas, there is a slightly inclined platform that has a maximum width of 30 km to the north, while it narrows in the south to approximately 6 km. A wide variety of landforms are preserved in this area, despite the high erodibility of the rocks emerging from the sea and the effects of human activities (construction of structures and infrastructures, fires, etc.). Of these landforms, we focused on those that enabled us to determine Quaternary sea-level variations, and, more specifically, we focused on the correlation between coastal and sea-floor topography in order to trace the geomorphological evolution of this coastal area. For this purpose, the Licosa Cape and the promontory of Ripe Rosse located in northern Cilento were used as reference areas. Methods were used that enabled us to obtain a detailed digital cartography of each area and consequently to apply physical-based coastal evolution models. We believe that this approach would provide a better management of coastal risk mitigation which is likely to become increasingly important in the perspective of climate change.

Keywords: coastal geomorphology; submarine geomorphology; cliffs; sea-level changes; Cilento; southern Italy

1. Introduction

In relatively recent coastal landscapes, such as those of central–western Mediterranean Sea, the events responsible for the landform evolution and the controls they underwent must be sought within the last hundred thousand years. Furthermore, morphogenetic events continue to exert their effect and shape the landscape today, which is complicated by the actions of human beings who built facilities and infrastructures along the coasts to promote tourism or facilitate mobility [1]. These actions are often performed without analyzing landforms and processes carefully, thus causing instability or increasing environmental vulnerability and degradation [2].

This study aims to highlight the main emerged and submerged landforms present along the spectacular coastscape of the National Park of Cilento, in southern Italy. This coastal landscape, with lovely inland areas, received several international awards. In 1997, the entire region was recognized by UNESCO's (United Nations Educational, Scientific and Cultural Organization) Biosphere Reserve with the aim of maintaining a long-term equilibrium between man and his environment by conserving biological diversity, promoting economic development, and preserving cultural values (MAB – Man and Biosphere program), while, in 1998, three sites in the Cilento area (Paestum, Velia, and Padula) were included in the list of UNESCO world heritage sites in the category of "cultural landscapes" of global importance. Finally, in 2010, the area of the National Park was added to the Global Geopark Network of UNESCO, recognized for its rich geological heritage, numerous historical sites, and cultural traditions [3,4]. In this area, many previous studies enable us to reconstruct the morphological evolution of the coast and to determine the consequences of sea-level changes [5,6], where understanding the consequences can help to mitigate the risks affecting some specific sites (e.g., landslides, floods, storm surges, etc.) [7,8]. Furthermore, an estimate of future scenarios, which foresee a global sea-level rise due to global warming, could contribute to the achievement of sustainable planning and sustainable tourism development [9–11].

2. Study Area

The Cilento coastland extends over 100 km along a wide rectangular promontory between the Gulf of Salerno (northwest) and the Gulf of Policastro (southeast) on the southern Tyrrhenian margin of the Italian peninsula. (Figure 1).

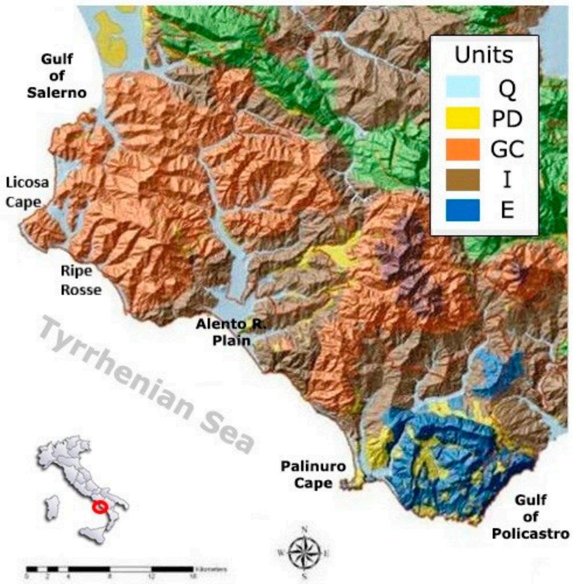


Figure 1. Geological map on DEM (Digital Elevation Model), from Campania Region Technical Cartography at the 1:5000 scale of the. Legend (only for the units shown in the text): Q—Quaternary post-orogenic units; PD—Pliocene deposits; GC—Middle Miocene syn-orogenic units (Cilento Group); I—Lower Tertiary internal units; E—Mesozoic–Lower Tertiary external unit.

Its complex morphology is characterized by mountain reliefs that reach the coast and by narrow floodplains. The causes of this complexity are attributed to the post-orogenic tectonics of the Apennine chain, which occurred from the Early Pliocene to the Middle Pleistocene through extensional faults, which disrupted this sector of the chain. It represents the southern sector of the "fold and thrust belt" formed in the central Tetide area from the late Cretaceous, due to the interaction between the European and African plates, the opening of the Tyrrhenian ocean basin, and the counter-clockwise rotation of the orogenic front [12]. This area has a long and complex lithogenetic history, with various tectono-sedimentary events and orogenic shifts [13], which today enable us to distinguish several lithostratigraphic units outcropping along the coast (Figure 1).

The inner units, comprising principally lower Tertiary deposits (Ligurian complex [14]), are mainly composed of marly and variegated clays, with sedimentary facies belonging to the ocean floor, which are transported upward to calcarenites and calcilutites, often with flint, and then with shales, sandstones, and rare conglomerates formed in a distal turbiditic environment [15]. In outcrops, they generally occupy the lower portion of the sequences, and, in many cases, they represent the lithotypes of the submerged coastal area. In this case, they are partially covered by veils of more recent sediments [16–18].

The external units are mainly composed of Mesozoic–Tertiary carbonates (Bulgheria unit—Middle Liassic to Lower Miocene [13,19]), representative of sedimentary environments ranging from shallow-water carbonates (often back-reef facies) to deep-water carbonates. The outcrops of these units are located on the high and rocky coastline of southern Cilento [18] (Figure 2). On the coastal bottoms, even partially emerged, these rocks are often covered with calcareous algae and animals with calcareous skeletons (sponges, corals, serpulids, bryozoans, mollusks) [17,18,20,21].

Figure 2. An aerial view of a coastal stretch in the calcareous–dolomite successions (External Units).

In disconformity on the previous units, Middle and Upper Miocene syn-orogenic units are present, whose successions are made up mainly of fine to extremely coarse pelitic and calcareous–marly arenaceous turbidites deposited in deep submarine fans (thrust top basin) [22]. Of these sequences, those of the Cilento group (Upper Burdigalian–Upper Tortonian) [23] are the most common along the coast, which are generally found on internal units. In submerged areas, these units are frequently covered by recent sands colonized by fossil organisms and sometimes by seagrass meadows [17,18]. The sand cover usually passes to muds away from the coastal bottoms.

The Quaternary post-orogenic units include all continental sediments, transitional sediments, and marine clastic sediments, deposited after the final emergence of the Apennine Chain, probably beginning in the Lower Pliocene [12,13]. In Cilento, they are represented by exposed aeolian, fluvial, slope, lake, and travertine deposits along the river valleys and on the plains near the coast, as well as by the marine transitional deposits stacked on the emerged and submerged coastal areas. These units may show intercalations of the products of Campania volcanic activity [24–27] (Figure 3).

Figure 3. A cross-section in the last Quaternary alluvial and colluvial deposits in southern Cilento.

The geological and tectonic setting mentioned above led to a prevalent morpho-structural control of the rocky coastal landscape of the Cilento area, sometimes resulting from the retreat and replacement of the previous fault-line scarp, alternated with small, elongated coastal plains (e.g., Alento River plain) [27,28]. These plains were formed by the deepening of the rivers favored by the correspondence with tectonic lineaments and the easy erodibility of the outcropping lithotypes.

The filling of these flared coastal valleys occurred due to over-flooding and marine ingressions. The traces of marine sediments uplifted to different altitudes from terraces, and the transitional sediments on the continental shelf show how sea level variations are superimposed on tectonic events. This is more easily seen along the southern coasts of Cilento composed of external carbonate units. In particular, the coastal profile of Mount Bulgheria shows ancient level surfaces (up to 400 m) with marine sediments from the Lower Pleistocene onward [29,30]. Calcareous cliff faces at sea level are often vertical [3,31].

