# Coastal Geoarchaeology and Neocatastrophism: a Dangerous Liaison?

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Abstract

Here, we explore the relationships between Mediterranean archaeology and the geosciences with particular emphasis on shoreline ~~mobility~~ and harbour evolution. We review ancient and recent geoarchaeological research on the palaeoenvironmental evolution of ancient harbours; in particular, we elucidate a renewal of catrastrophism. We argue that there is an absence of rational grounding and overemphasis on natural hazards at historical time scales. Research into the collapse of ancient societies is, in our view, oversimplistic and partly driven by bibliometric opportunism. Caution is needed to ensure that neocatastophism does not alter the paradigm of geoarchaeology.

Özet

Burada, Akdeniz arkeolojisi ile yerbilimler arasındaki ilişkilere ve kıyı çizgisi hareketliliği ile limanların evrimi özeline bakmaktayız. Eski limanların paleo-çevresel evrimi üzerine yapılmış eski ve yeni araştırmalara yeni bir bakış verilmektedir. Argümanımıza göre tarihi ölçeklerde bilimsel temellendirmelerden çok, doğal felaketlerle açıklama yönünde aşırı bir eğilim bulunmaktadır. Eski toplumların çöküşü üzerine yapılan araştırmalar bizce son derece basittir ve biraz da kitabî-edebî ölçülere dayanmaktadır. Jeoarkeolojinin paradigmasının yeni-felaketçilik tarafından etkilenmemesi için dikkatli olunmalıdır.

## 1. Introduction

In this article, we explore the relationships between archaeology and the geosciences with particular emphasis on Mediterranean shoreline ~~mobility~~ and harbour evolution[1]. Why should a multidisciplinary approach be adopted? How can oversimplifications and the

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[1] Morhange 2001; Fouache 2003; Marriner 2009.

fallacy of circular reasoning be avoided? How can non-deterministic research questions be formulated?

The archaeological sciences now widely embrace the most advanced analytical techniques developed by the geosciences. The past two decades have witnessed an unprecedented growth of new archaeometric tools (e. g. geophysics and genetics) to understand the archaeological record.

Here, we review recent geoarchaeological research and consider how the content of scientific papers dealing with ancient harbour palaeoenvironments has evolved during the past century. From an epistemological point of view two trends can be distinguished that differ both in their paradigms and objectives consistent with academic frontiers[2].

## 2. Pioneering studies on coastal and harbour geoarchaeology

Investigation into human impacts on coastal palaeoenvironments is relatively recent, even though this topic has long been a central tenant of palaeogeography. A number of geographical and geological societies were created during the 19th century, around the same time as the archaeological schools at Rome and Athens. Archaeology was seen as a means of showcasing political prowess and establishing a cultural stronghold. It was very much at the centre stage of the British, French and German race for intellectual supremacy in understanding the roots of ancient civilizations around the Mediterranean. The resulting encyclopaedic inventories, and the supporting institutional frameworks which accompanied them, are illustrative of the shift towards precise recording and measurement in all areas of the natural and archaeological sciences. For instance, it was during the first part of the 20th century that many scholars started to draw parallels between coastal progradation and harbour silting to explain the reduced size or isolation of many ancient harbour basins[3].

In France, the work of Desjardins[4] and Pâris[5] in Delos or Renan[6] in Tyre and Sidon are of notable significance (**Fig. 1**). In 1846, Raulin embarked upon an expedition to Crete, whose geology was virtually unknown at the time. Raulin, who was a geologist, cartographer and naturalist, compiled his observations in a 1,000-page book and published the first true geological map of the island in which the geology and uplifted coastal zones of the island were precisely delineated[7]. Sea-level variation was an early research focus and many geographers investigated this question. For instance, Negris[8] studied submerged archaeological ruins in Leucade, Egine and Delos and concluded that sea level had risen by 3 m since

[2] Leveau 1995; Leveau 2005.

[3] e. g. see Georgiades 1907 or Lehmann-Hartleben 1923.

[4] Desjardins 1876.

[5] Pâris 1916.

[6] Renan 1864.

[7] Raulin 1869.

[8] Negris 1903a; Negris 1903b; Negris 1904a; Negris 1904b.

the Roman period. His ideas met strong opposition from the geologist Cayeux who advocated sea-level stability for the last few thousand years. According to Cayeux[9] the submerged archaeological structures were the result of local subsidence whereas for Negris they were a uniform trait of the coastline, which could be observed in many different places around the Mediterranean. In France, the fixist dogma of Suess slowed ~~for a number of decades~~ progress in the measurement of relative sea-level changes using archaeological data.

