Mediterranean Alluviation: Highlighting Vita-Finzi's Scenario with hypothetical assessments

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Abstract

Discovering a causal mechanism to account for detected cycles of alluviation in the Mediterranean region during the Holocene has been a matter of debate for more than three decades. It is very difficult if not impossible to refer Mediterranean erosion and alluviation in Holocene times to a monocausal approach; whether to the climatic dominance which brought by Vita-Finzi in his pioneering work (Mediterranean Valleys, 1969) or to the anthropogenic dominance of later scholars such as Van Andel and others. Mediterranean alluviation most probably yield a more complex multi-causal explanation between environmental context which is ecologically vulnerable environment, Geology and tectonic, climate fluctuations and human impact.

المستخلص

إنّ اكتشاف آلية تبيين الأسباب التي أدت إلى الإرساب في حوض البحر المتوسط كانت ولازالت مثاراً للجدل لأكثر من ثلاثة عقود.

يعد من الصعب جداً أن لم يكن ضرباً من المستحيل تناول الأسباب التي أدت إلى عمليات التعرية والإرساب النهري في حوض البحر المتوسط في عصر الهولوسين وإرجاعها إلى سبب وحيد سواء أكان هذا السبب تغيرات المناخ التي اقترحها فيتا-فينزي في دراسته الرائدة عن أودية البحر المتوسط ومناصروه ، أو إلى سيادة وهيمنة الإنسان وتأثيره على البيئة التي اقترحت من عدة باحثين أمثال فان-انديل واخرون.

إنّ الإرساب النهري في حوض المتوسط على الأرجح يعزي لأسباب متعددة وأكثر تعقيداً مما كان يعتقد سابقا قد تسهم فيها الجيولوجيا والتغيرات المناخية وتأثير الإنسان ولربما تعمل هذه الأسباب متضافرة لإنتاج هذه الرواسب النهرية.

Introduction

Since the pioneering work of Vita-Finzi of the Mediterranean valley alluviation (Vita-Finzi, 1969) the possible impact of climate change and human impact in shaping the Mediterranean environment have been debated and argued by Bell (1982), Boardman and Bell (1992) and Hunt et al. (1992).

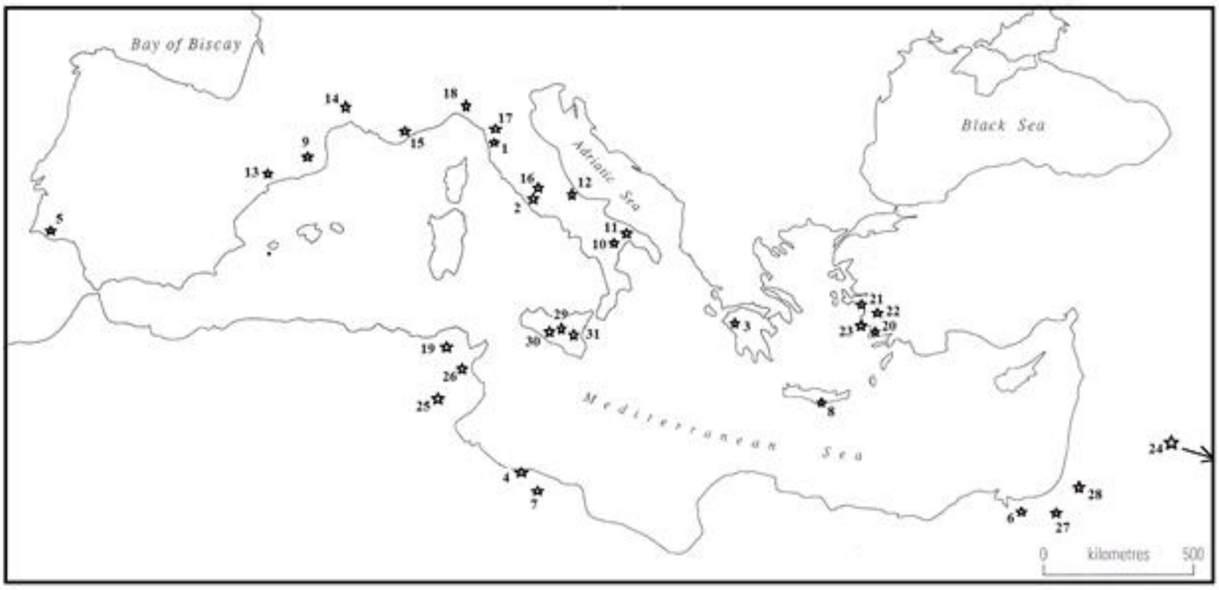

Fig. 1: Location map of the concerned localities. 1); Tuscany Italy; 2) North of Rome, Southern Etruria; 3) Al Pheus River Olympia; 4) Tripolitania, Libya; 5) South Portogal, Agiave; 6) Norhern Sinai, Egypt; 7) Ben Walid, Wadi N'f'd, Wadi Gobeen, Libya; 8) Valley of Vasilikos, Cyprus; 9) Epro Valley, Spain; 10) Basilicata, Southern Italy; 11) Feccia Valley; 12) Bifero Valley, Molise Italy; 13) Ebro in Spain; 14) Rhone; 15) Aigues-Mortws; 16) Tiber former port of Rome; 17) Arno River; 18) Po River; 19) Medgrada Valley, Tunisia; 20) Ephesus, West Turkey; 21) Miletus West Turkey; 22) Kucuk Menderes river; 23) Buyur Menderes Delta; 24) Musandam Peninsula, Oman; 25) Henchir Rayada, Tunisia; 26) Wadi Akarit Tunisia; 27) Wadi Faynan,

Jordan; 28) Wadi El Hasa, Jordan; 29) Salso Valley, Sicily; 30) Paltani Valley, Sicily; 31) Dittaino Valley, Sicily.

