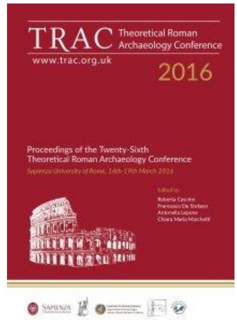


Paper Information:

Title: Studying Evolving Landscapes: Geomorphology as a Research Tool for Landscape Archaeology
Author: Kevin Ferrari
Pages: 115–132

DOI: http://doi.org/10.16995/TRAC2016_115_132
Publication Date: 23/03/2017

Volume Information:

Cascino, R., De Stefano, F., Lepone, A., and Marchetti, C.M. (eds) 2017. *TRAC 2016 Proceedings of the Twenty-Sixth Theoretical Roman Archaeology Conference*. Rome: Edizioni Quasar.

Studying Evolving Landscapes: Geomorphology as a Research Tool for Landscape Archaeology

Kevin Ferrari

Introduction

A fundamental aim of landscape archaeology is to analyse how environmental conditions and geomorphology influenced the location of ancient sites and their spatial organisation. Settlement distribution has always been influenced by geomorphology and we can identify some recurrences attributable to historical periods, geographic zones, military and economic conditions, and finally anthropogenic environment management.

Geomorphology has important impacts on several aspects – it influenced the spatial distribution of settlements, the urban planning of cities, and the organisation of the landscape via the construction of roads, canals, and other infrastructure. Physical geography is dynamic and can be subject to significant evolution. The security and stability of a city and its settlement pattern are strictly connected to efficient territorial and spatial planning (see Dall'Aglio 2009; Walsh 2014). The same elements could also condition the evolution, and even the possible development, or decline, of the settlement system. Through studying geomorphology we can also identify which locations were usually preferred, and we can obtain maps of archaeological potential, allowing us to better predict the location of previously undiscovered sites.

Our attention will be especially focused on Roman colonisation in Italy during the Republican period – a phenomenon that involved complex cultural, economic, political, and strategic aspects. The foundation of new cities was one of the means through which the Romans spread their culture and attempted to control subdued territories (for further considerations concerning the Roman Republican colonisation see Bradley 2014 and Pelgrom 2014). The *deductio* of new colonies was associated with the organisation of the neighbouring territories with actions like the creation of roads, centuriation, land reclamation, and river control. Cities were inextricably connected to the territory and the neighbouring environment. A study of Roman colonisation could not disregard what the geographical context was and what impact on the landscape these operations had.

However, knowledge of the modern landscape does not allow us to fully understand the real connection between geomorphology, environmental conditions, and anthropogenic activity because it is vastly different from the ancient reality.

Thus, we should aim to reconstruct the ancient landscape in order to better understand how the Romans may have been conditioned by natural elements in their planning activities. The evolution of the landscape, especially erosion and alluvial deposition, could also influence our potential to find archaeological indicators of settlement and human activities, and could thus affect our interpretations.

Geomorphology and Recent Environmental Transformations

The current landscape shows many traces of the ancient one. By analysing aerial photos, ancient maps, and with the assistance of specific geological research we can identify the specific temporal points at which certain transformations took place and how they conditioned human activity and settlement patterns. We can also highlight also the mutual influence between anthropisation and environmental conditions. Human activity had a significant impact on the landscape and could be considered alongside morphogenetic factors like natural events. The focus of this paper will be fluvial environments like alluvial and river delta plains, because, thanks to their particularly pronounced dynamic nature, we can analyse and highlight these processes with particular evidence (Fig. 1).

We can offer some examples of environmental transformations that took place in the recent past, when human influence was stronger than in the previous centuries. A good example is the evolution of rivers. A river channel position shift occurs when the main channel of a river abruptly changes its course. Meandering and braided rivers are especially vulnerable to such shifts. A shift in river channel position has large impacts on local ecology, economy and society, especially through impacting the availability of water, which is important for agriculture and transportation. Only enormous engineering works can prevent a river from switching to a new channel, or restore a river to its former course. However, such efforts are very complex and costly. We cannot disregard the impact that these transformations could have had on the settlement pattern.

In the central area of the Pianura Padana, in the north of Italy, we can identify several traces of successive river transformations (from geological to historical periods) as the palaeo–channels of the Adda River, Oglio River, and Mincio River on the Pleistocene level of the plain (Marchetti 1990), but some changes were more recent (Fig. 2). The Serio river, for instance, in Roman times was further east than now, in correspondence to the current channel known as Serio Morto, and separated the *ager Bergomensis* from the *ager Cremonensis*. In Late Antiquity the deterioration of climatic conditions and the reduction of human influence produced significant environmental transformations, including the Serio River's abandonment of its riverbed (Ferrari 1992) (Fig. 2). We can find another example in the Crati river delta plain, in Calabria. Close to the river mouth was the location of the ancient city of *Sybaris – Thurii*. The river flows into the sea with a single channel, but the ancient Greek and Latin texts tell us that originally the colony was between two rivers that flowed into the sea separately. The hydrography of the plain was subject to radical modifications, and today the Coscile River (the ancient Sybaris), that originally had a separate mouth, flows into the Crati upstream (Bellotti *et al.* 2009) (Fig. 3).