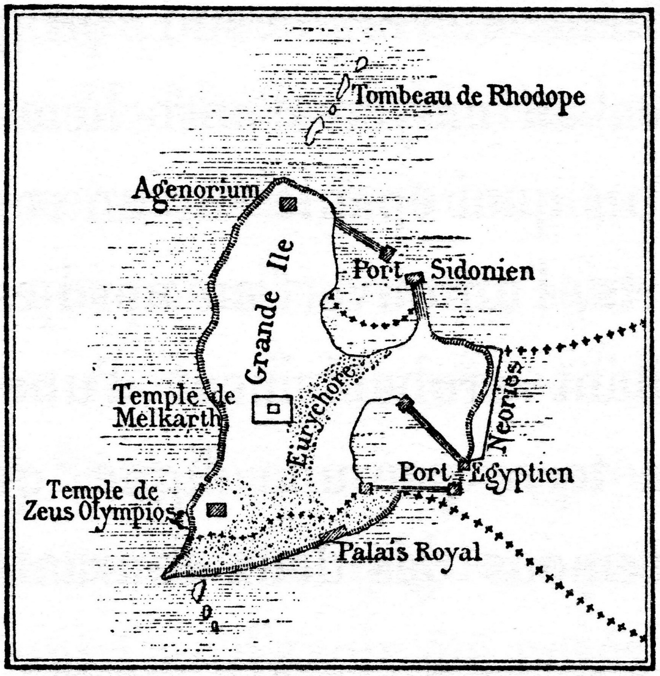


Fig. 1 Renan's (1864, fig. p. 569) reconstruction of Tyre and its ancient harbour areas. The northern harbour (Sidonian harbour) is partially silted while the southern part of the city is correctly interpreted as a submerged quarter of the ancient city. This contrasts with the interpretations of Poidebard (1939)

German researchers were early pioneers in the study of antiquity, marrying information about ancient societies with their environmental contexts. Invited by Schliemann to participate in the excavation of Troy, Dr. Virchow, a polyvalent pathologist, anthropologist and prehistorian, stayed in the Troad region to undertake research. Their joint efforts laid the foundations for a very fruitful scientific collaboration between archaeology and the geosciences[10]. As early as 1886, Cold identified the role of delta progradation in shaping the evolution of Western Anatolia's rias, in particular the deltaic plains of Küçük and Hüyük Menderes. Greece was also a research focus of German geographers such as Neumann and Partsch[11]. Later Philippson published an encyclopaedic synthesis of Greek landscapes[12]. The work of Hafemann[13] contains the first radiocarbon data of the 365 A.D. uplift of Western Crete.

In Great Britain, early geoarchaeological observations were made by Spratt to identify and date archaeological sites in Western Crete[14]. Since this time, archaeoseismology has significantly contributed to our understanding of Western Crete[15]. The main research advances in multidisciplinary studies were made in Northern Europe with for instance the

9 Cayeux 1907.

10 Virchow 1879; Wagner et al. 2003.

11 Neumann – Partsch 1885.

12 Philippson 1959.

13 Hafemann 1965.

14 Spratt – Leake 1854; Spratt, 1865.

15 Stiros 2001; Stefanakis 2010.

development of modern field methods including high-precision stratigraphy (Wheeler method).

In the next two sections, we describe common threads and knowledge gaps between two scientific communities, archaeosciences vs. geosciences so as to better understand the intellectual landscape that partially explains the rise of neocatastrophism.

## 3. Aims, expectations and research production of coastal archaeological teams

Here, we outline three research topics to show that archaeologists have always actively participated in coastal geomorphological research. They have contributed with surveys conducted underwater and at continental sites[16].

### 3.1 Relative sea-level changes

Relative sea-level changes are fundamental in establishing the palaeogeography and bathymetry of excavation sites. The fact that relative sea level has changed over the centuries is of particular important in understanding the archaeological record in coastal areas. For instance, relative sea-level variations constitute a natural hazard that could potentially have endangered any human settlement in antiquity. Relative sea-level data allows researchers to estimate the height of the water column in an ancient harbour basin and, subsequently, the maximum draught of the ships that could enter it[17]. Several recent studies (e.g. Portus, the ancient harbour of Rome) have proposed estimates for ship draught depths[18]. Palaeo sea-level indicators dated to the 3rd and 5th centuries A.D. indicate a relative sea level rise of 80 ± 10 cm since this time at Portus. The differences between the ancient sea level and the stratigraphic data provide important information on the water depth. For instance, in the entrance channel of the hexagonal basin of Trajan (Portus), the height of the water column was 7 m[19], confirming Roman texts from this period. The basin of Claudius was too deep, large and poorly protected to provide good shelter for the ships. These accurate field measurements contrast with the estimates inferred from hydro-isostatic computer models[20].

### 3.2 Shoreline changes

Shoreline changes continue to be interesting to archaeologists because they allow researchers to understand the physical context of excavated sites and to precisely locate the harbour basin(s) and waterfront. For instance, in Italy the work of Schmiedt[21] systematically interpreted aerial photographs. In a similar vein, the pioneering studies of

