Sedimentation as geomorphological bias and indicator of agricultural (un)sustainability in the study of the coastal plains of South and Central Italy in antiquity

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A B S T R A C T
Environmental research of ancient landscapes in the coastal plains, river valleys and uplands of the Mediterranean shows how erosion and sedimentation studies play a significant role in the evaluation of the archaeological record at the regional and local scales. As a rule, directors of landscape archaeological projects nowadays involve physical geographers in order to study erosion and sedimentation as potentially influential post-depositional processes that may expose or cover up archaeological remains (long) after regions or sites were abandoned. This is a phenomenon in the literature known as geomorphological bias, i.e. bias caused by landscape taphonomic processes. Key question here is to what extent archaeological settlement patterns are an artefact of landscape change, with deposition obscuring large parts of the ancient Mediterranean landscape. At the same time, it is important for our knowledge of past societies to establish whether these landscape processes affected the sustainability of the human environments of sites and regions already while they were settled, and how people adapted to environmental changes in accordance with the socio-political and socio-economic context. Sustainability is defined in this paper as the capacity of a rural economy to endure in a given environmental and socio-economic setting. A key question from this perspective is whether erosion and sedimentation studies can help explain why some rural landscapes in the long run were economically more viable than others. Drawing on case studies from landscape archaeological and excavation projects of the Groningen Institute of Archaeology, this paper approaches Mediterranean sedimentation history in South and Central Italy from the angles of geomorphological bias and sustainability studies. The focus is on the coastal plains of the Sibaritide in South Italy and the Pontine plain in Central Italy, both of which have been subject to profound landscape changes caused by sedimentation starting at least in the Bronze Age, and caused by erosion in their hinterlands as the result of long term human impact in combination with climatic changes, sea-level change and neotectonics. Although already settled in pre- and protohistory, both coastal plains were targeted for the first time during phases of Greek and Roman colonization as areas of organized agricultural expansion (see Table 1 for a chronological overview of archaeological periods). However, in both cases long term sustainable exploitation proved difficult due to a complex of environmental, technological, socio-economic, and political factors.

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1. Introduction

Since Vita Finzi’s, 1969 seminal publication *The Mediterranean Valleys: Geological Changes in Historical Times*, in which he outlined basically two phases of alluviation, a post-glacial Older Fill and a Late or post-Roman Younger Fill, each comprising several erosion and sedimentation cycles, Mediterranean landscapes have seen much geoarchaeological work detailing Mediterranean alluviation history of the later pre- and protohistorical periods and Classical Antiquity (Bell and Walker, 1992, 190–192; Walsh 2014, 81–101). Geoarchaeological research of ancient landscapes in the coastal plains, river valleys and uplands of Central and South Italy shows how erosion and sedimentation studies play a significant role in the evaluation of the archaeological record at the regional and local scales as they can elucidate geomorphological biases in data recovered from archaeological surface survey, and at the same time yield information on the sustainability of the Mediterranean landscapes of the past. As Roberts (1998, 191–192) states, historical soil erosion in the Mediterranean will often have been a combined product of natural and cultural forces, notably of climate and agricultural impact, and ‘thin or erodible soils, steep slopes, a vegetation vulnerable to fire, and rainfall that can be intense and erosive make the Mediterranean ecosystems sensible to uncontrolled human impact. Casana (2008), for instance, has shown how a variable precipitation regime increase,
including extreme weather events, will have strong effects on the rate of erosion in intensively exploited landscapes, such as the Hellenistic and Roman landscapes in the Northern Levant. From an archaeological perspective, John Bintliff’s 1977 publication *Natural Environment and Human Settlement in Prehistoric Greece* (1977) may be viewed as a benchmark in establishing a firmer disciplinary relationship between regional settlement history (as practiced by archaeologists) and the study of the natural environment of the Mediterranean (as practiced by geographers and biologists). However, those earlier models were still rather deterministic, as Bintliff himself readily remarked in a later overview paper on landscape change in Classical Greece published in 2000. In that paper, he concluded how between the end of the seventies and the end of the nineties rapidly growing body of empirical evidence would rather support more multi-causal interpretations whilst also raising important questions regarding the impact of these events on contemporary societies’ Bintliff (2000), 68; see also Bintliff (1992) and Bintliff (2002). At the same time survey archaeologists working in the Mediterranean became aware of the biases erosion and sedimentation represented for the interpretation of the regional archaeological record they were mapping. As van Leusen stated in his dissertation published in 2000, geopedological research had become a required part of regional projects not only in order to map one of the most important factors in past land use, but also to map geomorphological bias in the survey results (van Leusen 2000, chapter 8, 4). This paper focuses on these two main themes that can be summarized as landscape change as a major bias in regional settlement studies and the effect of landscape change in coastal plains on sustainable land use. (See Table 1.)