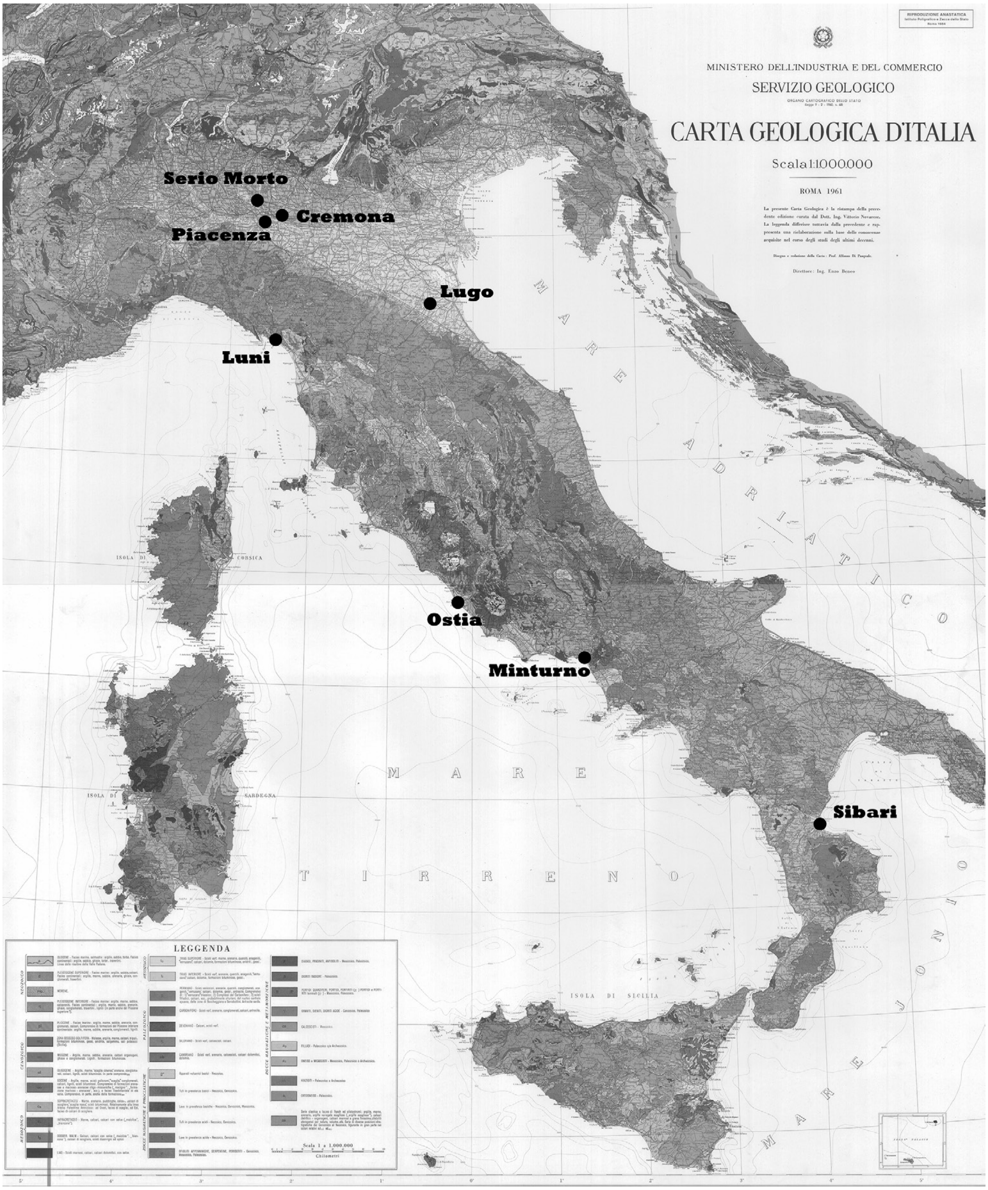


Figure 1: Map of the area mentioned in the text.

Geomorphology and Landscape Archaeology: Some Theoretical Considerations

From a theoretical point of view, the scientific debate on landscape archaeology primarily concerns the methodologies that could make this discipline as scientific and objective as possible, i.e. archaeological survey and geoarchaeological/palaeoenvironmental analysis (a very good synthesis of these kinds of studies is Walsh 2014).

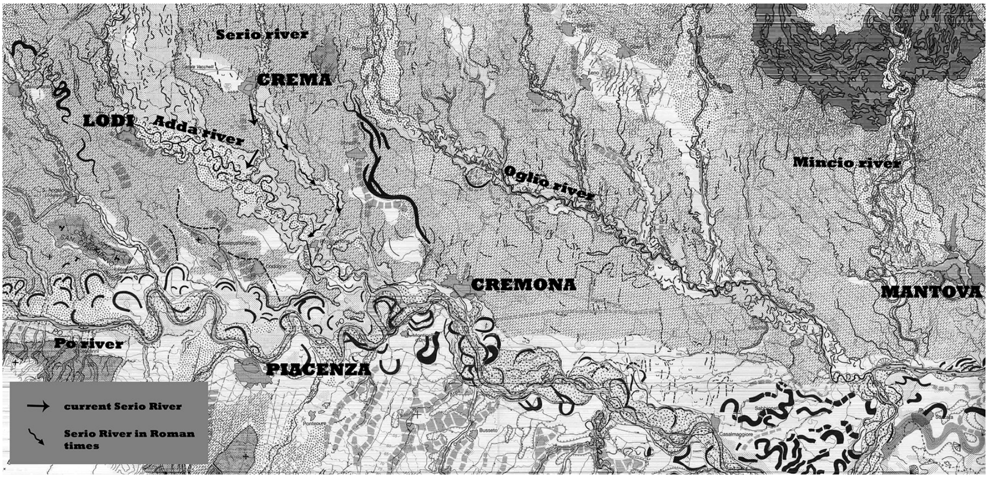


Figure 2: Geomorphologic map of the Pianura Padana (after Carta Geomorfologica della Pianura Padana*, Ministero dell'Università e della ricerca scientifica e tecnologica 1997; scientific project: Giovanni B. Castiglioni).*

Unfortunately, transformations of the physical geography like erosion or alluvial deposits could affect our methodological approach, and our interpretations. Knowing the number, typology, and chronology of the sites we can identify with archaeological survey are not necessarily entirely representative of the ancient situation. The previously mentioned Crati River delta plain is a good example. Sybaris (later *Thurii–Copia*), founded at the end of the eighth century B.C. near the river mouth, was abandoned between the end of the sixth and the beginning of the seventh century A.D. and disappeared under metres of alluvial deposits. Archaeological excavations found the Hellenistic levels about four metres under the ground level, and the archaic structures about five to six metres down. In the 1960s a campaign of specific research (geophysical and geological investigations and archaeological survey) extended to the whole plain and the nearest hills to locate the still undiscovered Greek city (Lerici and Raynei 1967; Quilici *et al.* 1969). The plain was almost totally lacking archaeological evidence on the ground level, but the absence of data does not imply the absence of settlements in the plain. Some geological cores found fragments of Greek–Roman pottery between four and eight metres underground. Moreover, we can identify similar situations also in the Pianura Padana, especially south of the Po River. A detailed geoarchaeological research project on the plain near Lugo (not far from the ancient *Faventia*) showed how the Roman layers were buried under at least four to five metres of sediments (Franceschelli 2008: 83–86). In similar contexts, we can see how the thickness of the alluvial deposits makes archaeological survey misleading and consequently we have to adopt different strategies (Dall'Aglio and Marchetti 1991). Erosion through destroying traces of human activity or bringing to light archaeological evidence usually buried under alluvial deposits (for instance when the river erodes new scarps), could affect our interpretations too. Moreover, if the fragments and the objects we can find with survey give us significant information, sometimes they do not represent all the chronological/typological complexity of the site.