16 Poidebard 1939; Leveau 2004.

17 Blackman 1973; Boetto 2010.

18 Goiran et al. 2009.

19 Goiran et al. 2010.

20 Lambeck et al. 2004.

21 Schmiedt 1970; Schmiedt 1975.

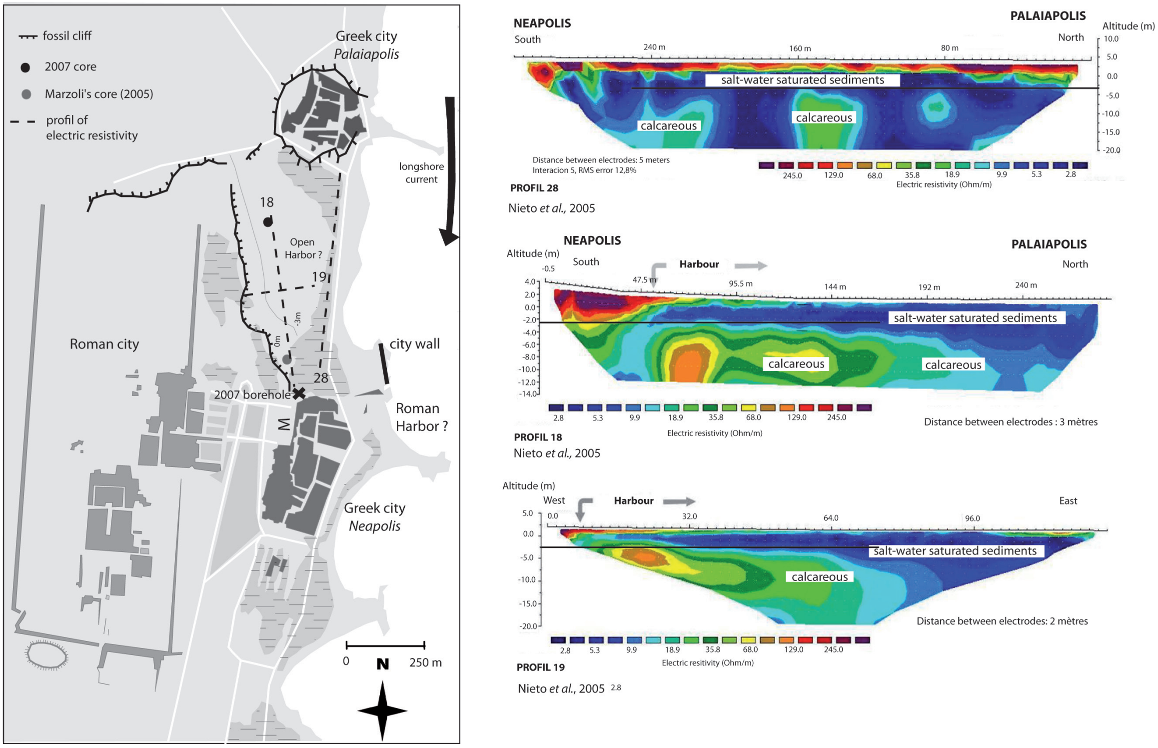


Fig. 2 Urban organization of the ancient city of Ampurias (Spain) and geoelectric data. Sedimentological analyzes inside the speculated Greek harbour have allowed to reconstruct its environmental evolution. It ~~constituted of~~ an exposed shoreline. These results underline three problems concerning the functionality of the harbour basin: (i) difficult access; (ii) an exposed environment; and (iii) a shallow draught depth. This calls in to question the idea of a protected Greek harbour in this cove (from Bony et al. 2011, fig. 2)

Poidebard and Lauffray[22] combined aerial photographs, dredging and underwater diving to investigate the archaeological sites of Sidon and Tyre[23]. A specificity of coastal archaeology is that it uses data from both underwater and inland coastal environments[24]. For archaeologists, it is important to differentiate between sea-level change and shoreline mobility (e. g. progradation) because the two phenomena can be both complementary and contradictory[25]. For instance, preliminary geophysical and geomorphological work at Ampurias[26] (**Fig. 2**), Cumes[27], Portus[28] and Elaia near Pergamon[29], etc. have allowed detailed mapping of the sites in addition to an indirect investigation of their sediment archives. However, the division of archaeological sites into geophysical zones corresponding to the different terrestrial and marine environments has remained somewhat hypothetical