Vita-Finzi deducted that the climate change is the major cause for the Holocene alluviation throughout the Mediterranean (Fig. 1) in which he termed these alluviations by the name of Younger Fill and he dated these alluvial deposits based on archaeological features and inclusion of Roman potsherd to the early to mid centuries of the first millennium AD. (Barker and Hunt, 1995). After that phase of alluviation of the Younger Fill another earlier and later episodes of alluviation has been identified by geomorphologists in different places of the Mediterranean basin and referred to the human impact on environment, these act of human like deforestation for cultivation or overgrazing rather than climate change.

In the Mediterranean countries (Fig. 1) Holocene deposits have been used as evidence for climatic change and human activity (Lewin et al., 1995). There is, however, considerable debate about the origins of the terrace deposits of Mediterranean countries.

Previous concepts of the Mediterranean Alluviation

Vita-Finzi, 1969 in his pioneering work of the Mediterranean valleys used a very large body of evidence from the entire Mediterranean region (Fig. 1) to provide a simple history of late Quaternary valley depositions and down cutting which has provoked an endless debate. In his classic book “The Mediterranean Valleys” he defined two phases of Alluviation, the Older Fill and the Younger Fill (Tables 1 and 2). These fills can be recognized easily in the field because of its colours and texture, the older fill tends to be red, the younger fills brown and greys. These fills are described below.

Origin of The Older Fil

Alluvia terraces in the Mediterranean area (Table 1) favoured changes in the sea-level as a control factor which determined whether the valleys cut down or buildup their deposits. This statement is valid for some places only and this isn't always the case. Major alluviation deposits coincided with low sea-level (Vita-Finzi, 1969). And nowadays all alluviations has taken place during low sea-level .Butzer, based on sedimentological evidence suggests that the alluviation in Eurafrican subtropics associated with increased rain and the presence of colluvium is indicating a very long, intense rain in a seasonal pattern (Vita-Finzi, 1969). In addition, there is evidence that flood events rather than climatic changes may have played an important role in the phases of alluviation and incision (Macklin and Woodward, 2009). This matter is very complex and complicated than it was thought to be. In Cyrenaica the frost shattering is the main component of source material of the terraces, research revealed that this situation of Cyrenaica doesn't work in Morocco.

Table (1) the older valley fill (Vita-Finzi,1969)

Local Name	Industries: Within the deposit	Industries: In upper horizon	Industries: On surface
Tripolitania			
Redeposited Plateau silts	Aterian Middle Plaeolithic		Neolithic Upper Plaeolithic
Cyrenaica			
Younger Gravel	Levalloisian		Levalloisian
Tunisia			
Limon rouges	Aterian	Mousterian	
Haute terrasse	Mousterian and a blade industry		
Algeria			
Redeposited *Alloviations* anciennes Redeposited	Mousterian Aterian Acheulo-Mousterian	Ibero-Maurusian Oranian	Ibero-Maurusian Oranian
Morocco			
Limon rouges soltaniens	Micoquian Mousterian Aterian		Ibero-Maurusian
Spain			
Limon rouges			
Alloviations rouges			
Italy			
Alloviations terrassees	Mousterian		
Greece			
Red Beds	Mousterian	Upper Plaeolithic	Neolithic 5400 a.c.
Jordan			
Obeterasse Upper terrace	Middle and Upper Plaeolithic		Kebaean

Younger fill

In Antiquity, the older fill erosion was controlled by water and soil erosion measures, and as these measures decayed the down cutting continued (Table 2). In Tripolitania, Algeria, and Tunisia wadis, they perform the down cutting which was very effective and the valley crust was breached at many dam localities.

Table (2) the Younger valley fill (Vita-Finzi, 1969). Note: E refers to erosion; C^{14} refers to radiocarbon dating; Shaded area refers to maximum duration of stream aggradation using archaeological remains-Younger fill relationship.

	B.C. A.C. 500 1000 1500 1967.
Tripolitania	E Roman Ddms a nd walls E Roman Sherds Arab Sherds C^{14} 610 E
Cyrenaica	Greek & Roman Sherds photo glass E
Tunisia	E E Roman Sherds E
Algeria	E E Greek & Punic Sherds E
Morroco	Punic, Berber and Roman Sherds Arab Sherds C^{14} 800 C^{14} 490 E
Spain	Roman Sherds Medieval sherds E
Italy	Roman bath Roman Sherds C^{14} 1400 C^{14} 1140 1534 E
Greece	Byzantine ruins Coins 363.575 Turkish midden E
Jordan	Roman remains E

Early studies

The first study of valley alluviation in the Mediterranean region was by Judson (1963a) in the Sicilian Gomalunga Valley, a 60 km upstream from

Catania. Geological and archaeological studies established that there were two historic age deposits, 1st one begun, after 8th century BC and ended prior 325 B.C. with a depth about 8-10 m (Fig. 2, no. 19). The second one is probably of medieval times which is a terrace of 4-5 meter thick (Fig. 2, no. 20). (Judson, 1963a,b; Judson,1968). In southern Italy, two bodies of sediments were investigated, one of (10 meters thick) deposited around the middle of Holocene (5000 years BP) and the second one (historic fill) is deposited about 500 years only (Neboit, 1984a).