While many survey projects nowadays integrate environmental work, to date there are only few studies available that have integrated such work on a regional scale. Moreover, it is uncertain whether archaeologists, or ancient historians for that matter, who work with regional settlement data always grasp the implications of erosion and sedimentation processes for a reliable interpretation of regional settlement patterns across space and time. But neither are the economic problems and opportunities that natural and man-induced landscape change brought to past societies always fully realized; in other words, how did landscape change affect the sustainability of settlement and land use in a given region in antiquity, and how did humans react to perceived changes in their environment and how did people develop and apply environmental knowledge (Walsh 2014, 7–9)?

Below I will address the issues of geomorphological bias and sustainability of Mediterranean landscapes outlined in the introduction by discussing two case studies from fieldwork projects carried out by the Groningen Institute of Archaeology in Central and South Italy (Attema et al. 2010, chapters 2 and 4 for introductions to these landscapes). First I will present examples of sedimentation regimes that had caused the profound burial of ancient land surfaces, as such seriously impeding the reading of settlement development on the regional scale. Two cases will be presented; the Sibaritide coastal plain in northern Calabria and the Pontine coastal plain in southern Lazio (Fig. 1). In both cases hand augerings, the cores of which were radiocarbon dated, have revealed the sedimentary impact of erosion during the later Holocene on the lower parts of the landscape. Next, the issue of how far we may study sedimentary archives from a contemporary perspective will be dealt with, in other words: how did erosion and sedimentation actually affect the sustainability of the human environments of sites and regions while they were settled? For this aspect, I will draw on the same two case studies, the Sibaritide and Pontine plain, defining sustainability in a landscape archaeological context as the capacity of a rural economy to endure in a given environmental and socio-economic setting. I emphasize the special position of the coastal plains in the Mediterranean environment being both among the most fertile and most vulnerable landscape units.

2. Sedimentation as geomorphological bias in South and Central Italy

The geography of South and Central Italy is characterized by inland mountainous areas, river valleys and wide coastal plains. In the latter, without exception, considerable sediments accumulated over time in their hinterlands (Brückner 1986; Abbott 1997; Abbott in Carter and Prieto 2011; Attema and Sevink, forthcoming); posing serious problems for our interpretation of regional settlement development. While early forms of urbanization in many of the South and Central Italian landscapes can now be traced back into the final phases of the Bronze Age (Paciarelli 2000), we must realize that due to geomorphological bias we have but a partial view of rural settlement accompanying nucleated settlement. This not only holds true for prehistoric phases, but also for the landscapes of Classical Antiquity. For example, in the Metapontine plain on the Adriatic coast, many of the farmsteads of the early Archaic period (around 600 BCE) may be buried below the alluvium of the Basento and Bradano rivers and their tributaries. In the Basento river valley, they were only found when infrastructural works were carried out below the current plough zone (Carter and Prieto 2011, 641–643). However, remains of farmsteads of the Classical and Hellenistic period, whose owners did not seek locations along the river but founded their farms over the plain between the main river valleys of the Basento and Brando, do appear in abundance in the plough zone (Carter and Prieto 2011, 677 ff.). Clearly the sedimentation regime of the Metapontine rivers has consequences for our chronological and spatial understanding of the scale of ruralisation during the Archaic period connected with Greek colonization.

The Holocene sedimentation record is not only a problem for understanding the settlement archaeology of the Metapontino, but that of other coastal plains of South Italy as well (see e.g. Abbott and Valastro 1995, Abbott 1997), and similar problems occur in the coastal landscapes and river valleys in Central and northern Italy, as exemplified by the buried prehistoric landscape of the Po plain (Calabrese et al. 2010). The two case studies of the Sibaritide and Pontine plains are therefore not exceptional as to their dynamic character, but at the same time serve to show the notable variability in timing, nature and impact of sedimentation regimes within regions across Italy, and by extension the Mediterranean.