22 Poidebard – Lauffray 1951.

23 Poidebard 1939.

24 Hesnard 2004.

25 Leveau 2006.

26 Nieto et al. 2005; Bony et al. 2011a.

27 Stefaniuk – Morhange 2010.

28 Keay et al. 2005.

29 Pirson 2010.

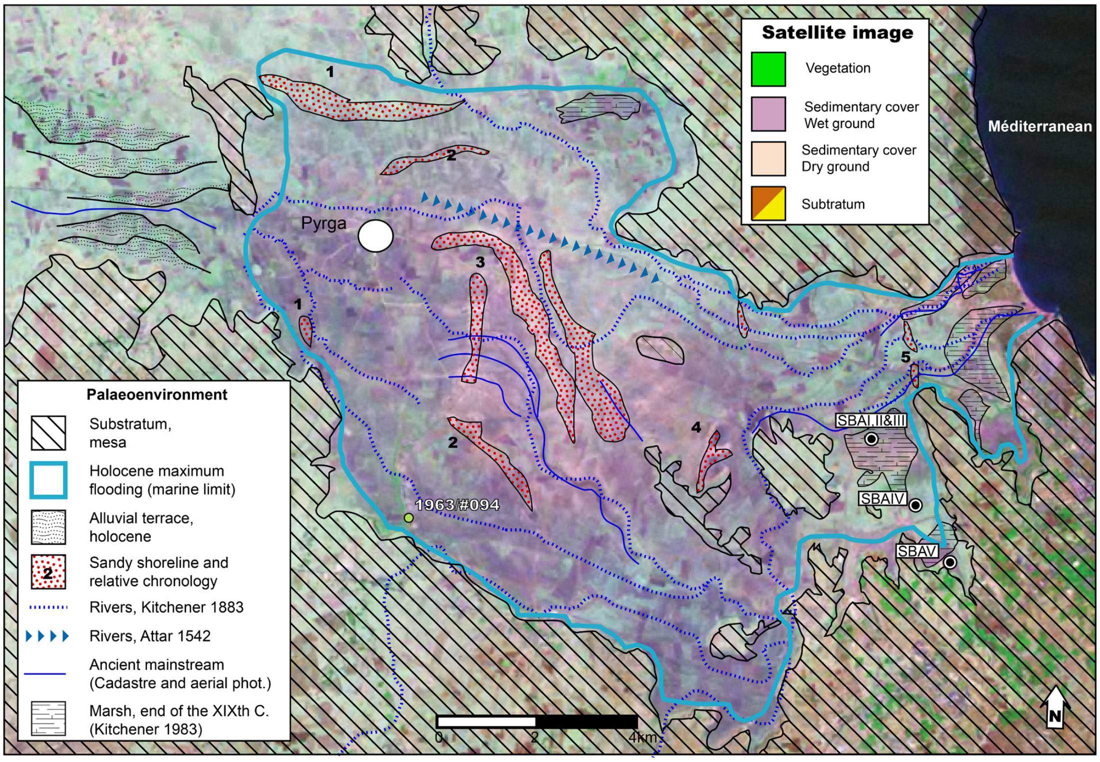


Fig. 3 6,000 years of coastal progradation in the ancient marine embayment of the Gialias river, Cyprus (from Devillers 2008, fig. ##)

and must be confirmed by archaeological soundings. Some case study examples illustrate the progresses that have been made. At Elaia (Turkey), it is now possible to follow the history of the settlement and its harbours from the 3rd millennium B.C. up to its abandonment in the 6th–7th centuries A.D.[30]. New chronostratigraphic information will help to understand the foundation and silting up of the closed harbour[31]. In Egypt, Flaux[32] has reconstructed the evolution of Lake Mariout situated on the western extremity of the Nile delta. Although the lake has progressively retracted during the last 2000 years, the archaeological record shows that it was actually an important axis of communication in antiquity. In Valencia (Spain), Carmona and Ruiz[33] have probed the geomorphological evolution of the Late Holocene coastal flood plain of the Turia River by cross-referencing sedimentological, stratigraphic, geoarchaeological and radiocarbon data. The Holocene marine transgression formed a lagoon environment on the coastal plain. During the Late Holocene, increased sediment supply to the lower reaches of the river led to the progradation of strand-plain ridges and the aggradation of the floodplain which caused the frequent relocation of the harbours to stay abreast with coastal changes. These case studies demonstrate a typical ›sea race‹ linked to the progradation of clastic coastlines (**Fig. 3**).

30 Pirson 2010.

31 Brückner et al. 2009; Brückner et al. 2010; Brückner et al. this volume.

32 Flaux 2011.

33 Carmona – Ruiz 2011.

## 3.3 Integrated palaeoenvironmental studies

At a final stage, analysis of multiple cores combined with laboratory studies of the lithoclasts, bioindicators and chemical isotopes allow geoarchaeologists to reconstruct palaeoenvironments and processes with an accurate positioning of the harbour sites. This multi-proxy approach produces a comprehensive picture of the archaeological sites in question and their evolution in time and space[34]. Chronostratigraphic data can yield precise information on the constraints and the natural potentialities of a site.

Two main types of archaeological publications exist: (a) those that propose a synthetic approach to cataloguing archaeological sites using geoscience. The thesis of Carayon[35] looking at Phoenicean and Punic harbours is a good example. At a local scale, Baralis et al.[36] proposed a similar approach for Apollonia Pontica (modern site of Sozopol in Bulgaria, Black Sea). In this manner, archaeologists avoid overly deterministic interpretations; nevertheless they must also circumvent an over-interpretation of geoscience data. This approach yields a geographical picture that is classic in its form but renewed in its content. A good example is the harbour of Genoa where Melli et al.[37] combined geomorphological and archaeological data. (b) Palaeoenvironmental studies that are exclusively based on biofacies chronostratigraphy usually provide a diagnosis of the marine accessibility such as the ancient

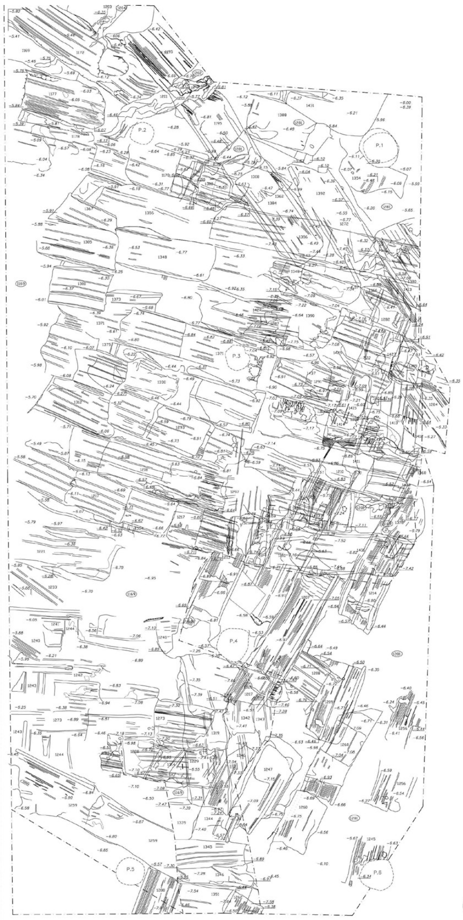

Fig. 4 Dredging traces in the ancient harbour of Naples (Carsana et al. 2009, fig. 3. 4). 4A: map. 4B: photography. The coastal landscape between Parthenope and Neapolis has been redrawn based on recent archaeological and geoarchaeological results. The excavation at the site of the Municipio station revealed several different levels of the sandy sea bottom of the harbour, which was used from the late fourth or early third century B.C. to the early fifth century A.D. The absence of pre-fourth century B.C. layers is due to extensive dredging between the fourth and second centuries B.C. Unprecedented traces 165 to 180 cm wide and 30 to 50 cm deep attest to powerful dredging technology that scoured into the volcanic tufa substratum, completely reshaping the harbour bottom