In Southern Etruria, 3-8 m of stream deposits buried Roman structures and date from either the late Roman or the medieval periods (Fig. 2, no. 18) Judson (1963 a,b) did not reach a conclusion on the causes of these alluviation events, whether these deposits induced by man or by nature or a combination of both, where , human impact on the formation of fluvial deposits is clear in Greece as well. The Alpheus river started to bury the classical places of Olympia not earlier than AD 500 (Fig. 2, no. 27) with almost 10 m terrace mainly accumulated during medieval times. Budel, (1965,1977) states that the most important reason for several changes in fluvial activity was the strong impact of man on nature. However, Dufaure (1976), supported the concept of anthropogenic initiation of sedimentation in Roman times for Olympia, but credits its build-up between the 8th and 15th centuries as mainly due to climatic reasons (Fig. 2, no. 28).

Modern Research

Studies of the alluviation patterns in the countries around the Mediterranean really started with the work of Vita-Finzi (1969), who classified the history of late Quaternary valley deposition into two major phases of alluviation, termed the Older Fill and Younger Fill. Each fill resulted from the silting up of stream channels, valley floors and coastal plains that had been incised during a preceding erosional phase. The colour of these two fills was different, the Older Fill colour is tending toward red tones and the Younger Fill toward browns and greys. Vita-Finzi dates the Older Fill to the late Pleistocene (ca. 50,000-10,000 BP), and the Younger Fill to late Roman (ca. 400 AD) early medieval time age of (Fig. 2, nos. 1-9). Both Fills were based on archaeological finds. Vita-Finzi (1969), concluded that climatic change was the primary factor responsible for the major phase of Holocene Mediterranean alluviation and valley sedimentation. Moreover periods of valley infilling, alternating with those of erosion in the valleys and simultaneous delta growth, have been also recorded by Vita-Finzi (1969, 1972). Between 50,000-10,000 BP. The older fill was deposited, which is the fill (I).Then, until 2,000 BP, there was an erosion and down cutting, with deposition of deltaic material between 5,000 and 2,000 BP. The Younger fill (Fill II) was laid down between 1600-300 BP and from 300 BP until the present there was erosion and increased deltaic building (Fig. 2, no. 10 and Fig. 3). Since Vita Finzi's work (1969) two schools of thought have developed. One school follows Vita-Finzi and they suggest that climatic factors caused Late Holocene alluviation. Among those who favor the climatic explanation are Leopold (1976), Bintliff (1977), Vita-Finzi (1969, 1972, 1975, 1976), Devereux (1982) and Hemple (1982, 1984 a,b). The other school supports anthropogenic factors. Among early workers who preferred the anthropogenic explanation are Bell (1982), Douglas (1967), Butzer (1972, 1974), and Dimbleby (1972). Since then valley alluviations in the Mediterranean coastlands have been a very important subject with much debate.

The "Climatic School"

Bintliff (1976a, 1976b, 1977) found that the model of Vita-Finzi (1969), was applicable in the Greek archaeological sites. He suggested that aggradation of the Older Fill needed much higher rainfall than occurs at present, and he correlated it with the presumed pluvial phase which took place in the early-middle part of the last Glaciation. On the other hand, he conformed with Vita-Finzi when he related and attributed the Younger Fill to climate change, which took place between the middle of the first millennium A. D. and late medieval times. Hemple (1982; 1984 ab) is considered to be among those who is suggesting that the climatic factor is causal in alluviation and he reports that the debris, alluvial fills, and terraces of the basins, valleys and coastal plains in Greece and Crete were deposited before significant human activity took place. On the other hand, Hemple (1982; 1984a, b) suggested that ancient gravels built up before the Wurm high glacial, and younger deposits were deposited at the end of Wurm, in the Holocene during the "Atlantic phase of the Holocene. Meanwhile, he referred only to the most recent phase of sedimentation to anthropogenic causes (Fig. 2, nos. 29-30) He also mentioned that deforestation has not had a big effect because the forests existed in the plains and therefore deforestation did not cause soil erosion (since he observed the Greeks and Phoenicians settled mainly in the coastal plains). Therefore, he considered most recent sedimentation, is initiated by human activity. Moreover, he contended that the woods mentioned as existing from Antiquity (Mediterranean oaks and conifer) offer little protection against soil erosion. Thus, he suggested that many historical fills were caused by climate, not by man. Hemple (1982,1984 a, b) gives examples from south Greece and Crete, where the valley bottoms filled mainly before the cultivation of the land started. Gilbertson in Tripolitania, Libya, (in Barker and Jones, 198 1), recognised that in Wadi Merdum and Wadi N'f'd there were two phases of fluvial sediments aggradation. These are"Older Fill" and "Younger Fill". The Older Fill often contained Palaeolithic artifacts, while, the Younger Fill is composed of fine aeolian and fluvial sands and loams which are deposited in channels and depressions which has been cut in the Older Fill. The age of the Younger Fill was proposed as late Holocene. These two units (Older and Younger Fills) were considered as equivalent to the upper and lower terrace deposits as defined by Vita- Finzi in Wadi Lebda and the Jefara region, northwest of Libya. Vita-Finzi (1969) notes the commencement of alluviation in Cyrenaica in the first century CE (Fig. 2, no. 8),but the commencement of alluviation in Algeria, Tunisia and Tripoli take place in the 3rd or 4th century CE (Fig. 2, nos. 4,5,7). Alluviation is considered a common phenomenon relating to the Roman-Libyan levels in the area of the Libyan west, which has been investigated during Libyan Valley Survey (Barker, 1996). Radiocarbon ages and pottery date the building-up of valley fills in the Agrave (S. Portugal), starting from 2,000 years ago and finishing sometime after AD 1400, (Fig. 2, no.11). Devereux (1982), credited that to the increase in rainfall rather than cultivation practices, and he favours the climatic explanation. Northern Sinai experienced an alternating periods of deposition and erosion since the early Middle Palaeolithic with extensive gravels deposition to a height of about 19 m above the present wadi floor till the final period of silt deposition which is widely documented in the area; although lack of artifacts; it yielded radiocarbon dates of 1755 and 655 BP which Goldberg (1984) suggest as pointing to deposition during wetter intervals and erosion during drier intervals (Fig. 2, no. 26). In addition, two phases of alluviation has been occurred in Negev; the first one linked to agricultural expansion in later Roman period and dated to 62-543 CE and continues until around 7th century CE., the second one dates to c. 1200 to CE. 1700 and it was linked to onset of wetter conditions as suggested by tree-ring data (Bruins et al., 1986).