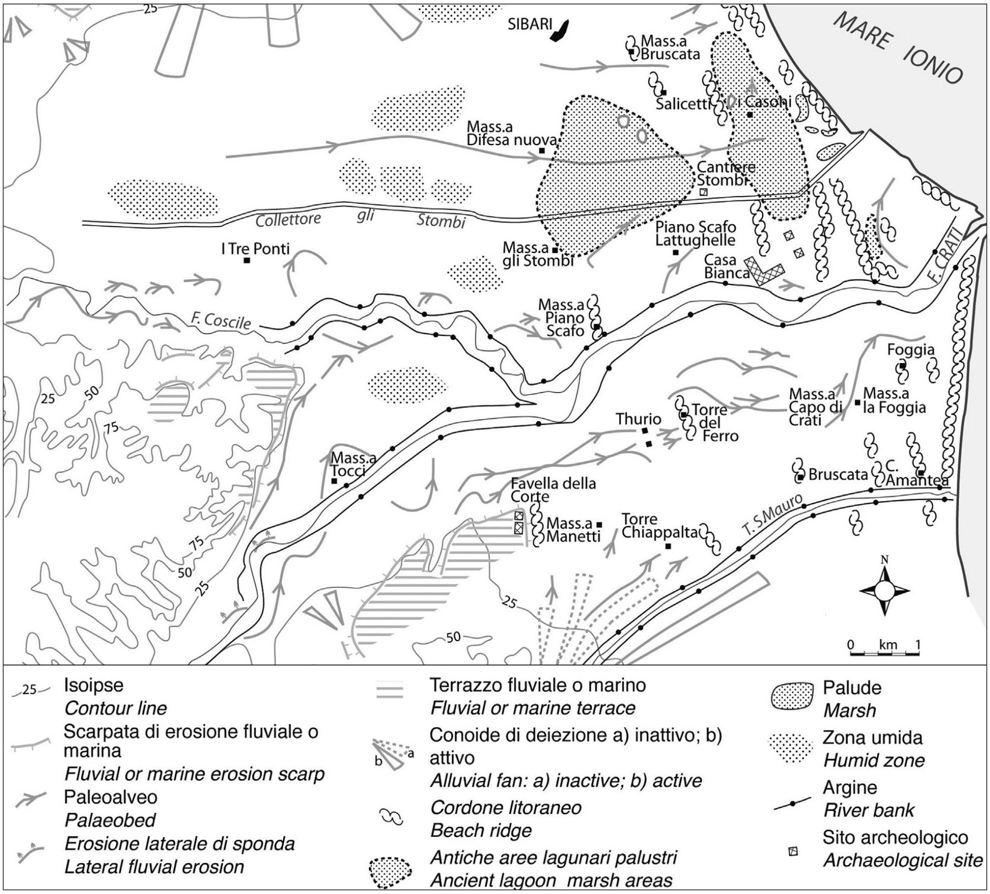


Figure 3: Geomorphologic map of the Crati river delta Plain (Bellotti et al. *2009: fig. 1).*

Archaeological survey is the most common approach used in landscape archaeology, but the dynamics described above make it insufficient to reconstruct the colonial landscape, therefore we have to adopt a multidisciplinary approach, based on the study of ancient cartography, aerial photos, the use of ancient Greek and Latin texts, the analysis of toponymy, epigraphy, and topography integrated with geological and palaeoenvironmental studies. All these elements allow us to give a more vivid and complete reconstruction of the ancient landscape when we have abundant archaeological data, but they can also help us to fill the gap in presence of insufficiency of this type of data.

For instance, the apparently contrasting description of the Battle of the Trebbia given by Polybius and Livy, allows us to imagine a different course of the river in 218 B.C., information that we could not otherwise infer from archaeological or geological data (Marchetti and Dall'Aglio 1982). Furthermore, the reconstruction of the evolution of the urban planning of Cremona and *Placentia* is not possible only with archaeological or geomorphological data because we do not have any evidence of the last quarter of the third century B.C. However, moving from a topographical analysis of the urban channels, we can hypothesise the existence of a first *castrum* built in 218 B.C. and replaced in 190 B.C. (second dedication of the colony) with the *forma urbis* that has survived to this day (Dall'Aglio *et al.* 2008; Dall'Aglio *et al.* 2011a).

The case of the Garigliano river delta plain (the river near the Roman colony of *Minturnae*, in southern *Latium*) is another good example of this integrated approach. This research, focused especially on the reconstruction of the ancient coastal landscape, was based on the analysis of all the available data: cartography, aerial photos, geological cores, pollen analysis, archaeological survey, and a detailed analysis of literary references (Ferrari *et al.* 2012). Thanks to the geologic and palaeobotanical investigations (a combination of manual auger cores and continuous mechanical drillings with sedimentological, malacological, and pollen analyses) we could identify all the most relevant phases of the delta evolution since the beginning of the Holocene and reconstruct what the ancient environment was (Ferrari *et al.* 2013b; Bellotti *et al.* 2016). *Minturnae* was founded at the beginning of the third century B.C. but there were different interpretations about the nature of the wetlands in that time. Some scholars believe that the northern basin could have been used like a harbour, others hypothesised that the area was reclaimed and centuriated (Ruegg 1995: 133; Andreani 2006; Ferrari 2016: 168–173).

In the Greek and Latin texts, we have several detailed descriptions of the marshes near the colony of *Minturnae* that we could compare with our palaeoenvironmental analysis. The use of a lexicon typical of a marsh (λίμνη; ἕλος and *palus*) finds correspondence with the presence of levels of silt and pollen of aquatic plants and shows that the area was characterised by swamps with shallow water basins and muddy soils that were rich in vegetation (reeds and aquatic plants), with Salix and Quercus dominating the arboreal plants (Ferrari *et al.* 2013a; Ferrari *et al.* 2014) and that the coastal wetlands could not be centuriated or used like harbours. In the Imperial period the river was under control and the water of these lakes was limpid and oligotrophic and, even though the Romans had the ability to reclaim it, especially the northern basin, they did not. Such a vivid reconstruction of the landscape and the solution of some long–standing questions was possible thanks only to this methodology.

In conclusion, to collect as much information as we can on the interaction between humans and landscapes, we have to broaden our approaches by both considering geoarchaeology a fundamental instrument but also taking into consideration equally all the available data.

Geomorphology on Anthropised Landscapes

Geomorphology and its Impact on the Settlement Distribution

Before the Roman period the settlement distribution was strictly influenced by natural elements like rivers, lakes, and wetlands. During the Roman period human influence on the landscape became more efficient and allowed the reclamation of new lands and to control rivers. Roads, channels, and the infrastructure linked to land distribution became important catalysts for new settlements. Some areas could be inhabitable only with permanent measures, and were consequently abandoned in the Late Antiquity, when human influence became weaker.