34 Marriner – Morhange 2007.

35 Carayon 2008.

36 Baralis et al. 2011.

37 Melli et al. 2011.

harbours of Naples[38] and Sidon[39] or Tyre[40]. However, it is increasingly apparent that these interpretations are often biased because of the frequent dredging operations that were conducted in many harbours during antiquity[41] (**Fig. 4**). In addition, the physical contextualization of an archaeological site does not necessarily ~~greatly~~ help archaeologists to accurately interpret it. For instance, with reference to the eastern Mediterranean, how does one characterize a Bronze Age proto-harbour in archaeological terms? What types of structures were used to protect the basins? It is important to stress that preliminary geoarchaeological studies are not a substitute for real excavation of the site itself even if the urban context is often a handicap.

Therefore, the role of geoarchaeologists is to elucidate the natural forcings that allow a dynamic contextualization of the archaeological sites at different spatial and temporal scales. In this respect, coastal evolution is a key for the understanding the relationships between human societies and their environments.

## 4. The objectives and expectations of ›naturalists‹

The interest of naturalists for the archaeological study of palaeoenvironments is mainly focused upon:

### 4.1 High-resolution measurements of relative sea-level variations

In direct response to global climate change and the recent acceleration of sea-level rise, there has been a renewed interest in measuring relative sea-level variations in archaeological contexts[42]. Indeed, harbour archaeological sites are interesting for three reasons:

(a) They can inform us about the sea-level position as far back as 3000 years ago, far beyond the realm of instrumental records which span at best a few hundred years. During this period, for which coral records are often less precise, ancient harbours are good archives to collect local sea-level data for historical periods.

(b) The ancient harbour structures form a solid base upon which marine organisms can grow. The study of fossil biological layers allows sea-level index points to be determined precisely, with centimetric accuracy in sheltered areas[43].

(c) Finally, the dating of the sites by pottery is often far more accurate and reliable compared with ~~the vagaries of~~ isotopic dating, which require floating calibrations and/or correction for marine reservoir effects. However, the major drawback of this approach is that it necessitates multiple investigations that can only be performed on archaeological sites

38 Amato et al. 2009.

39 Marriner et al. 2006.

40 Marriner et al. 2008.

41 Marriner – Morhange 2006; Morhange – Marriner 2010a.

42 e. g. Pirazzoli 1976.

43 Laborel – Laborel-Deguen 1994.

and at the same pace as the excavation work progresses. Moreover, to be accurate, the data need to be analyzed with a great deal of multidisciplinary expertise. In a world of science driven by speed of publication and biometrics the published results are often of poor quality. The majority of sea-level studies are not interpreted at the local but regional scale, which interprets the ›oceanic‹ signal in terms of crustal mobility (isostasic or tectonic) and eustatic change, using computer models[44]. Patiently cross-controlled multidisciplinary investigations can yield very accurate results and more nuanced interpretations[45].

## 4.2 Watershed erosion and base-level detritism

At the scale of the ancient harbour, it is of particular interest to estimate the relative rates of sedimentation in an artificial trap (e. g. harbour basin). These data reflect land use history and soil erosion in urban and watershed contexts. Three processes may disturb the continuity of sediment archives: (1) compaction, particularly in the case of fine-grained sediments of organic origin; ~~and~~ (2) sediment and urban waste dumping in waterfront areas; and (3) dredging which seems to have taken place in the majority of harbour basins as early as the Roman period, leading to stratigraphic hiatuses and chronological inversions[46]. Archaeologists have become accustomed to working with geomorphologists who have obtained convincing chronostratigraphic data during drilling projects, such as Goiran[47] looking at the harbour palaeoenvironments of Alexandria (Egypt). Nonetheless, these types of studies can only inform us about the physical conditions of harbour creation, while the social or historical reasons for port location remain largely elusive.

At the deltaic scale, sedimentation results from a complex interplay of climatic and human impacts that are often difficult to separate. Devillers[48] in Cyprus, Vött et al.[49] in Greece, Brückner et al.[50] and Kraft et al.[51] in Turkey have analyzed ancient delta geographies. These good examples offer an opportunity to link the disciplines of geology, geomorphology, archaeology, history and epigraphy to shed light on the changing palaeogeographies. At Ephesos, progradation of the Cayster delta during the past three millennia has significantly altered the harbour settings[52]. This work demonstrates how multidisciplinary research can greatly enhance our understanding of ancient coastal geographies during the past 6,000 years. However, elucidating the contribution of different natural forcings can rarely be envisaged unless a major high-energy event is identified.

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44 Lambeck et al. 2004.