The "Anthropogenic School"

Environmental change in the Mediterranean Basin induced by human activity can be traced back to the Neolithic agricultural revolution in the Near East around 8000 BC (Macklin et al., 1995). Furthermore, an agro-ecosystem was established in the entire coast of the Mediterranean in areas which were suitable for farming around 5000- 4000 BC, and since that time these areas were subjected to human interference (Ammerman and Cavalli-Sforza, 1971). The Mediterranean basin is very large and has diversity in its human history, bedrock, tectonic activity, climate and vegetation. Because of all these, Butzer (1969) raised a criticism of the Vita-Finzi model (1969). Furthermore, the interplay between vegetation cover, soil properties, and denudational forces has been neglected (Butzer, 1974). Further review of the later Holocene valley alluviation in the Mediterranean, by Bell (1982), showed that the valley fills were diachronously deposited. Accordingly, the climate factor was argued to be unlikely or at least is not as important as anthropogenic factors. Bell (1982) stressed that the causal agent for alluviation was human disturbance of the landscape. Alluviation occurred at different times at different localities, so climatic change was unlikely to be the main reason behind the pattern of Mediterranean valley alluviation. Several studies have supported Bell (1982), including Davidson (1971), Davidson (1980), Davidson el al., (1976), Wagstaff (1981), Gilbertson et al. (1983), Gomez (1987), Pope and van Andel (1984), van Andel et al., (1986), Chester and James (1991). Furthermore, even Vita-Finzi (1976) has mentioned that Mediterranean valley sedimentation was diachronous to an extent. Dating of these sequences is often problematical (Hunt and Gilbertson, 1995). In the Platani Valley, Salso Valley and Dottaino Valley in eastern Sicily, terraces were studied and classified by Neboit (1984a). A terrace was recognised up to 10 m above the river bed, which contained pottery from the 3rd century BC. (Greek Epoch), (Fig. 2, no.21) and an Older terrace at 15-20 m above the river bed, with no archaeological material, but had some on its surface, probably from the 18th century BC. (Fig. 2, no. 22). A younger terrace of 5 m, was of unknown age. It contained reworked artifacts. The main reason behind the formation of these terraces was assumed to be human activity. In Tripolitania, Libya, the "Younger Fill" at Beni Walid was subjected to a study by Gilbertson and Jones (Barker and Jones, 1982), and from this study they concluded that the climate in the Romano-Libyan period was almost similar to that of today and the intensive farming caused alluviation rather than a response to climate change, and attributed to soil erosion which may have resulted from over grazing. On the other hand, near Beni Walid, in the Wadi N'f'd and on the plateau near Wadi Gobeen, the sedimentological changes in the Wadi deposits were thought to be related to the irrigation practices in the Romano-Libyan times as well as to natural environmental fluctuation (Barker el al., 1983). Gilbertson et al., (1984) redefined the Older Fill and Younger Fill as Cobbly Fill and Wadi Alluvium respectively, and they found that their first correlation of Older and Younger fill to the Older and Younger terrace deposits of Vita-Finzi (1969) was not easy and accurate. Alluvial deposits in the lower Vasilikos Valley (Cyprus) were investigated by Gomez (1987), and four alluvial terraces have been identified at heights of approximately 10 m, 25 m, 55 m, and 80 m, above the bed rock floor of the Valley. The younger fill in the lower Vasilikos Valley differs in two ways from the deposits which were described by Vita-Finzi (1969). First, it is composed of two (not one) distinct units, a coarse (channel zone) and finer (flood plain) deposits. Secondly, radio-carbon dating suggests that the overbank sedimentation in the lower Vasilikos Valley was under way by A cerarmic Neolithic time (ca. 5800-5250 BC.). In Spain, in the Ebro Valley, three valley fills have been recognised by van Zuidam (1975). The two older ones, according to van Zuidam, were caused by natural processes and the younger fill which was deposited between 700 BC and AD 117, was caused by anthropogenic activity (Fig. 2, no. 12). In Basilicata, Southern Italy, Bruckner (1986, 1990), identified four periods of accumulation, the first one was climatically "eustatically" caused, whereas the other three were dated to the Greek-Roman Epoch (Fig. 2, no. 23), medieval times (Fig. 2, no. 24) and the last two centuries (Fig. 2, no. 25), owing their origin to human activities such deforestation and farming. In addition to that Barker and Hunt (1995) for example found an early Roman phase of alluviation in central Italy and they referred it to land clearance, also Carmona and Ruiz (2011) found Roman alluviation cycle in eastern Spain and they referred it to land clearance. The vulnerability of the environment (Mediterranean subtropics, easily erodible marls and clays as well as steep relief), was the main reason why human influence on nature had significant effects, including badlands formation in the hinterland and on the Valley slopes, and the creation of enormous sediment accumulations in the valleys and on the coastal plains (Bruckner, 1986). Holocene coarse and fine grained alluvial deposits from the Feccia Valley, Tuscany Italy, have been described by Gilbertson et al., (1983), and Hunt and Gilbertson (1995). They show that there are two sets of palaeochannel fills, and three sets of coarse alluvium. The palaeochannel fills contained pollen, molluscs and plant macrofossils reflecting a relatively well-vegetated landscape. On the other hand, some of the coarse alluvium was laid down after clearance phases. The phases of gravel sedimentation may be related to historical and archaeological evidence for periods of intensification of human activity and expansion of farming in the area. The depositional regime changed very rapidly. Two sets of palaeochannel, fill deposits and two sets of coarse sediments accumulated since the fifteenth century AD. The early history of the Bifero Valley, Molise, Italy predominantly reflects tectonic activity in the lower Pleistocene and a mixture of tectonics and climate change in the middle and late Pleistocene. In the Holocene, human activity played a very important role in shaping sedimentation patterns. The archaeological and geomorphological investigation which was carried out by Barker and Hunt (1995), defined the major phases of land use expansion and/ or agricultural intensification. These human activity phases coincide with aggradation phases. The phase of late Samnite/ early Roman aggradation does not compare well with the Vita-Finzi models (1969), of a climatically controlled late Roman/early Medieval Younger fill. Instead, where palaeoecological evidence is present, signs of cleared landscape and soil erosion are evident during aggradation phases. Generally the human activity appears to have been the dominant influence on fluvial activity in the Holocene. It can be noted that many of these studies are extremely simplistic conceptually. For instance, assumptions are made that river systems behave similarly from their headwaters to the sea (Graf, 1983 b. c,d). In practice, few rivers behave in this way, though very few palaeo-fluvial studied have documented this, one notable exception by Rose (1995). Very rarely concepts such as threshold behaviour are considered (Hunt et al., 1992).