Two notable examples are worthy of consideration. Near *Minturnae*, the first stable settlement known is a village on the top of a rocky promontory (Monte d'Argento) that was in use from the Late Bronze Age to the Iron Age. In the Late Bronze Age, the marshes and coastal lakes were bordered by small sites, characterised by spreads of pottery but without structural evidence (Fig. 4). These settlements were placed along the Pleistocene beach ridges close to the wetlands, but they were probably abandoned from the end of the Bronze Age. The Roman colonisation changed the settlement pattern radically. The countryside was characterised by the diffusion of a lot of small farms usually placed inside the Pleistocene dune and not far from the most important roads. The Garigliano was used to connect the sea and the land, and several rural settlements were located along the river. The exploitation of the region culminated between the second century B.C. and the second century A.D., after this century there was a drastic decrease in archaeological attestations (Ferrari *et al.* 2012; Ferrari 2016: 159–177).

The situation near the Serio valley is another good example of the impact of geomorphologic units on settlement distribution (Dall'Aglio *et al.* 2010). The area between the Adda River and the Serio River is characterised by three orders of fluvial terraces, corresponding to different periods of fluvial activity. The preferred units in the Bronze Age and in the Middle Ages, when the management of the environmental conditions was more difficult, were the most ancient fluvial terraces, not involved by alluvial events, and especially the scarps that separated the different orders of the terraces. Even today, the most important urban centres of the region, probably originating in the Middle Ages, are located on the border of the terraces in order to control the underlying zones and to use the scarps for defensive purposes. In contrast, in the Roman period the centuriation and the creation of a road system led to a widespread diffusion of farms and little settlements.

The analysis of the toponyms shows that the geomorphology influenced also the continuity of settlements (Fig. 5). Almost all of the toponyms that originated from the Roman period are on the more ancient and stable terrace. The second order of terraces, where the centuriation is less preserved, commonly contains towns whose toponyms come from natural elements or medieval activities of reclamation. This area was abandoned in Late Antiquity because of its environmental instability and was again permanently occupied only in the Middle Ages. Hydrographic and environmental instability in this area, especially in the current Adda river valley, had a great impact on the landscape. Due to river instability marshes and wetlands were so widespread that the higher terrace took the name of an *insula* (*Insula Fulkerii*) and the neighbouring wetlands took the name of a lake (Gerundo Lake – Dossena and Veggiani 1984).

Geomorphology and its Impact on the Location and the Urban Planning of the Roman Colonies

Geomorphology also influenced urban planning. The case of *Placentia* and Cremona is interesting - two Latin colonies in the Middle of the Pianura Padana founded in 218 B.C. to control the area of the *Boii* and the *Insubres*, becoming the bridgehead of the following Roman expansion in the northern Italy (Dall'Aglio *et al.* 2011a; Dall'Aglio *et al.* 2011b). They

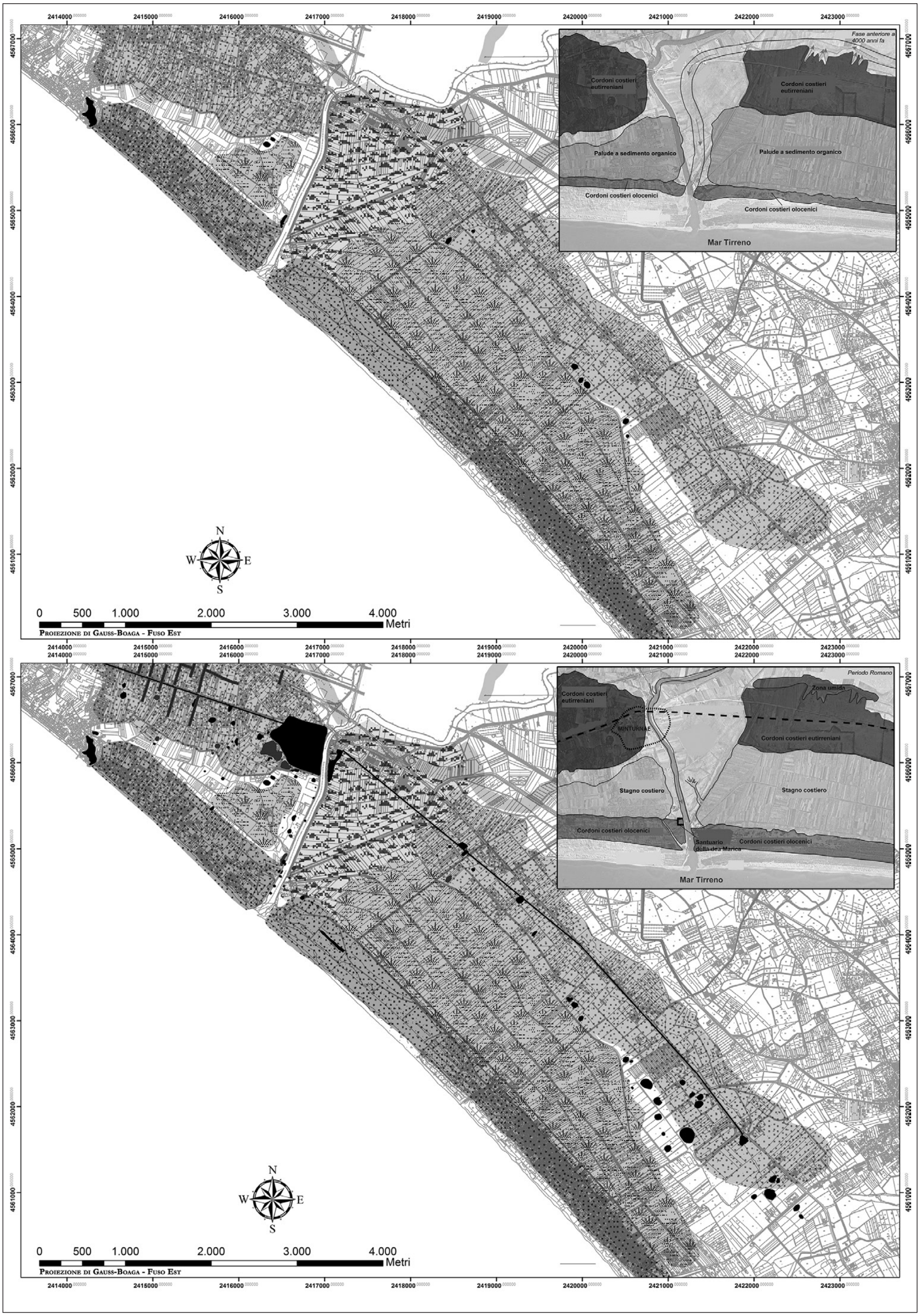


Figure 4: Archaeologic map of the coast near Minturnae *(Pre Roman and Roman periods– Ferrari 2016: fig. 66, 67).*