In the plain of the Sibaritide, sedimentation has been intense, and here the entire prehistoric to (post) Roman landscape is buried under a many meters of alluvial sediment, the causes of which are debated in the geological literature (Vanzetti 2013, 24–28 for an overview). In the Pontine plain the situation is different. Here the protohistoric settlement phases are only locally deeply buried, while as a rule the Roman landscape is visible in the plough soil (Attema et al. 2010, 31–58). This signifies that sedimentation was reduced in post-Roman times, possibly because of lack of sediment supply from an already eroded hinterland. The two case studies illustrate not only the problem of how to cover serious chronological and spatial gaps in our knowledge of regional settlement development that are due to geomorphological bias but also the problem how to reconstruct evolving and contracting regional settlement on the basis of partial data.

| Table 1 |
| Periodisation used in this article (date ranges are in years BC/AD). |
| 6500–3650 | Neolithic |
| 3650–2250 | Eneolithic (Copper Age) |
| 2250–1700 | Early Bronze Age |
| 1700–1000 | Middle Bronze Age |
| 1300–925 | Late Bronze Age |
| 925–725 | Early Iron Age |
| 725–580 | Late Iron Age |
| 580–480 | Archaic period |
| 480–30 | Republican period |
| 30–476 | Imperial period |
| 476–1000 | Early Middle Ages |
2.1. The Sibaritide plain

The vast alluvial coastal plain of Sybaris is located on the Gulf of Taranto on the Adriatic Sea and is surrounded by the foothills of the Pollino mountains in the north-west and the foothills of the Sila and Mula mountains in the south-west (Attema et al. 2010, 82). Fig. 2 shows the extent of the plain with sites mentioned in the text and major rivers draining it. These rivers over time deposited thick layers of clay and clayey silts. Sedimentary deposits at places contain intermediary layers with organic materials suitable for radiocarbon dating. From published dated sequences obtained in various investigations by coring, it can be safely deduced that sedimentation in the plain started well before the foundation of the Greek colony of Sybaris (e.g. Cherubini et al. 1994; Cucci 2005; Bernasconi et al., 2010; Attema et al. 2010, 22 and fig. 1.6; Ferranti et al. 2011). A recently published, though highly tentative reconstruction of the intensity of sedimentation across time on basis of all available radiocarbon dates by Italian protohistorian Alessandro Vanzetti, would indicate that sedimentation had already started by around 6000 BCE. This is interpreted by this author as the consequence of serious human impact on the landscape in the hinterland of the plain due to the neolithisation process. This, however, seems unlikely given low population numbers (compared with later periods), the use of hoe cultivation and the non-anthropogenic factors that should be taken into account (Vanzetti 2013, 27 and Fig. 4). Sedimentation in following phases would, according to this author, have been less intense, and relatively stable periods occurred, as for instance during the Eneolithic and Ancient Bronze Age. During the periods of Greek colonization and subsequent Hellenistic and Roman periods, rural expansion in the plain was possible, although hydrological management would have been required (Bellotti et al., 2009, 69). Sedimentation increased again during the later historical periods which, in combination with failing hydrological management, resulted in a deeply buried archaeological landscape.