Delta expansion in Historic time

Deltas throughout the Mediterranean underwent rapid expansion in the late Holocene. Examples are the deltas of the rivers Ebro, Rhone, Aigues-Mortes, (which was a coastal port at the time of the Crusaders), Tiber (the former port of Rome, Ostia antica, is now silted completely), Arno (Pisa was isolated from the sea in the Medieval periods), and Po (a rapid delta growth since the 12th century) (Bruckner, 1986). The Ebro delta in Spain hardly existed in Roman times, but underwent rapid expansion during 16^{th} an 17^{th} century and by 19^{th} century the growth of delta become slow instead of being increase. There is no evidence that this delta was created by human interference (Grove and Rackham, 2001). Rathjens (1979) discussed the causes behind the formation of deltas, and he refers them to anthropogenic action especially the deforestation, production of charcoal for fuel, the cultivation of grain and olive trees, and over grazing because of widespread goat keeping. In Tunisia, due to extensive vegetation clearness and deforestation (in 146 BC) in the Madgrada, Valley, sedimentation took place in the valley bottom and also to sea ward in the river's delta. A fragmentary barrier spit began to develop by the 5th century AD (Fig. 2, no. 16) , by the 13th century AD, this barrier spit consisted of distinct islands, then littoral drift began to close the passes between the islands during the 13th and 14th century (Fig. 2, no. 17). By the 16th century the barrier spit was more or less continuous (Fig. 2, no. 17)Thornton et al., (1980). The ancient Greek city that exist within the modern day boundaries of Benghazi was found around 525 BC.; at that time it was known as Euesperides and was located on the edge of lagoon which opened from the sea, it was deep enough to receive small vessels. It was deserted in the middle of the 3rd century BC. probably because of silting up the lagoons from wadi deposits, so the small port became insufficient any more (Kenrick, 1985). In west Turkey, phases of delta growth can be precisely dated by archaeological findings. Furthermore, there are many coastal archaeological sites which were partly covered by alluvial deposits, with their harbours silted up. Among these sites are the cities of Ephesus and Miletus (Bruckner, 1986). According to Eisma (1978), the delta of Kucuk Menderes river progressed slowly between 750 and 300 BC (Fig. 2, no. 32) then in the period 300-100 BC (Fig. 2, no. 31) it moved forward rapidly for a distance about 5 km and then with decreasing speed in Roman times 100 BC- AD 200 (Fig. 2, no. 34) and finally more slowly in Early Middle Ages AD 200-700 (Fig. 2, no. 33) On the other hand, the data which relate to Buyuk Menderes delta (Maiandros) are less complete, but the delta formation seems to have had a similar history up to the Early Middle Ages (Bruckner, 1986).