45 Pirazzoli 1976; Erol – Pirazzoli 1992; Morhange et al. 2001; Faivre et al. 2010.

46 Marriner – Morhange 2006; Morhange – Marriner 2010.

47 Goiran 2001.

48 Devillers 2008.

49 Vött et al. 2007.

50 Brückner et al. 2005.

51 Kraft et al. 2007.

52 Brückner et al., this volume.

New research avenues of interest include the impacts of palaeo-floods[53] or the dislocation of ancient harbours in the face of deltaic progradation. In the Western Mediterranean, the multidisciplinary work undertaken on the Rhône delta, associating fluvial chronology and the displacement of the coastal zone, has produced remarkable results[54]. The Roman harbour of Fréjus (France) is another good example[55]. In the Eastern Mediterranean, work at Troy[56], Klazomene[57], Piraeus[58], Acarnania[59], Phoenicia[60], Cyprus[61], the Nile delta[62] and the bay of Haifa in Israel[63] perfectly illustrate the scope and importance of adopting an interdisciplinary approach. Significant advances have been made in the last two decades can be linked to the democratization and systematic use of isotope chronologies. Isotopic dating has allowed archaeologists to independently test the history of the environments and human societies[64]. This advancement has been accompanied by the development of new techniques including the systematic use of bioindicators and geochemical proxies[65]. Ancient written sources and other historical documents have therefore lost their importance as exclusive sources to understand the archaeological record. Onus is now placed on comparing and contrasting geoscience and archaeological data.

## 4.3 A proliferation of proxies?

There has been a growth in the means of measurements beginning with the use of relatively simple bioindicators to increasingly complex proxies (such as the use of micro-charcoal and phytoliths as indicators of palaeo-fires etc.) derived from the wealth of modern quantitative techniques. Geoarchaeological research is now being carried out to gauge the level and intensity of human impacts at finer spatial and temporal scales.

Although geoarchaeological studies are increasingly quantified, understanding the relationships between human societies and their environment remains highly subjective. The study of the past demonstrates that coastal ecosystems have been subjected to a multitude of natural and human forcings for many millennia. Environmental response is evaluated via the processes involved, their reversibility or resilience and the time scales over which they operate. Quantitative palaeo-ecology provides an estimate of the dynamics involved and of the cumulative impacts that the climate and human pressures exert on these

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53 Bravard 2006; Benvenuti et al. 2006 for the harbour of Pisa.

54 Bruneton et al. 2001; Provansal et al. 2003; Vella et al. 2005.

55 Bony et al. 2011b.

56 Kraft et al. 1980 and 2002.

57 Goodman et al. 2008; Goodman et al. 2009a.

58 Goiran et al. 2011.

59 Vött et al. 2006.

60 Marriner 2009.

61 Devillers 2008.

62 Goodfriend – Stanley 1999; Flaux et al. 2012.

63 Zvieli et al. 2006.

64 Leveau 2006; Kaniewski et al. 2011.

65 Véron et al. 2006.

systems. The role of climatic and human forcings during the Holocene period is still a difficult area of study because of the plethora of research interpretations[66]. In this rich intellectual context, it is paradoxical to observe a recent growth in neocatastrophic research[67].

## 5. The revival of catastrophism

In the Eastern Mediterranean, neocatastrophism probably has its roots in the study of the Bronze Age eruption of Santorini and its speculated impacts[68]. In harbour research, Caesarea Maritima in Israel constitutes an iconic example of both multidisciplinary archaeological excavation and neocatastrophism. This latter point can be summarized in two stages:

A *first neotectonic theory* was developed by researchers during the early 1990's[69]. These authors produced evidence for neotectonic activity in the ancient basin of Caesarea Maritima, where large Herodian breakwaters are presently submerged at 5–8 m below sea level, whereas other contemporary coastal installations in the same area remain at sea level. Seismic reflection surveys elucidated a series of shore-parallel faults that have been interpreted as displacing both the eolianite outcrop and the submerged breakwaters. These faults present offsets of 1–3 m. Mart and Perecman[70] have suggested that the subsidence of the ancient breakwaters was caused by neotectonic displacements of these faults, enhanced by liquefaction. They conclude that neotectonic activity has shaped the southern Levantine coast during the past 2000 years. These interpretations are reminiscent of Neev et al.'s[71] book and its focus upon coastal neotectonism. This work was rapidly contradicted by the geophysist Gill[72] who demonstrated that the seismic profiles do not provide any evidence for faults or reliable displaced marker horizons. It seems most likely that ›subsidence‹ of the Roman moles has resulted from a scouring of marine sands from under the harbourworks.