The effects sedimentation in the plain of Sybaris have had on the visibility of the archaeological record is clear from even a quick glance on the archaeological map of the Sibaritide produced in the late 1960’s by De Rossi et al. (1969). (Fig. 3) While the foothills show a busy protohistoric and classical landscape, the plain is suspiciously empty, except for the excavated site of Sybaris that was founded by Greek settlers in the period of the Greek migrations starting in the late 8th century BC. Indeed, Sybaris was only discovered after an intensive mechanical coring and geophysical campaign carried out in the 1960s by a research team of the University of Pennsylvania led by Froehlich Rainey in collaboration with Carlo M. Lerici of the Italian Lerici foundation (Rainey and Lerici 1967). The Greek colony was found to be located along the river Crati below a thick cover of alluvium. Palaeogeographical research indicates that the settlement bordered a lagoon that would have functioned as an inland harbor (tentative reconstructions in Bellotti et al. 2009, Fig. 2). Considerable progradation of the coastline since the Iron Age, although reconstructed in various ways, is responsible for the now more inland position of ancient Sybaris that at the time was certainly a coastal city like most other Greek and Phoenician colonies planted around the Mediterranean and the Black Sea. Archaeological materials collected at considerable depths from the over 1500 Rainey/Lerici corings and radiocarbon dating of sediments, done as part of the various environmental investigations referred to above, demonstrate continuous alluviation in the coastal plain of Sybaris following ancient occupation phases,
this renders archaeological surface survey a hopeless exercise. Fig. 4 shows the dated deposits in hand augerings carried out by the Groningen Institute of Archaeology in the plain. At certain locations we found that radiocarbon dates at a depth of over 7 m were not older than 2150 years BP. The regression line indicates an average sedimentation speed of 0.5 cm/year over the period 2100 to 450 BP and suggests that strong sedimentation stopped at about 450 BP. The number of dated augerings on the whole is still limited, as Roovers 2011 has stressed, and it is not possible to differentiate sedimentation processes in more detail over the plain, as is possible for the second case study presented below. However, a conclusion that can be made is that the sedimentation rates will differ according to the proximity of the rivers (Roovers 2011, 21). The calculations on average sedimentation speed are in line with similar estimates by Italian researchers (Cotecchia and Pagliarulo 1996; Cherubini et al. 1994).

In the Rainey/Lerici corings, datable archaeological layers with identifiable Archaic, Classical and Hellenistic or Roman materials were generally found at depths between 3 and 6 m, far below the level reached by modern deep-ploughing. Mapping the archaeologically relevant augerings in GIS in period maps, as illustrated in Fig. 5, gives an interesting but of course very partial insight in the rural development of settlement in the plain. In the sixth century BC, the city of Sybaris would already have been quite large and ruralisation low, but by the 4th c. BC, after the refounding of the city, then called Thurioi, the city had contracted, but ruralisation had increased (Roovers 2011). In the Rainey/Lerici corings in the plain only few Roman Republican or Imperial materials were found that can be related to the Roman colonia of Copiae. The plain appears to have been largely abandoned during this period, settlement in the foothills was also lower, as we have observed in systematic archaeological surveys along part of the foothills of the Sibaritide (van Leusen and Attema 2003).

2.2. The Pontine plain

The Pontine plain is located on the Tyrrenian coast in Central Italy and borders inland on the limestone massifs of the Lepini mountains in the north and the Ausoni mountains in the east (Fig. 6). It comprises a complex series of marine terraces on the coast and an inland lagoon, still open during the Bronze Age (Feiken 2014, 259–280 and Fig. 9.2 on the palaeography of the Pontine plain). The lagoon was gradually filled in with lagoonal sediments turning it into a swamp as the marine terraces impeded drainage of rivers originating in the hinterland and water coming from springs at the foot of the Lepini mountains (Kamermans 1991, Sevink et al. 1984). The swamp, today drained, became historically known as the Pontine marshes. Colluviation and alluviation in the plain notably affected those parts of the plain adjacent to the foothills of the Lepini and Ausoni mountains, but were also caused by rivers originating in the nearby Alban hills that deposited sediments in the northwestern part of the Pontine plain (Sevink et al. 1984, Attema and Delvigne, 2000). In the northeastern part, the Amaseno river deposited sediments burying parts of the ancient landscape, including that of the Roman period (van Joolen, 2003). Like in the Sibaritide, the landscape, as we perceive it today, is thus very different from that of antiquity, and in the Pontine plain sedimentation has likewise been an important agent of environmental change. However in contrast to the plain of Sybaris, sedimentation in the Pontine plain has only buried
parts of the archaeological landscape, and alluvial and colluvial deposits generally cover only the pre-Roman phases; Roman and later artefacts pertaining to ancient settlements in large parts of the Pontine plain (although not everywhere) will appear at the surface after ploughing while Roman built remains may still be visible on the surface (Attema 1993, Attema and van Leusen 2004, de Haas 2011). This means that, although to a lesser extent, the Pontine plain is influenced by a strong geomorphological bias as the archaeological surface record will highlight Roman occupation phases but underrepresent previous phases.