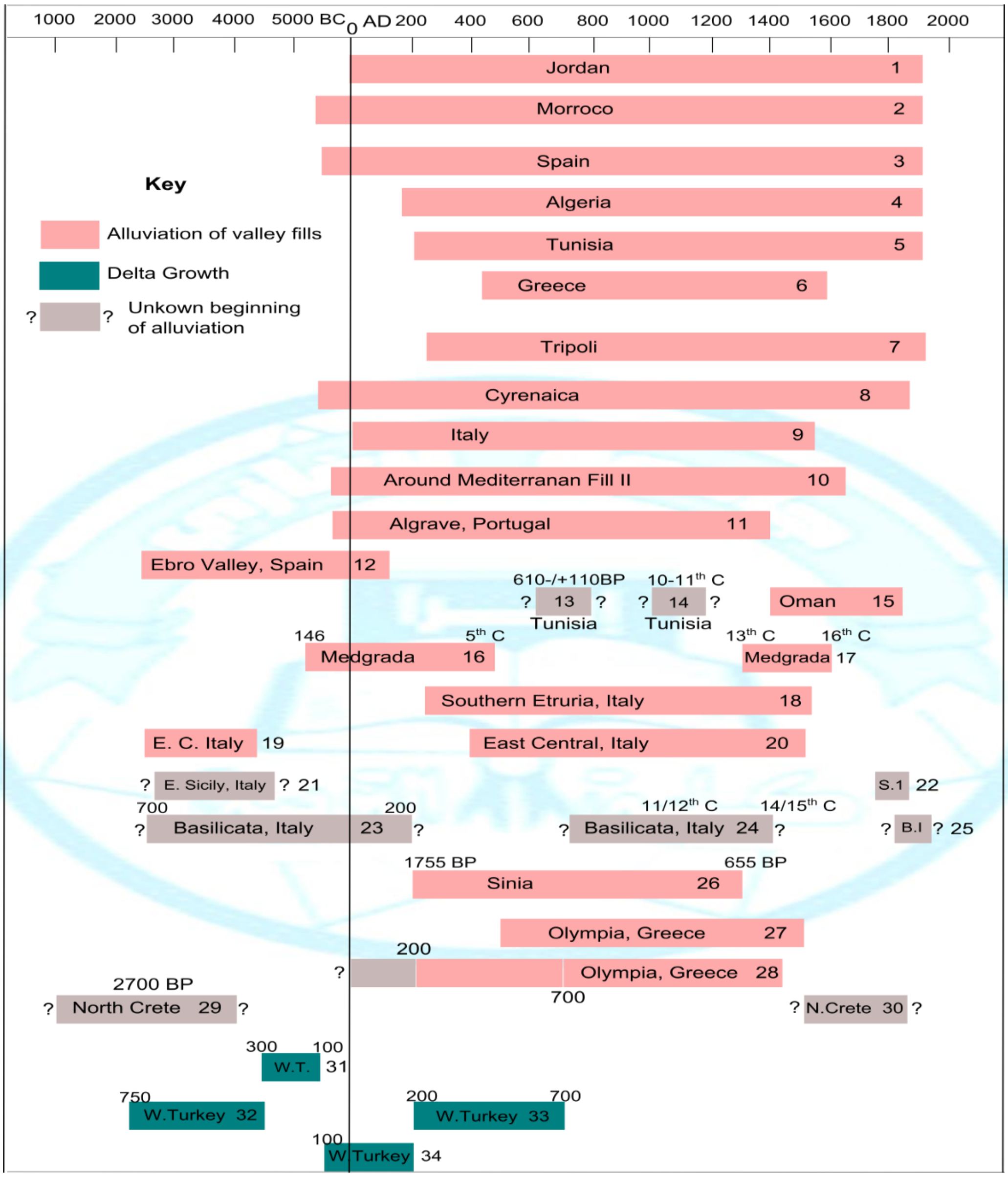

Figure (2) Selected historical alluviation in the Mediterranean region.