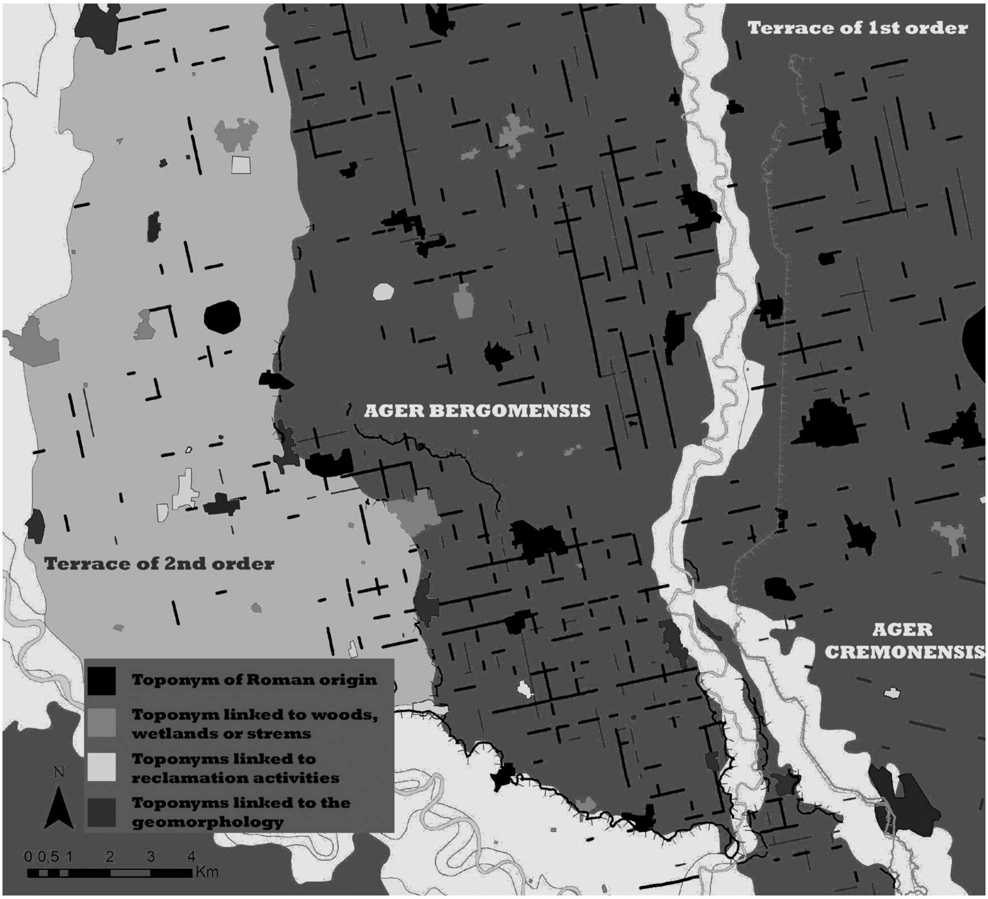


Figure 5: Distribution of toponyms between Adda river and Serio river.

were founded on the course of the river Po to control two very important crossing points of the river. The Po River flows into a valley delimited by scarps of irregular width. Where the river was more stable, the valley is narrower and it is easier to cross the river, and Cremona and *Placentia* were placed in correspondence to two of these geomorphologic bottlenecks.

Placentia was placed on the border of the scarp of a Pleistocene terrace south of the river and controlled the ford of the Po and Trebbia rivers. In 218 B.C. the Trebbia had a different riverbed and flowed into the Po east of the city, and the famous battle of Trebbia took place when the river was still in its ancient position. It probably changed riverbed before the beginning of the second century B.C. when the Romans completed the definitive organisation of the territory.

Analysing the digital terrain model of the city, we can identify several pieces of geomorphologic evidence (Dall'Aglio *et al.* 2007; Dall'Aglio *et al.* 2008; Dall'Aglio *et al.* 2011a; Dall'Aglio *et al.* 2011b; Dall'Aglio *et al.* 2012): two ancient Holocene meanders of the River Po north and west of the colony eroded the Pleistocene terrace giving it a particular shape expanding outwards; the ancient river bed of the Trebbia and the valley of the ancient meander of the Po river border the southern and eastern side. *Placentia* was placed on the border of this Pleistocene scarp to control the underlying river Po and occupy the higher area of the terrace between the just described evidences. In the current urban planning we can identify the original scheme of the Latin colony and we can verify that the ancient city conformed perfectly to the geomorphology. Two sides of the city correspond to the scarps of the Pleistocene terrace of the Po River (northern and western sides) and the western district of the city is not regular because the walls were placed exactly on the border of the scarp (Fig. 6 B).

Cremona was placed north of the river, on the border of a Pleistocene fluvial terrace known as *Livello Fondamentale della Pianura*, exactly where the terrace, eroded by the river meanders, expands outwards into a sort of peninsula (Dall'Aglio *et al.* 2011a; Dall'Aglio *et al.* 2011b; Dall'Aglio *et al.* 2012). Analysing the digital terrain model of the city, we can identify the scarps of the Pleistocene terrace and we can see that the colony took up the whole area between the two Po meanders and the valley of another little stream, the Cremonella, whose ancient riverbed was east of the city. Natural elements did not delimit the northern side, therefore the Cremonella was diverted and was used to mark the northern limit of the city, while the ancient riverbed continued to border the eastern side. The shape of the city was not a regular square as we might expect, moreover, the southern side had a curved outline because the walls conformed to the border of the scarp (Fig. 6 A).

Even though we can identify recurring elements in the urban planning like the division in regular blocks, the real shape of these cities was not completely geometric and conformed to the geomorphology. Moreover, the combination of walls and scarps made the defensive system more efficient than elsewhere.