The rest of the coast is composed of terrigenous deposits of internal and syn-orogenic units that gradually descend toward the sea through stratified escarpments or covered by debris, locally terraced, with generally concave profiles and sometimes composite with different slopes [3,31]. This diversity is due to the presence of marly–clayey levels or pelitic interlayers, which facilitate the occurrence of landslides in continuous evolution. In order to complete this brief geomorphological analysis, it is essential to mention the coastal slopes composed of clastic sediments, such as those represented by steep Pleistocene dune–beach systems of the Pleistocene. The oldest marine abrasion surfaces preserved in soft rock date back to the Upper Pleistocene [30] and are mainly found in the northern coastal section. Lastly, in order to complete the geomorphological scenario, accumulations of debris and sand tongues occurred at the base of the cliffs on the shoreline and close to micro-crags formed by terrigenous and clastic rocks. The former come from the dismantling of the adjacent slope, whereas the latter come from the coastal morphodynamics which transport sand and deposit it in the inlets [3,31].

The analysis of the submerged portion mainly concerns the continental shelf [16,17] (Figure 4) with a variable maximum width of 30 km in the north and a minimum width of 6 km in the south and an edge generally located at a depth of 200m except for the northern stretch of coast, where it is situated at a depth of approximately 230 m (Licosa Cape offshore), and the southeastern stretch of the coastline in the Gulf of Policastro, where it is located in shallower water (<100 m). The average slope varies from 0.3° in the northern sector to 0.8° in the southern sector, in correspondence with the narrowest portion. In this submerged portion, several marine abrasion terraces were identified, which were formed by the action of the sea waves during the Pleistocene paleo-standings of sea level with edges located at various depths [16,17]. Furthermore, in order to confirm that the major structural elements of the emerged part continue beneath the sea surface near the emerged valleys (e.g., Alento River Valley), depressed areas were identified, which are filled with sediments with varying grain size. In geophysical sub-bottom profiles, there is a series of normal and listric faults, oriented northwest to southeast [32]. The latter were caused by the collapse of the Tyrrhenian margin during the Pliocene and the Lower Pleistocene [12,16,17]. This type of fault probably defined the current coastal profile of the Cilento promontory which has the same orientation. At lower depths, sandy plains generally prevail in continuity with the emerged beaches and degrade toward the mudflats offshore. Locally, sands can also be found at greater depths; in this case, they represent ancient relict shorelines which were formed when the sea level was lower than it is today [16–18].

The climate on the Cilento coast is temperate with average annual temperatures of approximately 17 °C (12.6–20.8 °C) and an average annual rainfall that varies from 730 mm in the northern sector to 790 mm in the southern sector. Rainfall is concentrated in spring and late autumn, while, during the summer, there are long periods of drought. This climate is favorable for the development of evergreen forests and Mediterranean scrub along the coast. Of particular interest are the native spontaneous species that grow in the coastal areas, approximately 10% of which are of considerable phytogeographic importance, as they are endemic and/or rare [33,34]. On the beaches, among the sand communities, the increasingly rare sea lily (*Pancratium maritimum*) is still present; phytocoenoses with highly specialized halophytes live on the reefs in direct contact with sea spray and the endemic statice Salerno (*Limonium remotispiculum*) thrives (Figure 5a).

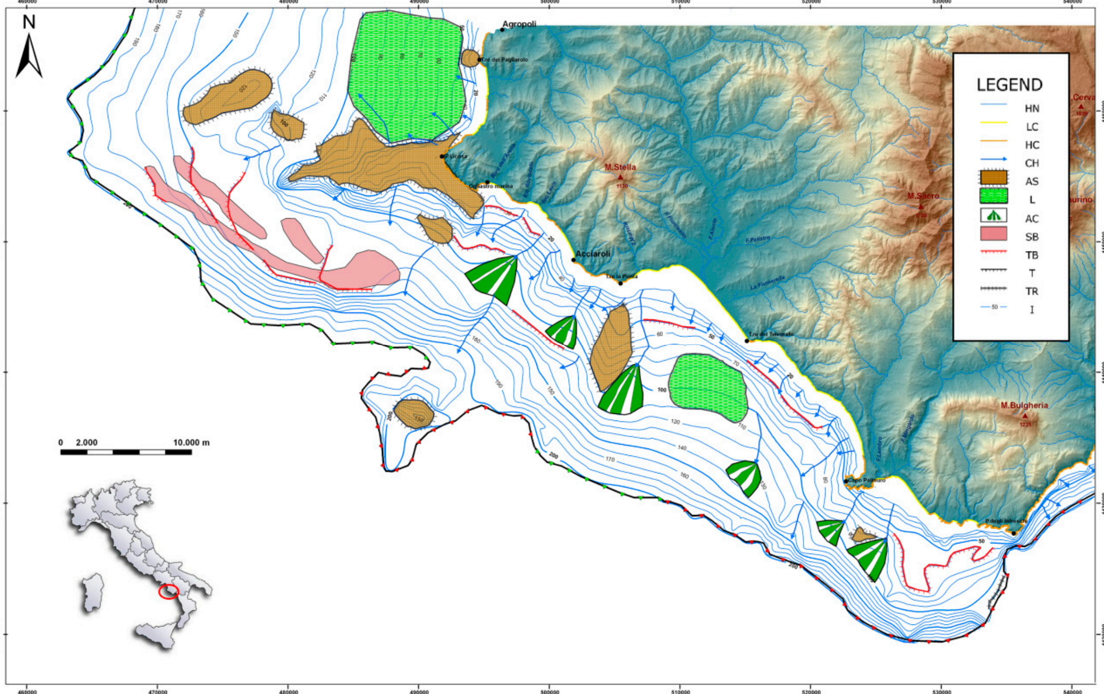


Figure 4. Geomorphological sketch map of Cilento coastal shelf (from [16]). Legend: HN: terrestrial hydrography; LC—low coast; HC—high coast; CH—channels incised in the sea bottom; AS—acoustic substrate rising from the sea bottom; L—depressed areas; AC—stack as ancient mouth complexes; SB—sandy bodies rising from the sea bottom; TB—edges of abrasion terraces; T—morpho-structural terrace; TR—trench; I—isobath.

(**a**) (**b**)

Figure 5. (**a**) Vegetated dune behind Cefalo Beach (southern Cilento); in the background, an inactive calcareous cliff is shown; (**b**) the Palinuro Natural Arch (southern Cilento) with precious *Primula Palinuri* and other rupicolous species.

On the coastal cliffs, the Mediterranean rupicolous species are dotted with precious endemics such as the Primula di Palinuro (*Primula palinuri*), the clove of cliffs (*Dianthus rupicola*), the *Centaurea* (*Centaurea cineraria*), the iberide florida (*Iberis semperflorens*), the Neapolitan *Campanula* (*Campanula fragilis*), and many other flowering plant species that compose a coastal landscape of rare beauty (Figure 5b). In the sunniest and driest areas, we find the ginestra of Cilento (*Cilento genista*), the carob (*Ceratonia siliqua*), the red or Phoenician juniper (*Juniperus phoenicea*), and holm oak and pine woods (*Pinus halepensis*), which seem to be expanding again as they are being reforested.

On these last stretches of coastline, frequent fires and the fact that the roads were widened to reach the homes built on the slopes increased land degradation and reduced slope stability. However, there are still coastal stretches that preserve their original natural condition which are monitored closely by the Cilento, Vallo di Diano, and Alburni National Parks with the aim of mitigating damage and preventing deterioration [3,31]. More recently, the municipalities of Santa Maria di Castellabate in the north and the Costa degli Infreschi and Masseta in the south developed marine conservation and monitoring strategies. The reason for protecting and monitoring these marine areas is because of the richness of their seabeds, which contain biocenoses of great interest, such as pre-coralligenous and coralligenous species, as well as large quantities of *Posidonia* seagrass beds (*Posidonia oceanica*) [17,18].

3. Materials and Methods

Firstly, a review of the existing literature on the geology and geomorphology of Cilento was carried out. Most of these studies were focused on short stretches of coastline that offered particular cues as they were extremely didactic and representative for the development of research (i.e., References [20,25,27]). Previous coastal geomorphological studies did not integrate information on the dynamics and geomorphological evolution of the submerged sectors. This study attempts to fill these research gaps by trying to correlate the emerged and submerged landforms of the northern Cilento sites near Punta Licosa, using an integrated approach (Figure 1).

Integrated geomorphological surveys and analysis were carried out, starting from current terrestrial and submerged landforms. These latter surveys were carried out using sea vision underwater lighting on boats and by performing underwater scuba dives. The results of these surveys were supported by consulting topographic maps of the area. The oldest topographic maps used were the 1956 1:25,000 scale supplied by the IGMI (Istituto Geografico Militare Italiano) and the more recent 2004 1:5000 scale map supplied by the Campania Region. The information on these maps was completed by observing various aerial photogrammetric images obtained from 1943 onward produced by the IGMI, up to those taken in 2012 by the Campania Region. Images found on the web were also analyzed, particularly those taken by Google Earth in 2015 [35], as well as those placed on the National Cartographic Portal of the Italian Ministry of Environment in 2012 [36]. From these images, the LIDAR-derived DEM was extracted for some specific areas.