Anomalous arid-zone alluviation patterns

A number of arid-zone areas show patterns which are not easily related to either the climatic explanation put forward by Vita-Finzi (1969) or to human influence as suggested by Bell (1982). In the Musandam Peninsula of northern Oman, the wadis are floored by the calcrete-capped alluvial and colluvial Fills of the Makhus Formation. The relationship of this formation to the coastal aeolinites gave indications that this formation was deposited during the last major marine regression (15-20,000 BP). About 10,000 BP incision supervened and outside those areas that are affected by the subsidence has persisted until the present day, barring a brief depositional episode (represented by the Khasab terrace) (Fig. 2, no. 15) which was dated by means of archaeological finds to between the fifteenth and 19th centuries A. D. (Vita-Finzi, 1978). In Tunisia, two very low post-Islamic Holocene terraces have been reported (Ballais, 1995). One of these terraces is at Henchir Rayada which contains Islamic pottery from 10th-11th century (Fig. 2, no. 14) and the other one at Wadi Akarit which radiocarbon dated to 610 +/-110 BP (Fig. 2, no. 13). These terraces were thought to be similar to the several aggradations, recorded from around the Mediterranean by Vita-Finzi (1969) but clearly do not conform closely to his model. The sedimentological characteristics show stratification which is comparable to that forming under the present day conditions. In Tripolitania, re-study of the evidence put forward by Barker and Jones (Barker and Jones, 1981, 1982) and Barker et al., (Barker et al., 1983) showed that the pattern of alluviation was not simple and did not conform to the Vita-Finzi model (1969) (Gilbertson et al., 1984; Anketell et al.,1995). A major early Holocene alluviation phase seems to have accompanied the Neolithic colonisation and agricultural development of the Tripolitanian wadis. The Roman-Libyan flood water farming systems were built on stable wadi floors, and appears to have functioned without sedimentation and erosion problems until the 16th Century AD. During the 16th Century AD, a major sedimentation episode deposited up to 8m of alluvium in the wadi floors (Gilbertson and Hunt in Barker et al., 1996). Alluviation after the Early Holocene was thus clearly not linked with the 1st-4th Centuries AD, or with its decline in the 5th and 6th Centuries AD. Neither does it conform to the Vita-Finzi (1969) model.

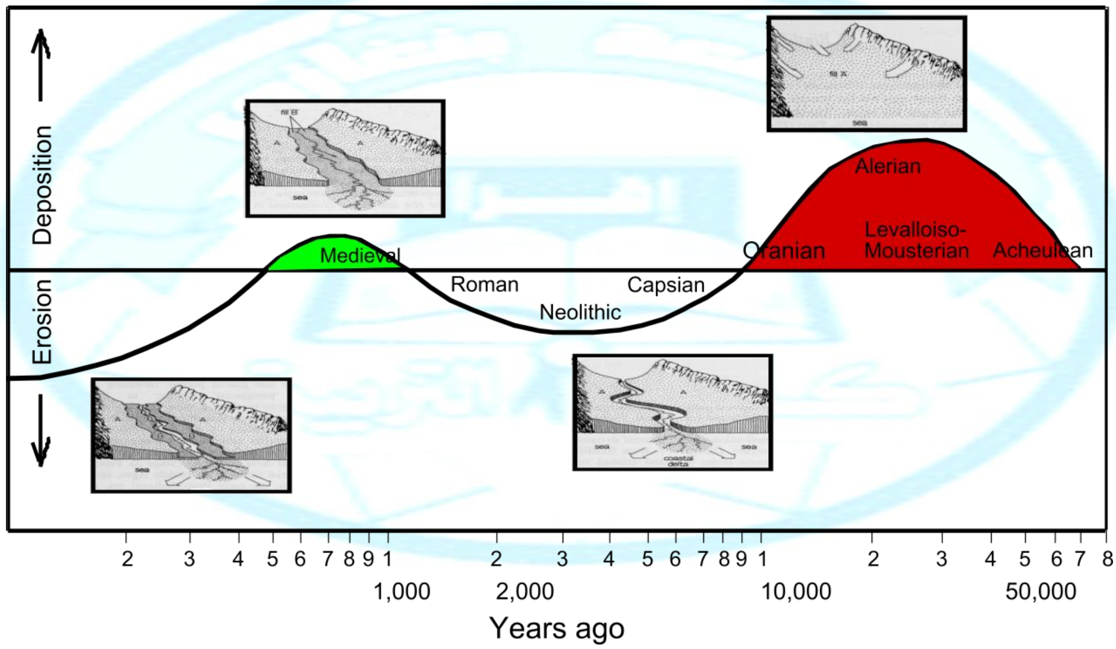

Figure 3: chronology of erosion and deposition (after Vita-Finzi, 1972) and Vita - Finzi's model for Mediterranean alluviation (modified after Bintliff, 1997).

Alluviation in Jordan

1- Wadi Faynan

The Wadi Faynan is a fluvial landscape and a sequence of Holocene and Pleistocene terrace deposits was developed (Barker et al., 2007).The early Holocene riverine deposits of Wadi Faynan catchment in SW Jordan were described. The early Holocene fluvial sediments are predominant fine-grained, epsilon cross-bedded and highly fossiliferous, providing convincing evidence for meandering perennial rivers in landscape characterized by forest steppe and steppe before 6000 years BP. A considerable alluviation occurred during the Early Holocene in the Faynan catchment: this ascribed to the impact of early farming activities (El-Rishi et al., 2007).The causes of the Early Holocene alluviation are likely to be the result of partial response to soil erosion brought about by the introduction of herding and arable agriculture. Whereas in the late Holocene alluviation appears to have taken place as a response to extreme aridity. Importantly, in the recent times, desertic conditions appear to have retreated from Wadi Faynan (El-Rishi et al., 2007).

2- Wadi el Hasa

Near Qal'at el Hasa, the Wadi Hasa is bordered by remains of several alluvial fills which contain cultural material. Both middle and upper Palaeolithic terraces (alluvial fills) probably a lacustrine deposits situated east of Qal'at el Hasa (Table 3). The history of accumulation and erosion of these fills must be considered in any account of the regional environmental record. Table 3 describes the fills (Copeland and Vita-Finzi 1978).