Below I will briefly discuss two areas in the Pontine plain, the lower Amaseno valley and the Campi di Sezze respectively. These areas are geographically near to each other, but show different sedimentation histories relevant to ancient occupation and land use potential (Fig. 7). Such investigations were carried out within the framework of the Pontine Region Project which, since the mid-1980s has studied the settlement and land use history of the Pontine region from the Bronze Age into the Medieval period (Attema et al., 2010, 31–58). On the basis of the sedimentological information obtained from hand augerings and radiocarbon dating of peat layers, several phases of (fluvio)-colluvial deposition could be reconstructed in the Amaseno basin dating between 1600 and 1400 BCE and CE 600–700 potentially burying archaeology (van Joolen, 2003, 68–84). In the plain below Sezze, radio carbon dated hand augerings likewise revealed a thick alluvial/colluvial sheet that covered the former landscape, but this sedimentation started earlier. Peaty deposits to depths of up to 6 m were dated to 2500 to 2200 BCE (Attema et al. 2010, 41–43; Feiken 2014, 196–200). The supply of sediments needed for this gradual transformation may be attributed to soil instability and consequent erosion in the Lepini and Ausoni mountains and in the Alban Hills. Palynological data from cores carried out in the plain point to increased human impact in all landscape units (van Joolen, 2003), while the chronology of sedimentation phases would in general terms correlate with increased settlement pressure in the wider landscape around the plain from the Middle Bronze Age onwards (Alessandri 2013 for Bronze Age settlement evolution). Sedimentation in the plain may thus have been caused by deforestation and subsequent grazing on the slopes of the Lepini and Ausoni mountains and the Alban Hills although the influence of climatic factors cannot be ruled out.
Nowadays, the Lepini and Ausoni mountains appear very eroded, and sediment supply in the plain of Sezze may have stopped in some areas during the Roman period. Excavations carried out by the Groningen Institute of Archaeology in the plain below Sezze at Tratturo Caniò revealed a succession of occupational layers, the earliest of which was found just above an ash layer attributed to the Vesuvius Avellino eruption dated shortly before 2000 BCE (Feiken et al. 2012; Feiken 2014). This ash layer has been observed in multiple corings and test pits in the Pontine plain (Sevink et al. 2011). Middle Bronze Age artefacts and ecofacts at Tratturo Caniò point to a settlement context indicating that by the beginning of the Middle Bronze Age the landscape bordering on the former lagoon had become sufficiently dry for permanent human occupation, though concentrated at certain attractive locations, such as relatively high and dry levees. Levels higher in the stratigraphy at Tratturo Caniò attested to occupation well into the Roman Republican period (Feiken et al., 2012; Feiken 2014; Attema forthcoming). Early Iron Age to Roman Republican phases showed a, possibly continuous, cultic use of the site, culminating in the erection in the Republican period of a small stone temple dedicated to the goddess Juno. In its surroundings intensive archaeological survey mapped a densely settled Roman countryside (Attema et al. 2014). The excavation at Tratturo Caniò however made clear how the Roman landscape visible in the plough soil was partly a continuation of earlier occupation phases not visible in the archaeological surface record due to alluvial and colluvial deposition following the initial Bronze Age occupation phase. At the same time, it makes clear how people adapted to changing environmental circumstances in the periods following the Bronze Age.

2.3. Local and regional variability in sedimentation regimes

The Sibaritide and Pontine plains show that both landscapes were dynamic environments due to alluviation and colluviation as a consequence of inland erosion. In this sense our examples can be said to be representative for the larger part of the coastal plains of the Italian peninsula (Attema and Sevink forthcoming). However, sedimentation histories appear to have quite different impacts on the visibility of the archaeological record. While in the plain of Sybaris, sedimentation covered the entire sequence of past occupation, in the Pontine plain this was more discontinuous and localised. Clearly sedimentation regimes are dependent on local geological circumstances, climatic changes and local episodes of human impact, and many more case studies from Mediterranean landscapes are available that reinforce this point (see e.g. Walsh 2014). While we must thus acknowledge local diversity in causes, effects and timing of sedimentation phases, there may be supraregional spatial and chronological patterning too, and more research should be done to correlate data on episodes of human impact with climate change now that in various studies Holocene climate changes are being described (e.g. Magny and Combourieu Nebout, 2013, Mensing et al. 2015). For instance, above we discussed the case of Tratturo Caniò in the Pontine plain; the challenge however will be to correlate this case with the many other observations done in the Pontine plain in order to arrive at a detailed long term regional picture of the interaction between man and his environment that includes Holocene climatic changes. As of yet, correlating the substantial body of environmental data from sedimentation studies and palynological research from the Pontine Plain with data relating to climate change is hampered by insufficient robustness of the available radiocarbon dates. The data from sedimentation studies and individual pollen cores have not yet been interconnected to carry out an integrated environmental study on the regional scale, though this is planned in current research of the Pontine Region Project. From our case studies it is clear that systematic research into the variable sedimentary regimes in order to map geomorphological bias is of the utmost importance for the evaluation of settlement patterns of any coastal landscape or river valley, and therefore should be an integral component in every landscape archaeological project. A second reason to study sedimentation and its origins, erosion, in archaeological survey projects is to obtain knowledge on the consequences of erosion and sedimentation for contemporaneous society, and how the phenomenon was perceived and dealt with in past societies.