The new geological cartography created for this area enabled us to highlight the emerged and submerged landforms of the Cilento coast; more specifically, sheets 502 "Agropoli", 519 "Capo Palinuro", and 520 "Sapri" [37–39] represented the basis for defining the nature and genesis of the coastal forms. Subsequently, the availability of a map realized by ISPRA (National Institute for Environmental Protection) for the inclusion of the National Parks of Cilento, Vallo di Diano, and Alburni in the UNESCO Global Geoparks Network provided us with a broader view [18]. In fact, this map not only adds to the information obtained from the sheets mentioned above, but it focuses on some specific aspects, such as the characteristics of protected marine habitats.

The set of information gathered enabled us to highlight the emerged and submerged coastal forms of Cilento in more detail than the existing literature and to qualitatively reconstruct the short- and medium-term geomorphological evolution of various coastal landscapes, such as high cliffs. However, the need to make this information available to planners and administrators for future reference led the authors to develop innovative approaches. Therefore, a cartography was created using the Salerno University geomorphological mapping system (GmIS_UniSa) [40], which is based on a GIS procedure which includes "traditional based on symbol" cartography, as well as polygonal structures, with complete coverage, based on objects and multi-themes of the dataset and the set of rules. This study provides the physical features of simple landforms or composite physical surfaces, by defining elementary polygons or several adjacent polygons and then determining the processes that generated them. Moreover, it enables us to establish the geomorphological model by defining the relationships (geometric, temporal, physical, geological, lithological, and hierarchical) between the different landforms represented [40,41]. Unfortunately, due to our limited knowledge of the seabed, it is not yet possible to create a similar digital map. However, the better representation of the emerged forms emerged with the "object-oriented" cartography and their relationships with the submerged ones led to an improvement of the knowledge in space and time of this coast.

Subsequently, in particular traits, such as Licosa Cape and Ripe Rosse, based on a quantitative restitution of the forms and the role of the coastal processes that generated them in the past, particularly since the late Pleistocene, we tested a physically based numerical model of evolution using SCAPE software with its open-source components and tools [42]. With SCAPE, it was possible to trace the evolution of the basal part of a particularly high coast, where wave action is "almost exclusively" set to continue for the next 500 years. The shape of the coast used for this software was identified by a series of large-scale profiles (1:2000), collected from the same reference line, while, for the basal part of the representative profile modeled by SCAPE, a 1:500 scale was chosen. The execution of the model generated a series of output files with data on the profiles of the rocky cliffs and the beaches below, on the annual flow and transport rate of sediments, and then on the accumulated annual volume. This information, obtained using programs such as Excel and Matlab, enabled us to obtain a graphic representation of the data acquired with the SCAPE program. The results obtained will help us to understand the coastal processes that occur on a particular stretch of coast, and they allow intervention measures and preventing or reducing damage and risks to the environment.

4. Terrestrial and Marine Landforms of Cilento

A detailed description of the terrestrial and marine landforms of the Cilento coast would lose sight of the purpose of this study. In fact, we wish to give emphasis to landforms which are relevant to a better understanding of vulnerable landscapes and to promoting the conservation of the emerged and submerged geomorphological features of the study area [3,18,43]. Of the 100-km-long Cilento coastline, 70% is rocky while 30% includes sand or pebble beaches. Approximately 14 km of coast [44,45] was not considered in these percentages, as they are mainly occupied by anthropic activities [46], and are more concentrated in the port areas (e.g., Agropoli in the north, Casalvelino in Alento River Plain, Marina di Camerota in the south), even if a few were built to protect the eroded sections of the coastline.

The direct survey assisted by aerial photographs, as well as by digital observation systems (LIDAR) on particular stretches, allowed the correlation between the various coastal stretches characterized by rocky outcrops composed of both the calcareous sequences of the external units and the turbidite succession of the internal and syn-orogenic units. Each sequence illustrates a different morphological configuration for geological reasons (lithology and tectonics) and for the erosive–depositional phenomena that influence it [47]. In some cases, these phenomena can be attributed to sea-level changes that occurred during the last hundred thousand years [48]. A further differentiation concerns how these high, rocky coasts are related to the current submerged portion, as the geophysical surveys carried out on the seabed in the last decades detected [16,17], which may be sharp or gradual due to the presence of debris stacks. The combination of these conditions involves a particular morphological evolution that is correlated with each type of rocky coastline [31,47].

Along the Cilento coast, rocks with low erosion resistance (soft rocks) prevail, represented by the sequences in which sandstones and/or calcarenites intercalate at clay levels. These successions are attributable to internal units, and to syn-orogenic ones and post-orogenic deposits. In many cases, the emerged portion is connected to the submerged portion by a broad coastal platform (>200 m) and with a sea-bottom slope that can only exceed 10% locally (Type A in Reference [49]; Type A1 in Reference [47]). The profile is generally convex with an almost uniform gradient (on average 45°), although there may occasionally be concavities in the upper portion of the cliff or gradient differences (Figure 6a).

The evolution of this morphotype takes place due to the parallel retreat of cliffs, which is induced by wave motion that progressively erodes the base of the cliffs, thus causing the collapse of the unstable material of the slopes. Moreover, meteoric degradation occurs on these slopes, which can be decisive when the turbiditic succession presents a high argillaceous fraction. In this case, shortening is also joined to the cliff retreat [47]. Therefore, few landforms created by coastal processes are conserved on these cliffs; however, where wave motion is less forceful (e.g., on a broad, sub-horizontal coastal platform) and there is less degradation (e.g., fewer pelitic intercalations, less extension of the exposed surface), relatively more recent landforms can still be observed today [50–53].

(**a**) (**b**)

Figure 6. Sea-cliff morphotypes: (**a**) convex slope (Type A in Reference [39]; (**b**) high coast with shore platform (Type B in Reference [39]).

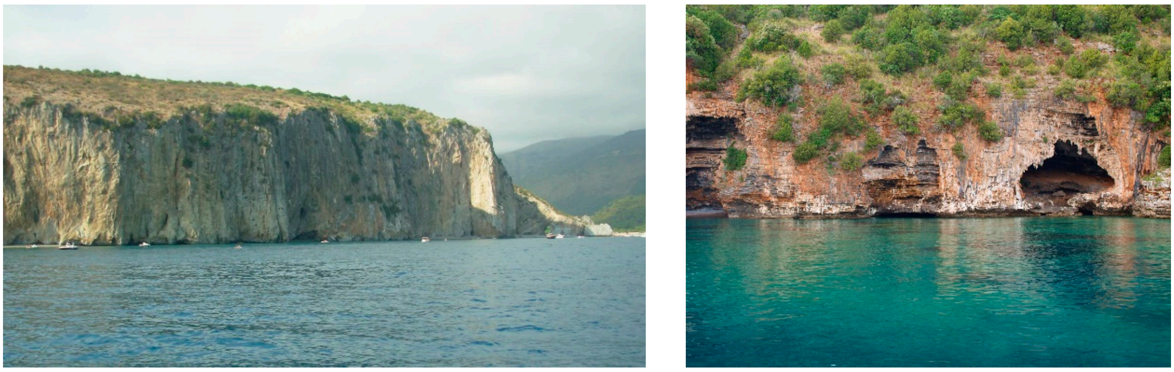
More specifically, the latest interglacial sediments and landforms (OIS5) are still preserved on coastal stretches with these lithotypes [54]. For example, the age of the sites of Ogliastro Marina and Acciaroli in northern Cilento was determined by analyzing the extent of isoleucine epimerization in protein preserved in molluscan fossils embedded in raised marine deposits outcropping at 4 m (a.s.l.) [55]. They are sandy matrix conglomerates or fossiliferous biocalcarenites containing the fossilized remains of numerous marine species (*Glycimeris glycimeris*, *Astralium* (Bolma) *rugosum*, *Natica* sp., *Venus* sp., *Cardium* sp., *Tapes* sp., *Pecten* sp., *Spondylus gaederopus*, *Cladocora coespitosa*, etc.) without a precise stratigraphic meaning, but certainly indicative of a warm–moderate environment. However, there are rather wide 4–5-m marine abrasion platforms in the northern sectors with slightly cemented sand dunes, which also lie below sea level. These platforms are covered with red or sometimes brown colluviums that may contain the pyroclastic deposits attributed to the Campanian Ignimbrite (39 ka before present (B.P.) [56]). Moreover, at approximately +2 m, a "beach rock" can still be seen in easily erodible soft rocks that could be evidence of one of the last sea transgressions in Late Pleistocene times.