Deposition in the Wadi Hasa was still on going at 2883-1988 BCE, and seems to be represented in a number of other valleys in the area (Frumkin, et al., 1994). The end of this phase is dated around 2137-1689 BCE.

Table (3) Summarized alluvial fills (Copeland and Vita Finzi, 1978), fills in chronological order.

Fill number	Description	Thickness (m)	Age based on radiocarbon dating	Age based on attribution of artifacts
Fill IV	A well-bedded deposit of fine gravel, sand and silt	2	Less than 2000 years old	Contains Roman and later shreds (one dating from AD 1250-1400 Historical Age
Fill III	well-bedded silty sands with basal limestone gravel	5	3950+/- 150 BP	Contains Kebaran (Epipaleolithic) artifacts
Fill II	Largely water laid angular to subangular fine gravel and silt. This unit cuts into fill I	1	9200- 8640 to 6000 BC	Contains Pre-Kebaran (upper paleolithic) artifacts
Fill I	Highly calcareous silt and clay containing bands of gravel, much of angular flints	30	Middle Pleistocene to 14000 BC	Contains Middle palaeolithic artifacts

The following alluvial chronology as described in (Table 3) was proposed by Copeland and Vita Finzi (1978):

- Fill I was deposited and accumulated during or after the Middle Palaeolithic occupation and continued up to early Upper Palaeolithic.
- Fill I was incised and the Fill II was deposited during the Late Pre-Kebaran (Upper Palaeolithic). Incision was renewed and accumulation of Fill III took place during or after the Kebaran.
- Fill III was incised before the Roman period and deposition of Fill IV took place during or after Roman times and continued into Medieval times.
- Fill IV was incised after the Medieval period.

3- Wadi Kofrein

In the lower Wadi Kofrein, fills which are represented by terraces have been described by Vita- Finzi and Dimbleby (1971) as follows in (table 4). The Wadi Kofrein has an ephemeral regime at the present day. Aggradation by streams with different seasonal or even perennial regimes are indicated by the well stratified character of the Wadi Kofrein deposits, and the peaty material (Table 4). Table 2 summarizes the lower Wadi Kofrein fills (Vita Finzi and Dimbleby 1971).

Table 4: lower Wadi Kofrein fills have been described by Vita -Finzi and Dimbleby (197 1)

Fill	Description	Thickness	Age
Younger deposit	Predominantly well bedded clayey silt, usually buff in color, with horizons iron stained	4m	Medieval
Lower terrace	Bands peaty material in the upper part, one of these bands is 0.3 m thick, yielded pollen. This Fill contain Roman potsherds	30m	Medieval

Generally, in Jordan, Cardova et al., (Cardova et al., 2008) suggested both climatic and anthropogenic processes were involved in the complex history of Holocene alluviation and in some cases their influence compliment to each other.

Discussion

From the previous review, it can be recognized that, in the Holocene a multicausality is more likely, in many instances, than a simple climatic causality of valley alluviation. The influence of human activity and climate will vary from area to area, depending on local agricultural and climatic history, rock type, vegetation, hydrology etc. (as mentioned earlier by Butzer, 1969; Hunt et al., 1992). The pattern of Mediterranean alluviation is demonstrably complex (see figure 2.2). Simple explanations are therefore unlikely: a view cogently expressed by Cooke and Reeves (1976). Those workers studied the cutting and filling of arroyos and canyons in California and Arizona. They reached no firm conclusions, but they favoured climatic factors in Arizona and human factors in California. These workers point to the possibility of multi-causality and the difficulties of linking cause and effect in simple fashion.

In the Pleistocene, however, anthropogenic causes are unlikely to be significant: climatic and tectonic causes are likely, but the pattern of alluviation events is not uniform around the Mediterranean.

In the Mediterranean most of the deltaic sediments come from erosion via rivers rather than the coastal erosion, having said that it seems hard task to come to conclusion that reveal the causes for the delta building and sedimentations but it looks that both factors contribute to the building up these delta, in addition to the geology and tectonic of every region.

Simply the growth of the human land cultivation, deforestation, grazing, etc. the time, played a spectacular rule which can directed towards anthropogenic impact beside the climatic one.

Conclusion

One can argue that the Mediterranean basin area is ecologically unstable environment (Heavy rain dynamic, steep slopes, often easily erodible unconsolidated sediments) All these may lead to an exaggerate the impact of man in shaping the Mediterranean area. But also the alluviation/sedimentation where dischronous. Climate was also fluctuated in the Holocen, by chance these fluctuation of the climate coincide with human activities, this situation may drive us to refer these alluviation to the climate. But every place has its own characteristics in term of geology, vegetation cover, human impact, etc. and we cannot generalize and just draw one picture for the whole basin area, if we want to be rationale in this subject, every place has to be treated individually. From the reviewed literatures, a large uncertainty covers this issue, however, many authors have made it increasingly apparent that eustatic and tectonic, climatic and anthropogenic factors interacted together in different manners and fashion to produce a much more complex series of controls upon Holocene alluviation in the Mediterranean region. Finally, the only satisfactory conclusion to this paper is to call for further investigation and thorough research and study.

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