3. Sedimentation as indicator of past sustainability of the Mediterranean landscapes of antiquity

Ancient agro-ecosystems, as Abbas Farshad (2002, 190) calls them, change “so gradually that they looked almost unchanged for centuries”. However, we know from environmental studies, as exemplified above, that erosion and sedimentation in certain landscapes were such that they must have had serious impact on the sustainability of ancient agriculture and subsistence strategies. Regional studies have shown that landscape change due to erosion and sedimentation in the Mediterranean occurred on the scale of centuries, most often due to intensification of land use in uplands and sub-mountainous zones, with climate change as an important factor too. Locally landscape change due to erosion and sedimentation could however have had short term consequences and may have taken the form of local catastrophic events, such as landslides, mudflows and lahars. An instance of a mudflow affecting the ancient landscape was mapped in detail in the Pontine plain and can be cited as an example of a short term, potentially catastrophic change (Attema 1993, 97–105). While Farshad (2002, 189) is right that knowledge of past environmental changes helps us to understand the dynamics, behavior, tolerance and resource potential of landscapes across time and space, and that this knowledge may be used for present-day strategies of land evaluation, it also informs us on the actual sustainability of ancient landscapes and the ways farmers dealt with
environmental change, or in the words of Kevin Walsh how ‘people understand and engage with their landscape and environment’. The latter scholar asserts that Mediterranean cultures do share certain forms of landscape-management strategies but acknowledges at the same time that ‘these strategies are contingent upon historical, cultural, and economic processes that vary across time and space’ (Walsh 2014, 7–8). Current cultural ecological approaches emphasize this relationship and are helpful in understanding the interaction between humans and their environments. Below I will explore this approach further, for which I again turn to the coastal plains of South and Central Italy.

Greek colonization on the shores of the Mediterranean was characterized by the founding of coastal settlements, many of which were quick to develop into sizeable port towns (Osanna 1992). In South Italy, Sybaris, situated on a slightly inland lagoon and river, is an eminent example of this. Clearly the population of these steadily growing cities had to be sustained by agricultural produce from the surrounding land. While initially the food demand would have been met by citizens working the land but living in the colonies, soon ruralisation of the surrounding countryside would have been necessary to meet the food demands of the expanding centre (Yoffee 2005, 60). This demand resulted in growing numbers of permanent rural settlements, villages, hamlets, farmsteads or a combination of these, producing food surpluses. This process must have started in the 6th century BC, as in the Metapontino with its Archaic farmsteads found below the alluvium along the Basento river, and in the Sibaritide with sporadic Archaic pottery from cores in the plain of Sybaris. From the abundant archaeological surface record dating to the Hellenistic periods, it is clear that successful expansion of rural settlement was dependent on hydrological technology to drain and irrigate the land, and implementation of canals led to successful rural exploitation (Carter and Prieto 2011, 1027–1051). Maintenance of hydrology was therefore imperative and dependent on a well-functioning socio-political organization. Joseph Coleman Carter has on the basis of his archaeological surveys convincingly shown how fluctuations occurred in the density of rural settlement during the Hellenistic period in the Metapontino and how already in the Roman period the intensive cultivation of the land was abandoned, due to a complex of political and socio-economic changes and subsequent environmental deterioration due to lack of caring for the land.