A *second more recent neocatastrophic theory* has focused upon tsunami impacts[73]. Underwater geoarchaeological excavations on the shallow seabed fronting Caesarea's seaport are inferred to document a tsunami that damaged the ancient harbour. The tsunami deposit is interpreted as being a 0.5 m thick bed of reverse-graded shells, coarse sand, pebbles, and pottery deposited over a large area outside the harbour. The lower portion of the deposit is composed of angular shell fragments, and the upper part of convex-up *Glycymeris* shells. The sequence records downcutting into shelf sands, with the return flow sorting and depositing intact and fragmentary shells. Radiocarbon dating and optically stimulated

66 Allée – Lespez 2006; Anthony 2009.

67 Marriner et al. 2010.

68 Marinatos 1939.

69 Mart – Perecman 1996.

70 Mart – Perecman 1996.

71 Neev et al. 1987.

72 Gill 1999.

73 Reinhardt et al. 2006.

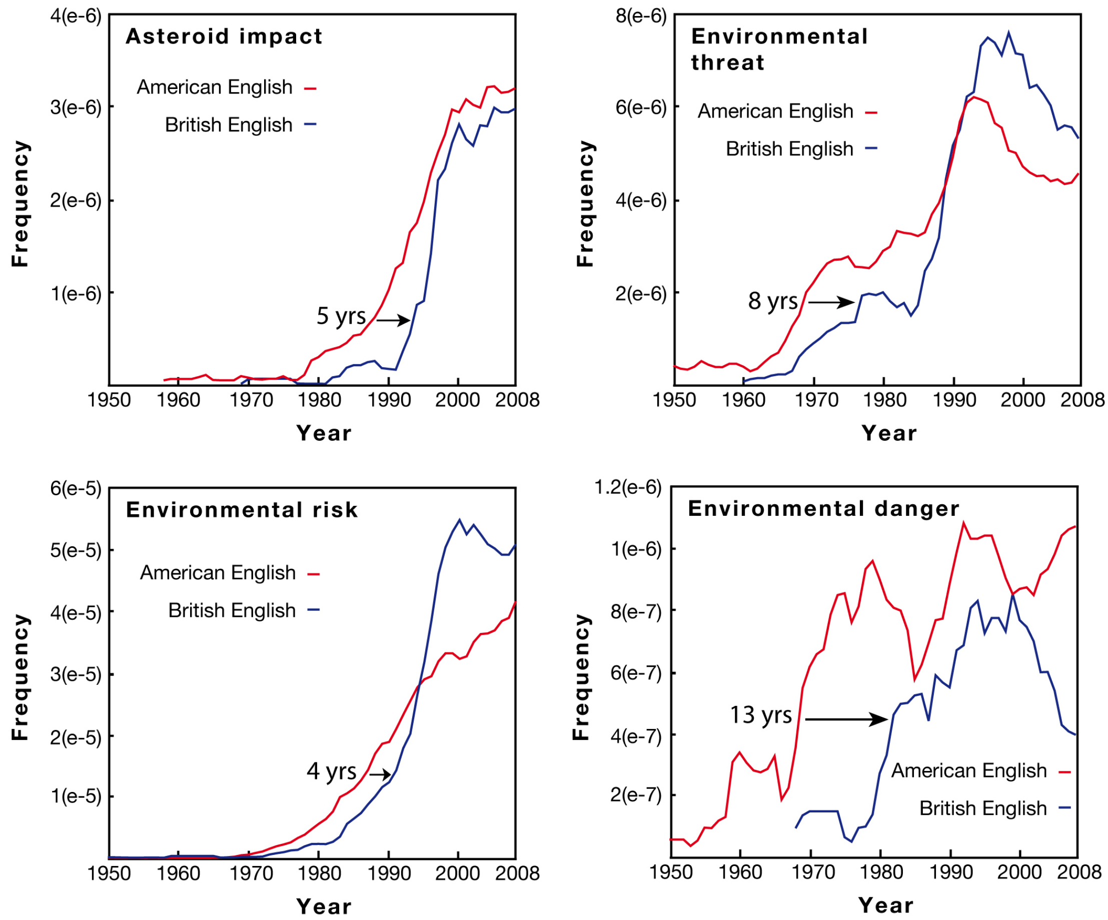


Fig. 5 Evolution of catastrophic keywords and palaeo-catastrophes since 1950 (source: Google Ngram, <http://books.google.com/ngrams> [##.##.####]). The frequency of these keywords shows a peak after 1980 that underscores an exaggerated interest in palaeo-catastrophes in intellectual inquiry and popular mindsets. We suggest that this reflects both (i) earth science that, as a historical science, uses the past (i. e. the rock record) to predict and quantify future changes; and (ii) media demand for catastrophes of all types and chronologies

luminescence dates constrain the deposit to between the 1st century B.C. and the 2nd century A.D., and point to the tsunami of 115 A.D. as the most likely candidate for the event. In 2009, the same research team[74] identified three tsunami events dated to around 1500 years ago, 2000 years ago and 3630–3410 cal. years B.P. This latter unit is attributed to tsunami waves produced during the Late Bronze Age eruption of Santorini. Particle-size distribution, planar bedding, shell taphoecoensis and dating supposedly distinguish it from normal storm and typical marine conditions. Somewhat ambiguously, coarse sediments that were previously considered to be ballast or storm deposits have now been systematically reinterpreted as tsunami deposits. Moreover, it is interesting to observe that a more nuanced analysis of the same biosedimentological data can produce non-tsunami scenarios. For example, in 1999, Reinhardt and Raban linked harbour destruction to seismic activity (influenced by the work of Mart and Perecman) and silting of the inner harbour.