Colonies near the mouths of rivers were founded with consideration of the specific environmental conditions of the coast. The challenges were different, particularly the coastal progradation and the occurrence of wetlands. For example, *Minturnae*, a Roman colony mentioned by Livy among the maritime colonies (Livy 27.38.3-5), was located on a Pleistocene

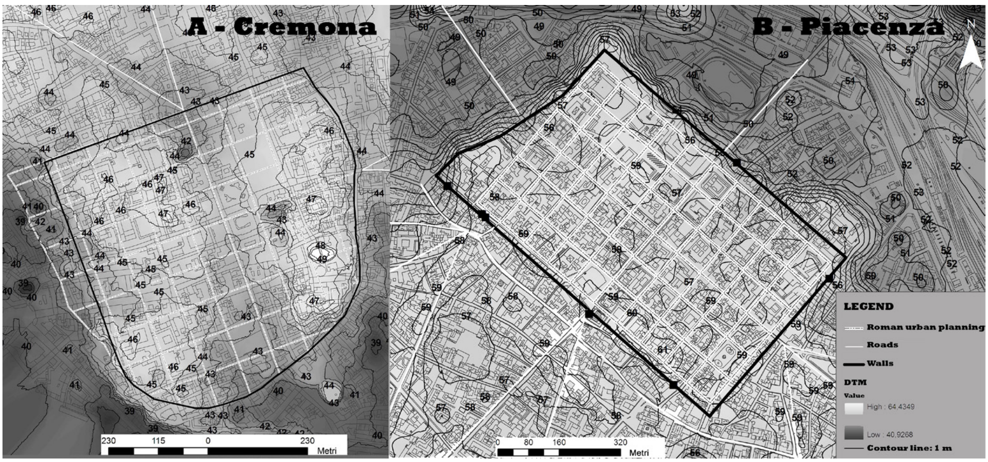


Figure 6: A: Digital terrain model of Cremona (Dall'Aglio et al. 2011a: fig. 12); B: Digital terrain model of Placentia *(Dall'Aglio* et al. *2011a: fig. 2).*

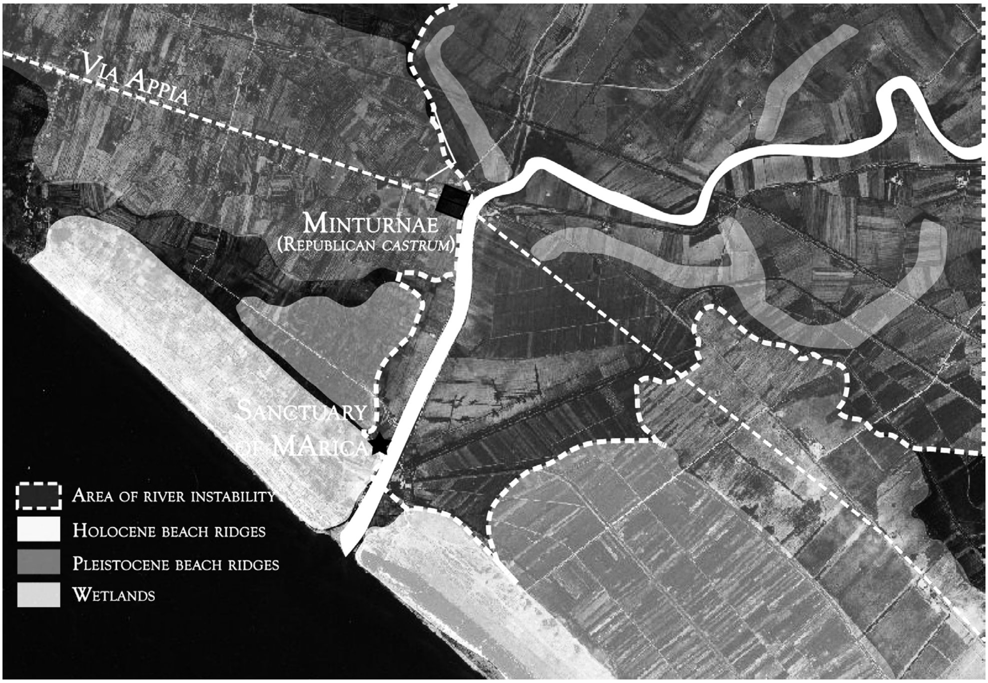
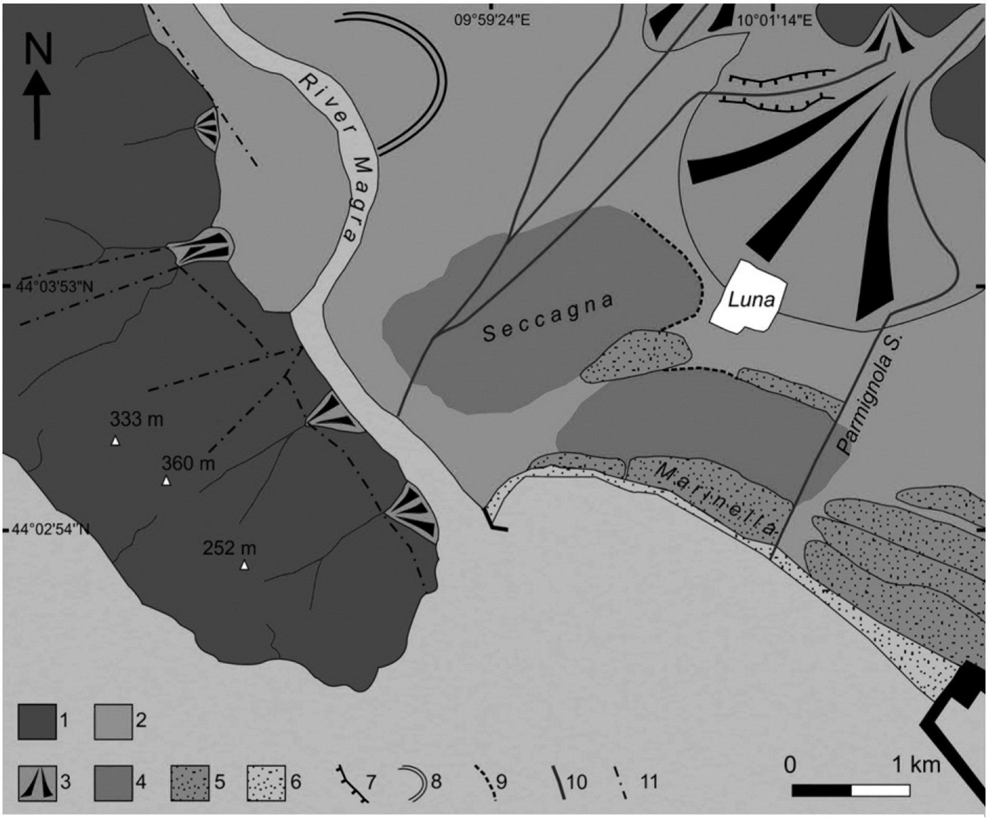


Figure 7: Geomorphology of the Garigliano river delta plain near Minturnae.

beach ridge where the Via Appia crossed the river and close to the river mouth and the coast, occupying a higher position than the neighbouring plain and wetlands (Fig. 7). The road passed through the region near the coast, on the top of the Pleistocene beach ridge dunes and crossed the Garigliano in correspondence to the unique point where the dune was cut by the river, i.e. where it had greater stability. The city was not directly on the shoreline because it had to control the ford of the river, because the coastline was occupied by wetlands, and because the Holocene beach–ridges were not large enough to allow the building of a city. In any case *Minturnae* was on the right bank of the Garigliano with a rich river harbour and had a landing place near the river mouth (Sanctuary of Marica). In the Imperial period the city expanded, but only within the boundaries of the Pleistocene beach ridge (Ferrari *et al.* 2012; Ferrari *et al.* 2013b; Ferrari 2016).