This "2-m bench" reaches a maximum width of approximately 35 m in a few stretches of coastline. It remains uncovered by the sea, yet it is overwashed by storm waves at high tide. It is an almost horizontal platform similar to that described in front of a cliff by Sunamura for Type B [49] (Figure 6b). Its position on the coast north of the promontory of Cape Palinuro means that it was less exposed to the most intense storm surges coming from southeast, as suggested by Reference [2] in similar contexts. However, its presence in other areas (cliffs north of Alento River alluvial plain), even if narrower, shows that they can also be in areas where they are exposed to strong storms. Pools and channels on the platform surface become enlarged and integrated as their protruding edges recede. Cliff recession occurs due to shore platform lowering and flattening, weathering processes, and the removal of weathered material by wave action [50].

On coastal slopes modeled in sequence with lithotype alternations (e.g., turbidite succession), there are widespread landslide phenomena and relative landforms are clearly detectable [57–60]. More than 220 different types of landslides were surveyed by various authorities [61]. Some landslides were caused directly or indirectly by wave action, while others were caused by lithological conditions (e.g., fractured rocks, layering, poorly consolidated sediments) or meteoric degradation (rainfall). The results of the survey show that rotational slides are the most common type of landslide, even though many of these are inactive; falls and complex landslides, such as slide-flows, are also very widespread.

The presence of debris at the base of the cliffs can modify their evolution or accelerate the formation of beaches in coves or bays toward the direction of the current along the coast.

In the southern coastal area of Mount Bulgheria, the cliffs are composed of extremely erosion-resistant limestone (hard rock) (Figure 7a). In many cases, these rocks lie below sea level, as they correspond to structural slopes. The profile is generally vertical or sub-vertical; thus, the action of the waves is drastically reduced. In fact, the depth of the sea at the base of the cliff is greater than the depth of the breakers [47]. Therefore, on these cliffs, defined by Reference [49] as plunging cliffs, subaerial processes can prevail. The most common of these processes is represented by rock falls, generally in correspondence with structural weaknesses [62–65]. Locally, erosional remnants are left on the seabed following cliff retreat, so that the seabed appears articulated, with small terraces, arches, and rocks emerging from sea, as observed on this coastal stretch. However, the retreat rate is lower than the previous morphotype, which allows for the conservation of a great variety of coastal landforms. In particular, at the base of the limestone cliffs, there are tidal notches or fossil biocorrosion grooves, often associated with holes bored by lithophagous species. Caves and hypogean karst cavities formed during the neotectonic period, which developed along the main fractured lines or occasionally along interstatal discontinuities, are almost always remodeled by wave erosion or marine biocorrosion and partially or totally filled with marine and continental sediments [3,29,66] (Figure 7b).



(**a**) (**b**)

Figure 7. (**a**) Sea-cliff morphotypes: high vertical coast (plunging cliff); (**b**) example of caves on limestone cliffs filled with sediments in the south of Cilento (Masseta location).

Marine sediments are generally conglomerates with a coarse, medium-cemented sandy matrix, known as "Panchina", mixed with bioclasts of gastropods and mollusks or coral fragments. They are usually associated with restricted and slightly sloping marine abrasion platforms. In other cases, they are represented by cemented biocalcarenites, such as "beach-rock", coral reefs, or "trottoir", such as "reefs", which are often composed of *Cladocora coespitosa* [20,21].

Continental sediments are almost always associated with low sea-level stands, which are essentially accumulations of pseudo-stratified breccias mainly composed of calcareous elements with sharp or blunt edges, in abundant reddish, colluvial, or pyroclastic matrix. Pre-Tyrrhenian breccias are often well cemented, poor or without a reddish matrix. In other cases, continental deposits are composed of reddish sands of colluvial or wind origin. There are occasionally karst speleothemes and concretionary accumulations in situ. The presence of pyroclastites (fine ash) is of particular importance as they are excellent chronostratigraphic markers [20,29]. Brown and immature soils settle on both breccias and colluvial deposits [20,29].

Unlike soft rocks, it is quite common to observe a series of landforms created during the oldest paleo sea-level stand on limestone and dolomite in southern Cilento. In fact, five marine terraces are located in this sector between 170/180 m and 40/50 m, and at lower altitudes such as +8/8.5 m, 3.5/5 m, and 2 m [20,21] (Figure 8).

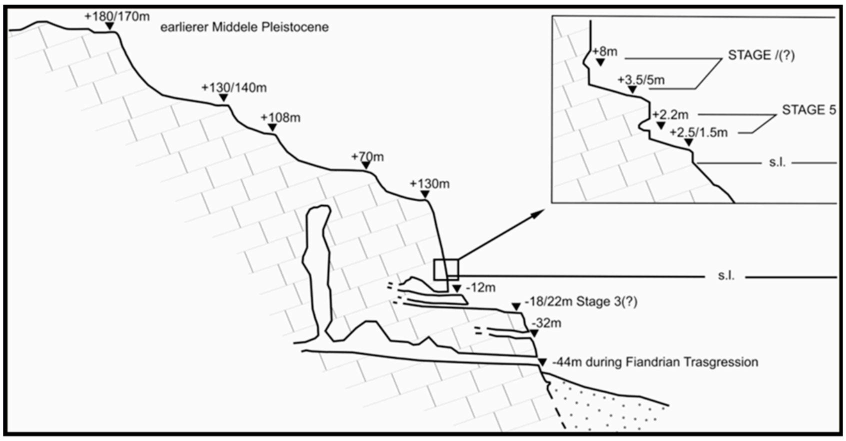


Figure 8. Schematic cross-section summarizing the evidence of paleo sea-level stands recognized in the subaerial and submarine sectors of Palinuro Cape [20].

The highest of the heights, which occasionally can present marine deposits, are attributable to the Middle Pleistocene for physical continuity with similar forms [30]. On the other hand, lower wave-cut terraces, represented by sea-notches and bioconstruction, are correlated to OIS5 [29,30]. The differences in position derive from the tectonic uplift this relief underwent during the Pleistocene [29,54]. According to the estimates carried out on the Middle Pleistocene marine terraces, the uplift rate should have reached 0.2 mm/year during the last 700 ka B.P. period [20,54], although the uplift rate may be significantly lower considering the traces of the Upper Pleistocene sections. In the submerged portion, evidence of several paleo-sea level stands were found, which are mainly represented by wave-cut terraces and sea-notches outcropping along the underwater cliff, and occasionally by marine conglomerates with *Lithophaga* burrows, which can be divided into four main groups located at depths of −44/46, −18/24, −12/14, and −7/8 m below sea level (Figure 8).

Particular morphotypes observed along the Cilento coastline are known as "slope-over-wall cliffs", which are generally composed of soft rocks [2] and have vegetated slopes (typically with a gradient of 20°–30° but locally up to 45°) that descend down a sub-vertical rocky cliff face to the sea. The upper part of slope may have an almost uniform gradient (especially where it follows stratification by immersion toward the sea, cleavage, joint or fault planes), but, more often, it is convex in shape like a hog's back and, occasionally, it can be concave, where the lower slopes of the deposit that covers it are preserved. Their genesis is generally attributable to the rise in sea levels during the Holocene after the last glaciation period. Because of glacio-eustatic sea-level changes, this morphotype underwent alterations due to wave actions during interglacial periods and sub-aerial (therefore, not marine) modifications during glacial periods (Figure 9).

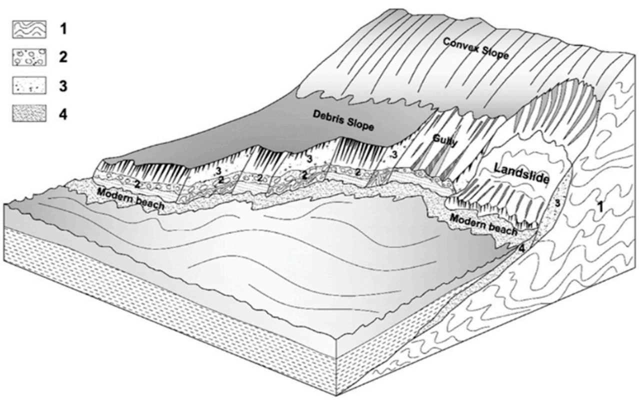


Figure 9. Evolution of "slope-over-wall" profile in a schematic cross-section. Legend: 1. deformed substratum; 2. solifluction deposits; 3. debris slope deposits; 4. modern beach sediments.

It can, therefore, be deduced that climate change played a fundamental role in their evolution, thus determining a climate-induced of erosion alternation of erosive conditions, sometimes attributed to sea processes and sometimes land processes, which occurred in various ways [48,53,67]. This is particularly evident on the stretch of coastline called Ripe Rosse in northern Cilento, and on the coastal stretch called Marina di Pisciotta in the south, adjacent to Palinuro Cape (Figure 1).