74 Goodman et al. 2009b.

In a similar vein, volcanic eruptions are also frequently invoked as drivers of change in the archaeological record, even though evidence for this assumption is rare. Even if Torrence and Grattan[75] have discussed several case studies illustrating the complexity of relationships between human societies and volcanic eruptions their position has largely been ignored. They suggest that volcanic activity frequently acted as a stimulus rather than a hindrance to cultural development. Despite the popular paradigm, which sees natural catastrophes as a constant threat and catalyst of past human disasters, closer examination of human history often reveals a very different story. For example, the impact of the Late Bronze Age eruption of Santorini has been the focus of considerable research, although debate rages as to how the eruption disrupted the environment and influenced the cultural trajectory of Eastern Mediterranean societies[76]. It has been argued that the eruption was responsible for widespread famine and climate change. The precise dating of the eruption is also disputed. It is unclear whether a weakening of Cretan culture was underpinned by the eruption or social changes. Far reaching impacts of the Bronze Age Santorini eruption and its energy are still enigmatic and are too often used to explain things for which other explanations have not been tested.

Numerous examples exist around the Mediterranean for archaeological sites that have been studied neocatastrophically, none more so than the earthquake of 365 A.D.[77] which ~~is part of~~ the ›Early Byzantine Tectonic Paroxysm‹[78]. Other examples include the submerged ancient cities of Menouthis and Canope[79], the ancient harbour of Phalasarna in Western Crete hit by a tsunami[80], Balos around 20 km to the north of Phalasrna[81] or even the vanished city of Helike in the Gulf of Corinth[82]. All these examples attest to a revival in neocatastrophic thinking in the study of Mediterranean coasts, accentuated by recent globally mediatized disasters such as the Sumatra earthquake of 2004 and the 2011 Fukushima disaster (**Fig. 5**). We believe that these recent disasters will increase the propensity for this type of publication. This hypothesis does not call into question serious academic research undertaken into paleotsunami impacts during the past two decades. For example, there are by far fewer field data in contrast to the historical tsunami catalogues with several thousand events mentioned. We question the deterministic causal link drawn between natural catastrophes and the history of human societies.

From an anthropological standpoint, it is important to ask how researchers produce their ideas? What are the factors driving a revival of catastrophic thinking? There are several non-exclusive issues of note. 1) Undoubtedly, researchers are exploiting irrational

75 Torrence – Grattan 2002.

76 Marinatos 1939; Driessen 2002.

77 Jacques – Bousquet 1984; Stiros 2001.

78 Pirazzoli 1986; Pirazzoli et al. 1996.

79 Stanley et al. 2001; Stanley et al. 2004a; Stanley et al. 2004b.

80 Pirazzoli et al. 1992; Dominey-Howes et al. 1998.

81 Scheffers – Scheffers 2007.

82 Marinatos 1960; Soter – Katsonopoulou 2011.

social fears of natural and technological disasters underpinned by media sensationalism. 2) Equally important is the need to justify the social role of the geosciences as an applied discipline. 3) It is still naively believed possible to draw-up a simple history of human societies and natural history. All of these unresolved issues have created an intellectual dispute overshadowed by the battle for supremacy between academic disciplines[83] and bibliometric competition.

## 6. Conclusion

In contrast with the rise of neocatastrophism, we have identified two recent fields of research activity that seem particularly promising:

(1) The history of palaeo-pollution. Lead isotope analyses developed in the geosciences have successfully been used to study sediment pollution caused by human activities. Lead is a particularly good marker to study human societies in the past. Environmental contamination by lead is related to its extraction and fusion as well as mixing to form metal alloys. Traces of human origin usually differ from those contained in the natural environment. Lead is also a marker of the geographical origin of ores during periods of intense human activities. Lead trace isotopes have been used to study the harbour sediments of Sidon[84], Marseille[85] and Alexandria[86]. These studies have not only shown the usefulness of lead as a marker of early human activities but also as a complementary proxy to understand the development of ancient maritime cities.

(2) Non-deterministic evaluation of the constraints, potentialities and palaeo-hazards of ancient sites[87]. The occurrence of palaeo-risks is a question that merits closer investigation in the coming years without neocatastrophic undertones (e. g. systematic search for tsunami deposits in ancient harbour basins) because this trend has falsely skewed public perception into thinking that ancient societies lived under the permanent threat of natural catastrophes. Unfortunately, this over-simplistic vision masks the true problems of environmental vulnerability encountered by human societies since prehistoric times. Geoarchaeological studies allow coastal vulnerability to be assessed over long period of times. The revival of catrastrophism tells us more about present social anxieties than the real impacts of historical catastrophic events[88]. Caution is required so that neocatastophism does not completely alter the paradigm of coastal geoarchaeology. For example, archaeology has sometimes been hampered by over-simplistic dogma to explain the collapse of ancient Bronze Age civilizations[89], the destruction of the Minoans by the eruption of

[83] Leveau 1995.

[84] Le Roux et al. 2003.

[85] Le Roux et al. 2005.

[86] Véron et al. 2006.

[87] Morhange et al. 2010b.

[88] Walter 2008.

[89] Schaeffer 1948; Nur – Cline 2000; Deckers et al. 2007.

Santorini[90] or rapid climate change[91]. None of these hypotheses have survived a serious cross-examination even though they continue to partly shape geoarchaeological inquiry. Nevertheless, we believe that extreme event studies can also help to improve public awareness on unknown risks.

As Leveau[92] has noted, one positive upshot is that the history of ancient coasts can no longer be written using ancient texts as the sole source of information, as was the case in the 19th century. Finally, using the geosciences has radically changed our perception of ancient harbour environments.

90 Marinatos 1939.

91 Weiss et al. 1993.

92 Leveau 2006.

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