Lunae is a different case. The Romans built the city on the border of the alluvial plain, on the top of an alluvial fan. The reconstruction of the original landscape was of the subject of debate. Some scholars hypothesised that *Lunae* was directly on the sea and that the shoreline conditioned the shape of the city. Recent palaeoenvironmental studies demonstrated that the indentation in the southern city wall, demonstrated by the archaeologists and based upon the ancient cartography, cannot be due to an articulation of the coastline (Bini *et al.* 2009; Bini *et al.* 2012) (Fig. 8). In fact, the shoreline never attained a far landward position, or at least a fringe of land of 20 m south of the city walls was occupied by a floodplain throughout the Holocene. The evolution of the southern and western basins was reconstructed in detail both stratigraphically and chronologically. If an important harbour, consistent with the evidence



Geomorphological setting of the study area: (1) bedrock; (2) alluvial plain; (3) alluvial fan; (4)wetland (remains of water basins representing possible harbours locations); (5) beach ridge; (6) present-day beach; (7) torrent scarp; (8) palaeochannel; (9) innermost penetration of the Holocene transgression; (10) main stream and/or channel; (11) main fault.

Figure 8: Geomorphological setting of the area near Lunae *(Bini* et al. *2012: fig. 3).*

bequeathed by ancient historians (Strabo 5.2.5), existed near the city of Luna, it probably lies in the western water basin but at least 250 m from the city walls, whereas the southern lagoon was too small and closed for hosting an important harbour.

Ostia is more similar to *Minturnae* than *Lunae*, because the city was directly on the river and was built on the top of a system of beach ridges from where its inhabitants could control the mouth of the river, the neighbouring lagoons and coastal lakes, maritime traffic and the road towards Rome. Geomorphology can allow us to see the question concerning the origin of the colony in a new light (Bellotti *et al.* 2011) (Fig. 9). Around 640 B.C., the beach–barrier separating the Ostia marsh from the sea was still too narrow and unsafe against storms and/or river mouth migrations for permanent human occupation so that in the seventh century B.C. there could only be an outpost with the purpose of controlling the strategic river mouth and, possibly, setting up salt extraction from the marsh. Only subsequently, around 450 B.C., when the cusp extended more than 1 km seaward, the available sandy land was wide and safe enough to set a fortified camp (*castrum*) and develop saltworks.

Geomorphology and its Impact on Centuriation and Land Division Systems

Geomorphology conditioned also the organisation of land division systems like centuriation (Dall'Aglio 2009). The security and the stability of a city and its settlement pattern were so strictly influenced by a correct territorial planning that, even though the land surveyors hypothesised a theatrical centuriation *secundum coelum*, almost everywhere the land division conformed with the natural environment (*secundum natura loci*) and the hydrography (Dall'Aglio *et al.* 2014). Rivers were frequently used as borders and neighbouring territories could be often characterised by different orientations of their *limites* so that, sometimes, we can locate ancient riverbeds identifying the contact points between *limites* with different directions. Additionally, sometimes the *ager* of a same city could show differently oriented blocks because the land surveyors conformed their activities to the local geomorphology, as we can see in the *ager Placentinus* (Tozzi 1990) or in other river valleys of the Marche (Campagnoli and Giorgi 2009). Moreover, the most dynamic areas were excluded from centuriation, as we can see in the *ager Cremonensis*, where the traces of *limites* are only on the older order of terraces and not in the Holocene valley of the tributaries of the Po (Vullo 1995).

Erosion and alluvial deposits also have an impact on the transmission of the centuriation. In the current landscape, we can identify several traces but the ground level of the Roman period is often buried under metres of alluvial deposits. Over the centuries alluvial events tend to

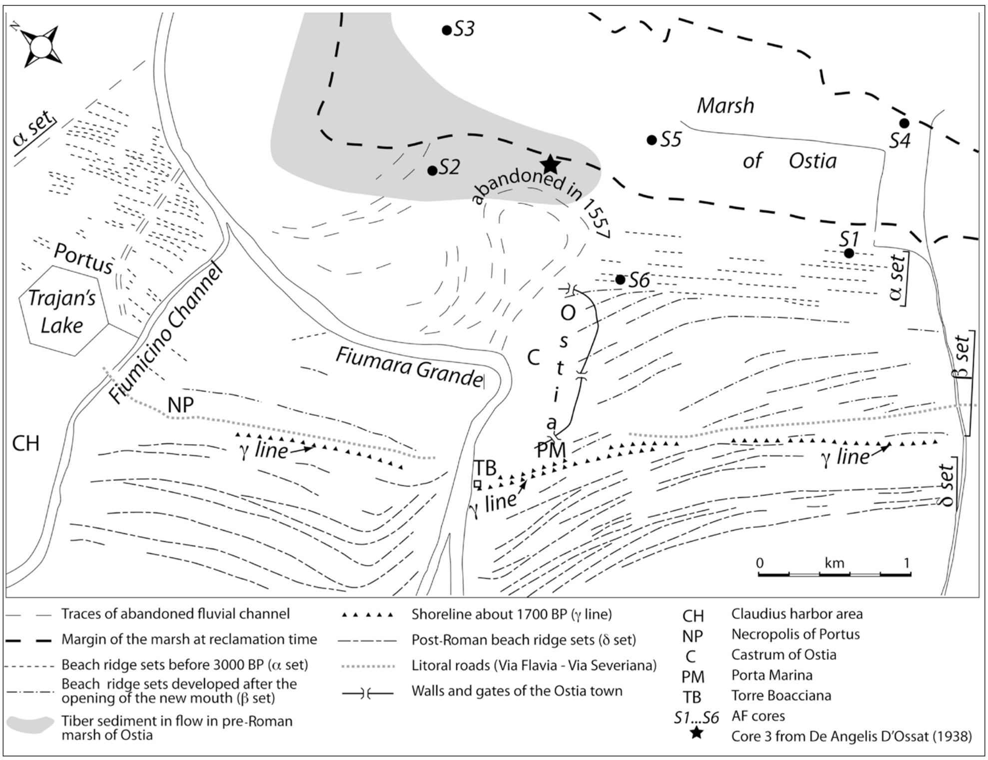


Figure 9: Morphological features of the Tiber river delta plain (Bellotti et al. *2011: fig. 3).*

bury under sediments and erase channels and roads, but often they are reactivated in the same place (a good example is given by Berger and Jung 1996). Scholars used to discuss 'preservation', that is to say that the traces of centuriation maintained over the centuries. However, it is not correct to use the term 'preservation' because we are not in front of ancient infrastructure that stayed in place since the Roman period through the principle of inertia or because they were useful. Recent hypotheses are based on the concept of resilience, i.e. the capacity of a system to respond to a perturbation or disturbance by resisting damage and recovering quickly (Marchand 2003; Robert 2003; Chouquer 2008: 868–874; Brigand 2011).