Even if the south of Cilento is not well known, due to its morphological conditions, there are some lovely beaches, which are popular seaside destinations. They are mainly situated at the mouths of incisions in valleys or in small bays. Long beaches can only be found in Santa Maria di Castellabate, between Casalvelino and Marina di Ascea, to the north and south of Palinuro [44,45] (Figure 10a). Only the "central" stretch develops in the small coastal alluvial plain crossed by the Alento River (Figure 10b). This river lies in a Pleistocene morphotectonic depression that lowers the succession of the Cilento group toward the sea [27].

(**a**) (**b**)

Figure 10. (**a**) Cala del Cefalo beach at south of Palinuro Cape, including wide dune with endemic species; (**b**) Alento River Coastal Plain: in the foreground, a stretch of the Casalvelino–Ascea marine coast with the port of Casalvelino and a series of defense works parallel to the coast; in the background, a stretch of low coast (beach–dune system).

The plain is dominated by a large sub-horizontal surface of a terrace composed of fluvial sediments of various grain sizes, and it contains fragments of building bricks, which partly cover the ancient Magna Graecia remains of the port of the city of Elea. This city was the seat of the famous philosophical school where Zenone and Parmenides settled, which was later seized by the Romans and given the name of Velia. The archaeological excavations carried out there today are an important tourist and cultural attraction. The aforementioned ancient marine terrace is responsible for the retreat of the coast over 500 m to the west. The area became a marshy area following the silting of the Greek port in the first century anno Domini (A.D.) and was definitively abandoned in the ninth century. Today, the Alento river and its tributaries are engraved on the terrace for 1–2 m. It is difficult to link this coastal variation to historic variations in sea-level rise; the alluvial progression appears to be related to climate changes that may have generated greater sedimentary deposits during the High Middle Ages and caused greater slope degradation [68]. In fact, the slopes that dominate the terrace are covered with a thick eluvio-colluvial cover composed of reddish clays and silt that form part of the foundations of the ancient Greek city and contain archaeological remains. The pedogenized deposits of the dune to the west of Velia lie on the terraced deposits and the historical colluvial sediments [69]. The submerged area nearest the emerged area is characterized by a gently sloping sandy bottom covered with current ripple marks formed by waves except for a few stretches [18]. It is generally colonized by fossil organisms (e.g., *Donax* spp., *Chamelea gallina*, *Callista chione*) that are able to resist wave and current action. Offshore, beyond 20/25 m, the muddy fraction contains fossil organisms such as mollusks of the Veneridi family, worms, and crustaceans. Large areas of the sandy plain are covered with meadows of phanerogams (*Posidonia oceanica*, *Cymodocea nodosa*), while the muddy coastal plain is characterized by "fields" of soft corals (Pennatulacei), particularly in the area in front of the Alento estuary [18].

On the sea bottom near the high coast characterized by a "slope-over-wall profile", small banks of gravel and coarse organic sand can be seen. These are low-relief seabeds with almost horizontal surfaces, due to erosion caused by low-sea-level stands following the Upper Pleistocene [18]. They are adjacent to the emerged part of the northernmost stretch of the study area in front of Mount Tresino and between Acciaroli and Pioppi, while it is more detached at a depth of 5 m in front of Ripe Rosse and Marina di Pisciotta (close to Palinuro Cape).

The submerged landscape which lies in front of Licosa Cape is of particular interest. Along this stretch, the continental shelf reaches a maximum length of approximately 23 km with a border that slopes gradually down to the ocean floor. In the profile, various edges of sub-horizontal surfaces modeled by wave action were recognized up to 150 m. According to Reference [16], the progradation of this platform toward the sea occurred until the last glacial expansion (18 ka B.P.), while the sub-flat surfaces were formed during the last sea level rise. In fact, the acoustic profiles, surveyed in this area, show a truncation of the prograding bodies near an erosion surface, covered by a thin drape of Holocene sediments. In order to confirm the sedimentary characteristics of these prograding bodies, a core sample was collected from the deepest part of the shelf at −149 m. At approximately 73 cm from the bottom of the core sample, there are coarse sands containing numerous whole or fragmented mollusk shells, including *Arctica islandica*, a cold-water species of the Pleistocene [16], which survived in the Mediterranean until the end of the Würm.

The channels identified on the continental shelf by the geophysical analysis were probably formed during the same period, near rivers and streams [17]. They represent the relict forms of a hydrographic network of subaerial origin when the sea retreated to the isobath of 110–120 m, while the sediments that cover them date back to the subsequent sea-level rise [70]. Therefore, these channels would have been formed when the continental shelf emerged from the sea during the last glaciation (18 ka B.P.) [16]. Some of these channels also show sedimentary bodies in their termini located at approximately −90 m, which can be interpreted as mouth bar complexes.

Finally, it should be noted that, according to References [16,17], the continental shelf has three terraces located at depths of 54 m, 86 m, and 107 m, modeled on the rocky bottom (acoustic substrate). Such a bottom has a limited extension and cannot be easily followed. Other terraces with irregular surface morphology were recognized by Reference [17], and depressed areas full of different size sediment grains were identified during the last study (e.g., north of Licosa Cape and in front of the Alento River mouth), which may be due to distensive tectonic lineaments activated during the Pliocene and Pleistocene. Among these, those that border the Alento River Plain continue in front of the seabed [17].

5. Future Scenarios

Understanding the evolution of a coastline is important for its conservation and enhancement. Firstly, we focused on a site in the Cilento that protects landforms from sea-level changes both on land and on the seabed, where a series of geomorphological processes took place from the Pleistocene epoch until today. Secondly, we evaluated the risks induced by geomorphic processes that occurred over time on a coastal cliff and how the knowledge acquired could be used for developing mitigation strategies. These interventions lower the degree of vulnerability and, consequently, the risk of losing structures and infrastructures present on the coastal landscape. These considerations also take into account future climate predictions [71–73], which indicate an increase in temperatures, which would significantly increase sea levels. According to the Intergovernmental Panel on Climate Change (IPCC) hypothesis, the sea level could rise by more than a meter by 2100 if there is a global temperature increase of 1.5 °C [74], which would affect coastal processes and seriously change the Cilento coastscape. This landscape attracts tourists from all over the world and helps the economy to thrive. For this reason, we try to predict what will happen in the future by reconstructing the geomorphological evolution of the coastal landforms [75,76].

Licosa Cape promontory is a site of Cilento that needs to be protected and enhanced (Figure 11a). In fact, both the emerged and the submerged areas are recognized as priority areas for protection. In fact, they are included in the National Park of Cilento, Vallo di Diano, and Alburni and in the marine protected area of Santa Maria di Castellabate. It represents a high morphological, northwest (NW)–southeast (SE)-oriented area characterized by rounded ridges with regular, moderately steep slopes, or less frequently with concave–convex profiles; transversely, the slope shows triangular-shaped facets. The promontory consists entirely of the basal turbiditic succession of the Cilento Group (Pollica formation: Upper Burdigalian–Langhian [23]. This arenaceous–pelitic succession, composed of thin/thick tabular layers, emerges along the outer edge of the promontory, and its height varies from 4 to 10 m (Figure 11b). On the eastern edge, the slope is joined by thick and polycyclic colluvial taluses (Late Pleistocene) and alluvial fans (Middle Pleistocene) [37,77]. The former are mainly composed of angular arenaceous clasts in a yellow to yellowish-brown and reddish-brown matrix that varies from loamy sand to sandy loam, while the latter have sub-rounded clasts and positive or inverse gradation. Both taluses and fans are dissected by minor canals and incisions, generally V-shaped, which are filled with alluvial deposits.

(**a**) (**b**)

Figure 11. Licosa Cape: (**a**) in the foreground, the islet of Licosa in front of the sub-horizontal promontory; (**b**) the profile of the marine abrasion terrace at +4 m of the Upper Pleistocene (in the background) cut in the turbidite succession of the Cilento group.

Along the north and southwest flanks of the Monte Licosa ridge, the basal debris deposits gradually adapt to the terraced surfaces of the promontory, close to several marine abrasion platforms [25]. The highest and largest terrace (20–25 m a.s.l.) with a surface area of 500 m^2 in the southwestern area, probably gives the promontory of Licosa its almost quadrangular shape. In addition to this terrace, there are three other orders of marine terraces suspended at different heights above sea level with relative organogenic and pyroclastic deposits (Table 1).