The same scenario can be sketched for the ruralisation of the plain of Sybaris where agriculture during the Hellenistic periods was widespread judging from the Rainey/Lerici corings with archaeological materials found in them. Apparently the produce from the plain, including that of the surrounding foothills, was capable to sustain the inhabitants of Thurioi, the successor city of Sybaris, with enough surplus for trading to bring in the capital needed to invest in the upkeep and embellishment of the city. But also in the plain of Sybaris farming was not sustainable in the longer term due to complex socio-economic, political and environmental factors. Already at the start of the Roman period, land was abandoned, while failing counter measures against the silting up of drainage canals led to the concurrent formation of extensive marshlands. Indeed, malaria ridden swamps were a common sight in the coastal plains of Italy from later antiquity onwards, a situation that only ended with the wholesale reclamation programs under Mussolini around the 1930’s when many of these swamps (both in Italy and...
elsewhere in Europe) were eliminated on a grand scale to be turned into agricultural land (Renes and Piastra 2011). Of the many projects, the reclamation of the Pontine Marshes is archaeologically and historically probably researched in most detail (Attema 1993, 28; Linoli 2005). Coastal plains like the plain of Sybaris and the Metapontino in antiquity, as well as in the recent past, were pre-eminently agricultural expansion zones with the more stable agricultural agro-ecosystems situated in the foothills. In the hills around the plain of Sybaris, for instance, settlement continued after the period of Hellenistic expansion, be it much reduced in terms of settlement numbers.

Also in the Pontine plain sedimentation caused landscape instability in the plain at various points in time and with spatial variability. Sedimentological and ecological investigations below the level of the Avellino ashes that covered the Pontine plain suggest that the surroundings of the fresh water lagoon were already cultivated well before the deposition of the ash shortly after 2000 BCE. However, at a later stage, at the end of the Bronze Age, alluvio-colluvial deposits would cover this particular part of the landscape, turning it into an unstable environment to live in, negatively affecting the Bronze Age wetland economy on the shores of the former lake. Judging from the archaeological evidence, occupation of the area around Tratturo Caniò remained possible, although settlement may have been intermittent. However, by the Roman period, the area, then either constituting farmland of the Roman colony of Setia, or land designated as ager romanus, was widely available for intensive agriculture, and a flourishing local economy developed here focusing on the production of wine and olive oil in the plain and foothills (Attema et al. 2014). At the same time the landscape along the lower Amaseno remained subject to environmental change for a longer period that extended well into the medieval period.

As such, the Pontine plain is a pre-eminent example of an agricultural expansion zone in a vulnerable landscape. Like in the coastal plains of South Italy colonized by the Greeks, attempts were also made in the Pontine plain to reclaim the area for intensive cultivation, here slightly later, during the mid-Republican period, and in this case the Romans (Walsh et al. 2014). While farming the Pontine plain initially may have been successful, as elsewhere, it was not sustainable, and we have evidence that the situation in the graben deteriorated by the end of the Republican period. In addition, here the plain became covered in swamps, again most likely due to lack of maintenance of the drainage works that initially had made settlement and intensive agriculture possible, but now led to the formation of marshes (Walsh et al. 2014).

On the one hand, the above case studies show that landscape-management strategies are indeed contingent upon historical, cultural, and economic processes that vary across time and space, as Walsh asserts, but also that we, through comparative research, may start to discern patterning in sustainable and unsustainable landscapes and landscape-management strategies in ancient Mediterranean landscapes. To study the phenomenon of episodic intensive cultivation cycles in the Mediterranean coastal plains, we clearly need extensive detailed sedimentological research of past drainage systems in combination with absolute dating of their initial construction, use history and their final

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Fig. 7. Map showing locations of cores in the ‘Campi di Sezze’ area (white dots) and the lower Amaseno river valley (black dots with white outline) and sediment cover (after Fig. 2.4 in Attema et al. 2010). The numerals 2–4 indicate various phases of sedimentation in the lower Amaseno valley.
References

Abbott, J.T., 1997. Late Quaternary Alluviation and Soil Erosion in Southern Italy (PhD dissertation) The University of Texas at Austin.


Alessandri, L. 2013. Lithium venus in the bronze age and early iron age/Li lithium venus nell’età del bronzo e nella prima età del ferro. BAR International Series 2565, Oxford.


Attema, P.A.J. Palus or ager, changing perceptions of the economic landscape of the Pontine Region (South Lazio, Central Italy) (forthcoming).