These characteristics indicate that the terraces were formed between the Middle and Late Pleistocene and, therefore, demonstrate the exact sequence of eustatic events and tectonic movements. More precisely, the chronological reconstruction of the terraces was based on (i) epimerization of isoleucine and U/Th dating methods on biogenic samples [78,79]; (ii) presence of Paleolithic pre-Mousterian industries [25,80]; (iii) presence of a pyroclastic marker layer, widespread along the southern Tyrrhenian coastal areas, which dates back to the OIS 3–2 transition [26,81]; and (iv) stratigraphic correlations on a regional scale [78,82].

Table 1. Synthetic table of morphological indicators of paleo sea levels at Licosa promontory; a.s.l.—above sea level.

Measured Heights (m a.s.l.)	Geomorphological Markers/Other Indicators	Age/Chronostratigraphy	References
20–25 m	Wave-cut terrace/tephra layer + lithic industry	No dating/reliable a correlation to OIS7 (for stratigraphic position, tephra surveyed and characters of the stony artifacts)	[25,26,80]
8–10.5 m	Wave-cut terrace/tephra layer	110 ka (^{230}Th/^{234}U)/correlated to OIS5e	[25,26,78]
3–5 m	Wave-cut terrace/tephra layer	102 ± 4 ka (U series dating)/correlated to OIS5c	[25,26,79]
1.5–2 m	Wave-cut terrace/tephra layer	25.3 ± 0.3 Ka/correlated to OIS5a	[25,26]

A full-coverage object-oriented mapping was performed in order to provide a complete representation of the promontory of Licosa Cape (features and evolution processes) at different scales. All the surface features identified by field surveys and aero-photogrammetry analysis were automatically identified, hierarchically organized, and mapped using the GmIS_UniSa procedure [40] (Figure 12). Special attention was given to the objective recognition, classification, and mapping of present-day land forming processes (incised channels, rock cliffs, and shallow landslides) superimposed on stadial Pleistocene landforms (terraced alluvial fans, marine terraces, talus slopes, colluvial hollows in headwaters) (Figure 12).

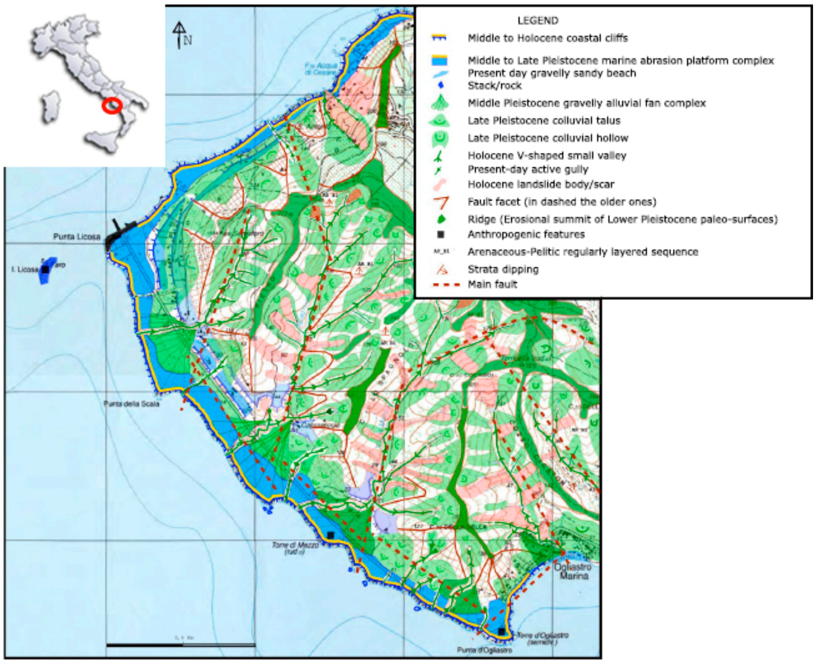


Figure 12. Geomorphological map of Licosa Cape made with the GmIS_UniSa procedure [40].

This was not the case for the submerged area in front of Cape Licosa, for which the submerged landscape map was developed by Reference [18] for the Cilento National Park, Vallo di Diano, and Alburni (Figure 13). As previously mentioned, the submerged landscape is extremely interesting for the topographic features that are visible on the sea floor and for those that can be highlighted by the acoustic profiles that were realized in the area. In particular, close to the shoreline, the rocky bottom corresponds with the sea floor except for a light veil of silty/sandy sediments covered by hydroids and stooling silicones. This rocky bottom emerges at a short distance forming a little island with an almost flat-topped summit. Offshore, at the depth of about 25 m, there is another sub-horizontal surface that slopes gently seaward, which is composed of organogenic sands and gravels produced by the fragmentation of coralligenous bioconstructions. According to the survey carried out on this terrace, the surface is characterized by sediment waves (megaripples). Also, in this case, its shape reveals phenomena that occurred when the sea level was lower during the upper Pleistocene–Holocene period or during the sea-level rise after the last glaciation as suggested by various authors [16,17,77].

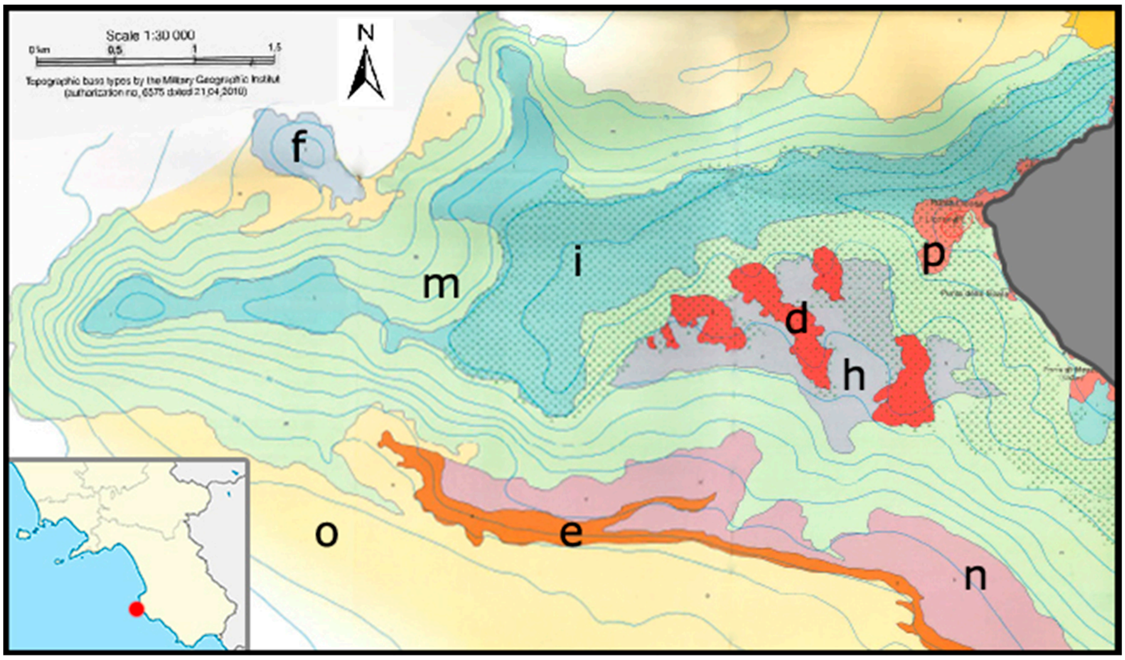


Figure 13. Submerged landscape map of Licosa Cape (extracted from Reference [17]). Legend: d—spur with coralligenous bioconstruction; e—rocky bedding planes covered by bioturbated mud; f—bank with coarse organogenic cover; h—depositional terrace composed of organogenic sand and gravel; i—wave-cut terrace with mixed organogenic cover; m—slope with mixed organogenic sediments; n—deep terrace with muddy bioclastic cover; o—shelf muddy plain; p—rock; the dotted cover indicates the phanerogam plants.

Other depositional bodies are found at greater depths and run parallel to the edge of the platform. They are characterized by a type of echo with an indistinct background without reflections in the substrate [16], which indicates the presence of more reflective sandy deposits than pelitic deposits. The upper part is sometimes covered with a thin layer of Holocene sediments. According to Reference [16], the characteristics of the sandy deposits are attributable to a beach environment when the sea was at its lowest level (18 ka B.P.), which are useful for carrying out beach nourishment interventions along the coasts.

The emerged and submerged landforms detected close to the Licosa promontory suggest that the polyphasic and polycyclic evolution that occurred during the Quaternary was affected by climatic variations. In the emerged portion, the debris deposits at the foot of Mount Licosa could be due to the cold phases of the Upper Pleistocene, when there was little or no forest cover and the land was covered with semiarid vegetation such as grasses and shrubs [83,84]. These phases favored the fragmentation of the rocks (cryoclastic processes due to freezing/thawing cycles) when large amounts of debris were produced on the slopes. At that time, sea levels were low, and the emerged area reached its maximum extension, as confirmed by the acoustic recordings and the beach sediments found in the previously mentioned core sample. Moreover, during the interglacial or interstadial–stadial periods, the relatively finer parts of the upper and steeper parts of the slopes were removed by different transport processes (gravity and/or water) [82,85]. This material, which was distributed on the wide coastal plains during the coldest periods, accumulated close to the coast in the warmest periods. On the basis of these characteristics, at least two generations of debris deposits were identified, including the oldest glacial/interglacial stages (OIS9(?) 7–6) and the last interglacial/glacial cycles (OIS5 to 4–2). Under these conditions, with the rising sea level, semi-submerged terraced surfaces with relative deposits were modeled, similar to those identified in this site.

The highest terrace may have reached its present position between 20 and 25 m due to a tectonic uplift, which probably occurred in the Upper Pleistocene. According to Reference [77], it was modeled in the Middle Pleistocene (OIS7), corresponding to a time range between 245,000 and 190,000 years before the present. However, the overlapping of fossil-rich sandstone deposits associated with this terrace, on dark-red deposits belonging to continental dunes, could make the older traces recede to a previous colder stage (OIS8). The terraces at lower altitudes are not easily recognizable, except for those that can be observed at approximately 4 m along the whole promontory. This may be due to the worsening of erosion phenomena along their escarpments which occurred during warm periods. With regard to the best represented terrace, organogenic deposits are associated with thicknesses of approximately 50 cm with a pyroclastic level. Using the data obtained from these elements, it was possible to trace the formation of these terraces back to the Upper Pleistocene (OIS5c [79]). The Licosa Cape promontory is currently covered by typical Mediterranean woodlands even if they appear to be quite degraded [34], which is due to repeated deforestation carried out until the middle of the 20th century for agricultural purposes. More recently, the innermost area was used for grazing animals, while the area nearest the coastline was placed under protection. In fact, these areas were left to a slow and spontaneous re-naturalization. The man-induced degradation of the landscape probably increased the geomorphic instability of some escarpments, especially in the piedmont area. Moreover, a hypothetical sea level rise could accelerate erosion and reshape this landscape, as occurred in the past. In a future scenario, the emerged and submerged landforms described will be less visible. However, the documentation for the valorization of the site may prove useful for promoting the geomorphological evolution of this stretch of known coast.

The other stretch of coastline analyzed in detail was Ripe Rosse, which lies to the south of Licosa Cape (Figure 14). It shows how a better understanding of the coastal geomorphological evolution can be useful for mitigation and protection. On this high rocky stretch of coastline, the risk of landslide increased significantly, which may be due to the anthropogenic changes of the upper slope caused by the construction of an important road for tourism facilities and commercial activities in the Cilento and by a particular geomorphological evolution, as occurred on other coastal stretches of Cilento.

Figure 14. An example of "slope-over-wall" profile at Ripe Rosse in the northern Cilento; note that plants on the detritus cover the slope and the gravel/pebbly beach at the foot of the cliff; along the cliff, thin and fine turbidite outcrops can be seen.

Ripe Rosse is reachable from the beaches that surround it. There is a rather narrow strip (2 to 4 m wide) where debris of all sizes accumulated, which indicates the numerous rockfalls that make up the cliff. It is an outcrop with a large turbidite succession greater than 150 m thick, belonging to basal formation of the Cilento group (Pollica formation: Upper Burdigalian–Langhian [23]. In particular, this succession is composed of coarse-grained and medium-grained sandstone layers, generally with clear bases, which pass upward to finer sand, silt, and mud. The sandstone layers are sometimes replaced by conglomerates with erosive and concave bases. Laterally adjacent to these coarser deposits, there are finer grain sizes and thinner turbidite layers and chaotic intervals interlayered with these turbidites, interpreted as submarine landslides, in a basin floor fan [86,87]. The plants (e.g., *Genista cilentina*, *Ceratonia siliqua*, *Juniperus phoenicea, Pinus halepensis*) that cover the slope belong to the Mediterranean scrub, whereas, in the adjacent submerged areas, seagrass meadows (*Posidonia oceanica*, *Cymodocea nodosa*) are widely diffused. This coast represents a key biodiversity asset, as it performs important ecological functions that are highly considered by the UNESCO Man and Biosphere program since 1997 [4].

As previously mentioned, "Ripe Rosse" has a slope-over-wall profile, which is composed of a convex upper part and a vertical lower part, which was formed by the sea-level rise following the last glaciation [31]. This is confirmed by the presence of a small wave-cut platform covered with coarse organogenic sands and gravels at depths of 5 m to 25 m from the sea bottom in front of the cliff, which was formed during the last sea-level drop [17,18]. Moreover, as revealed by Reference [88], the gradient of the shallowest part of the coastal shelf is very low and has an irregular topography with small scarps and other positive morphologies up to the terraces at −43 m, which does not allow precise sea-level estimation. Therefore, it is believed that this was due to the climatic oscillation occurred in the last Pleistocene and Holocene and, consequently, the processes influenced by it, which influenced its geomorphological evolution and led to the current condition of the cliff. Moreover, this evolution could also be decisive in the future, when a sea-level rise is expected.

To this aim, a SCAPE numerical model was used, which gave promising results on coastal risks and mitigation methods. This model was preceded by geomorphological analysis including field surveys, elaboration of maps (1956 and 2004) and aerial photos (1943, 2012, and 2015). The multi-temporal processing was completed using available multi-temporal Google Earth (GE) images from 2015 [35] and images placed on the National Cartographic Portal by the Italian Ministry of the Environment [36]. The DEM obtained by LIDAR was extracted from this website.

This detailed analysis enabled us to determine the geomorphological features of "Ripe Rosse", as well as to reconstruct its short- and medium-term geomorphological evolution, as we obtained information on the processes that occurred in the past, especially since the late Pleistocene. The spatio-temporal information of the area was obtained and digitalized on a geomorphological map using the GmIS_UniSa procedure [40], which proved useful for the numerical model but is not reported in this paper. The model, which was calculated on several profiles of the coastline, includes their geometrical features, input data, as well as files, describing wave conditions, tidal levels, average sea level, annual sediment flow, sediment transport, and accumulated annual volume.

The profile of "Ripe Rosse" mainly consists of an upper portion with a moderate slope (mean 40°) that descends toward a vertical basal cliff (mean 80°) into the sea with a slightly inclined coastal platform up to 200 m in width. More specifically, Ripe Rosse has a convex, colluvial, debris flow slope on the remnants of a buried, uplifted marine platform, covered with rounded, gravelly marine deposits, hanging onto the cliffed bedrock slope. The original, longer convex–concave profile was connected to a lower sea level during the last glacial age. The cliffed slope was progressively modeled by a slope retreat mechanism due to the post-glacial sea level rising until the present day. A threshold behavior of the entire coastal slope profile, with a general gravitational collapse, was identified after the complete disruption of the buried marine platform [67].

Such peculiar profiles could be formed on coasts where cliffs of relatively resistant rock are degraded by periglacial freeze-and-thaw processes resulting in solifluction, and they form coastal slopes that are then undercut by marine erosion. This process is still active on high-latitude coasts, but it was more widespread during Pleistocene times, when coasts that are now temperate were subjected to the down-slope movement of frost-shattered rubble during cold phases with low sea levels. The Pleistocene cliffs became slopes covered with solifluction deposits composed of angular gravel. This slope apron deposit extended out onto what is now the sea floor. Late in Pleistocene times, the climate became milder and vegetation grew on these coastal slopes. The sea level rose, and the slopes were undercut by erosion.

This evolution was simulated to predict future climatic conditions, since climate tropicalization will be the most popular topic for the next few hundred years. Starting from its current state and bearing the sea-level rise in mind, the effect of the marine processes at the foot of the cliff was reconstructed (Figure 15).

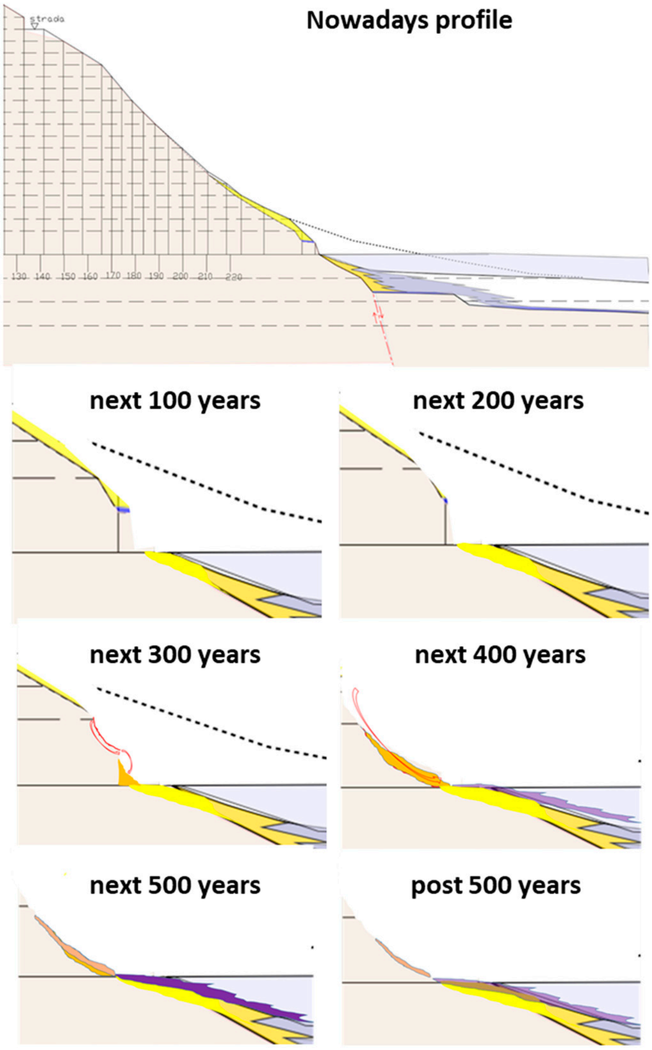


Figure 15. Qualitative reconstruction (step by step) of the geomorphological evolution for the next 500 years. The dotted line indicates the topographic surface at −15,000 years from the present with the sea level at −130 m from the current position. In yellow, the detrital material covering the slope and then deposited at the base of the cliff is shown; in orange, the material dismantled from the wall is shown, which determines the general collapse of the cliff, once the threshold is exceeded.

The removal of the material collapsed from the slope and the formation of a large platform of coastal erosion was also considered. The formation of a vast beach at the foot of the cliff, made of sediments transported from the adjacent coast in erosion or by piles of rocks that fell from the slope above, is the result of erosion processes which change the profile of the cliff. The morphological expression of this change in the coastal platform is represented by the increase in its gradient and the decrease in its height, which accelerates the recession rate. The simulation realized with SCAPE software was tested for 500 years starting from the current conditions and considering the hypothesis of a sea-level rise of 1 mm/year on a 10-m-high cliff. The result was a 140-m cliff retreat, represented graphically by the Excel and Matlab programs along the modeled section and in a representative profile (Figure 16).

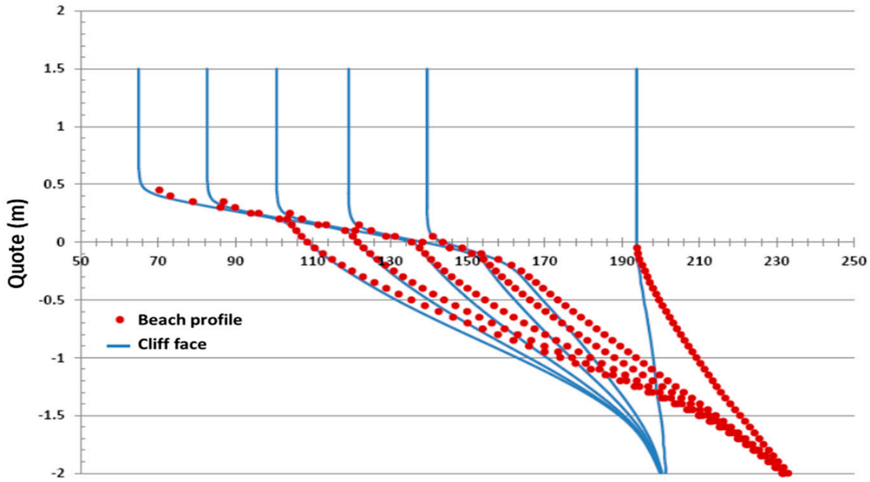


Figure 16. Parallel retreatment of the "wall" and landward shifting of the beach profile in the next 500 years simulated by SCAPE software.

The simulation showed clearly that the vertical basal part of the coastal slope recedes parallel to itself with uniform denudation intensity if the slope processes are constant and/or the rock resistances are uniform. It is important to note that the recession is facilitated by the continuous removal of debris from the base of the slope and the formation of a partially submerged accumulation.

Unfortunately, it is not yet possible to simulate the entire slope above the wall; however, the progressive retreat of the wall should intercept the threshold of the slope portion with the detrital material, which would accelerate the evolution of the entire coastal slope as confirmed by the geomorphological reconstruction. If this were to happen in hot and humid climatic conditions or under high anthropogenic pressure (slope cuts and wildfires), there would be an emphasis on the subaerial processes extended to the entire slope with a consequent evolution of the "substitution" of the slope shape. This evolution could lead to the consumption of the top portion and shorten the coastal slope, which would increase the risks to which the road would be subjected, which is the only road leading to the coastal resorts located southward.

The coastal slope of Marina di Pisciotta, northward to Palinuro Cape, is in a similar situation. In this case, a slow-moving landslide [89] occurred on the cliff escarpment, which affected both the roads and the railway line that connect northern and southern Italy (Salerno–Reggio Calabria line). Also, in this case, it is a high coast with a "slope-over-wall" profile. Gaining knowledge of the geomorphological evolution of this type of coast would enable us to implement appropriate risk mitigation strategies, which would prevent roads from being damaged and improve mobility and the economy.

6. Conclusions

The coastal landscape of Cilento (southern Italy) has a great variety of terrestrial and marine landforms. Despite the continuous degradation of rocks with different degrees of erodibility and the negative effects of mankind on the territory, these forms are able to maintain their morphological characteristics. These characteristics make the landscape attractive to tourists, who choose the Cilento coastal areas for their holidays, but they also capture the interest of researchers and experts in coastal geomorphology [3,18]. For this reason, the Cilento territory and the contiguous marine areas are protected, both at the national and at the international level. However, even if it is possible to protect the environment and ensure sustainable development inland, it can be difficult in coastal areas, due to both anthropic pressure and climate change effects. As previously mentioned, the Cilento coastline was already affected by erosion processes that led to coastal erosion and shoreline retreat [44,45] and by numerous landslides that occurred on the cliffs or the slopes behind the beaches [61]. Seas and oceans are under considerable anthropic pressure due to structures and infrastructures built close to the coast to the detriment of the conservation of the environment, and the ports and coastal defenses are not entirely adequate for the context. On the other hand, a sea-level rise caused by an increase in temperatures would have further effects on the coastline that cannot be fully controlled. These impacts would be greater where the adjacent beaches and structures cannot be effectively protected, and greater still on soft rock cliffs, like those found in the study area.

With regard to Licosa Cape, where anthropic pressure is not so high, climate change effects should be considered for the conservation of the landforms. Due the presence of a wide coastal platform, the estimated rise in sea level would probably not have significant short- and medium-term effects on the area close to the terrace. However, there could be an intensification of landslide phenomena along the slopes of the Monte Licosa ridge and swamping in the terrace area, which already occurred in the past in warm periods. The case of the "slope-over-profile" profile would be completely different as verified by the application; once the threshold represented by the wall is exceeded, there would be a huge earth flow followed by the complete collapse of the slope and the destruction of the structures/infrastructures built on it. In Cilento, there are numerous infrastructures such as roads, but risk mitigation in order to conserve these landforms would entail huge economic costs. Zoning regulations could help to protect the area, as the result of a detailed knowledge of the landscape and its space–time evolution [90]. To this end, efforts should be made to adopt multidisciplinary approaches that use innovative topographic and geo-morphometric analyses that enable us to develop a detailed digital geomorphological map and enhance our spatio-temporal knowledge.

This paper provides useful information on the landforms for planners and operators working in the area. Meanwhile, for the site of Ripe Rosse and other places located in areas prone to landslides, a proposal was put forward to establish the "prototypal moving geosites" within the Geopark Network in order to emphasize their scientific, educational, and social relevance [91]. To this aim, we wish to invite researchers to monitor these particular geosites as students strive to understand the forms and processes related to them. Mankind should implement activities that do not damage directly and indirectly our geological and geomorphological heritage in order to conserve all terrestrial land and marine landforms.

Author Contributions: This research was conducted in collaboration between the authors. Both authors, G.D. and A.V. were involved in the conceptualization of the problem, in the identification of the data and in the preparation of the manuscript. While A.V. mainly conducted data integration and contributed to the drafting of the document, G.D. set up the methods to develop future scenarios. Discussions and analyzes were conducted by both authors. Both authors contributed to the revision of the manuscript.

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