The research conducted in the plain near Lugo, north of Faenza, could show clearly this process (Franceschelli and Marabini 2007; Franceschelli 2008). The analysis of the centuriation was integrated with geological cores that found the Roman levels at a depth of four to five metres, beneath layers of wetlands dating to the Middle Ages. Because of this discontinuity, the traces of centuriation that we can identify on the ground cannot be the effect of preservation but were probably restored according to the principle of resilience. The area was subject to environmental instability in Late Antiquity and several zones of the plain were abandoned and became wetlands. In the Middle Ages these areas were reclaimed again and, starting from the neighbouring zones where the centuriation was preserved, some infrastructures were renovated creating a sort of new centuriated landscape.

The area between the Adda and the Serio River can give a different example of the environmental dynamics that conditioned the continuity of the traces of centuriation (Dall'Aglio *et al.* 2010). The *cardines* in the southern *ager Bergomensis* are more preserved than the *decumani*, because they were useful to drain a large area full of natural sources. As previously stated, in this area we can identify three orders of fluvial terraces. All of the best-preserved traces of centuriation are on the higher and older terrace. The second order of terraces was centuriated, but it was characterised by a greater environmental instability and the ancient *limites* are less recognisable (we can identify more traces of palaeochannels and more toponyms typical of an uncultivated area). After the demographic crisis of Late Antiquity, several settlements were abandoned and people disregarded the management of infrastructures so that the more unstable areas get back in wetlands or woods (Fig. 10).

Geomorphology as Result of the Interaction between Human Activities and Environment

Human activities had also a direct impact on natural transformations and could be considered morphogenetic factors like natural events. A good example could be the relationship between land reclamation, activities of river control, and progradation of the coastline. The analysis of the beach ridges allows us to reconstruct the continuous progradation of the coast because of the transportation of fluvial sediments. A specific study of this process highlighted that the progradation was faster when human activity inland was more significant (Anthony *et al.* 2014). Reclamation and deforestation combine to increase the quantity of sediments in the rivers and the construction of river-banks prevent overflowing; therefore, the rivers transport more sediment to their mouth.

We can see an example of this process in the Pianura Padana (Marchetti 2002: 367–368; Simeoni and Corbau 2009). This plain was characterised until the first quarter of the second

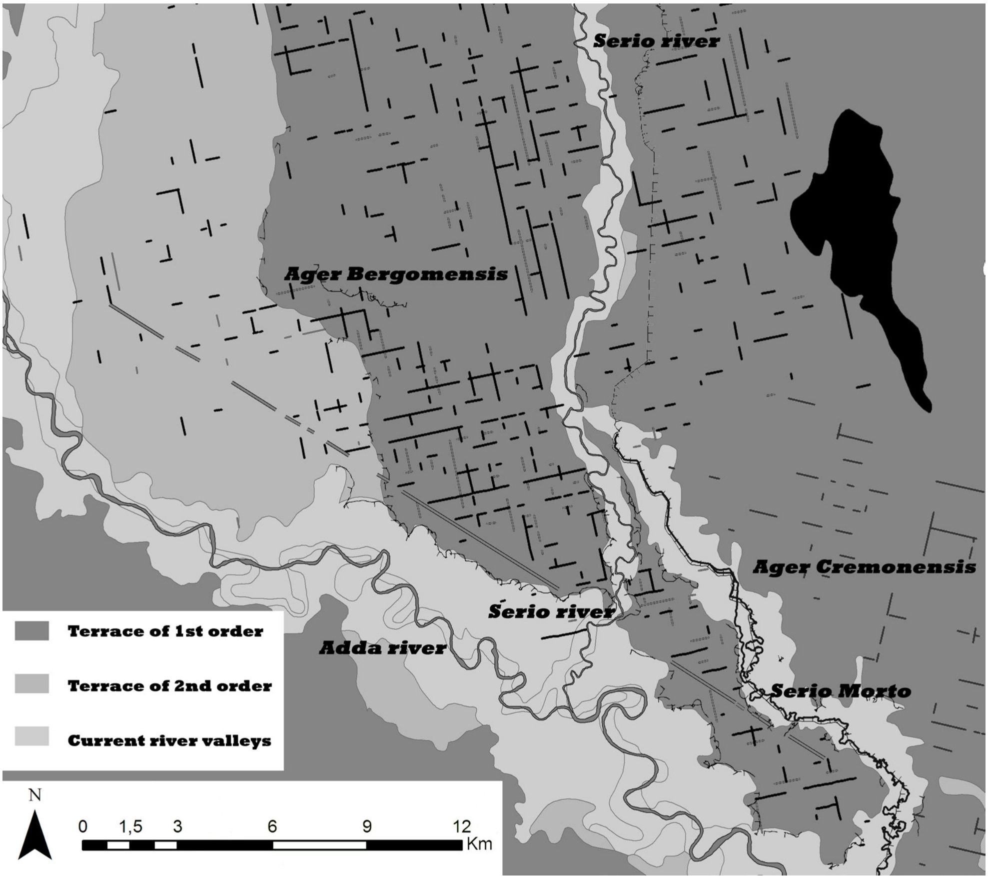


Figure 10: Traces of centuriation between Adda river and Serio river.

century B.C. by the occurrence of woods and wetlands. During the second century Romans founded a lot of colonies and gave lands to the settlers. Almost all of the area between the hills and the Po River was centuriated and the rivers were embanked. The analysis of the beach ridges and the descriptions of the river mouth given by Greek and Latin writers (Polybius II, 16, 7–12; Strabo V, 1, 5–7; Pliny III, 119-122) allow us to highlight an acceleration of the process of coastal progradation during the Republican period, when human activities inland had a greater impact (Alfieri 1994: 14–15; Dall'Aglio 1994: 60–62). Therefore, Roman colonisation created a new landscape.

Conclusion

Geomorphology is very important to understand Roman colonisation and, more generally, to reconstruct the origins and the evolution of the landscape. We can identify which geomorphologic units were preferred by settlers (for instance the scarps of fluvial terraces, river point bars, alluvial fans, or beach ridges) and how the ability to control the environment influenced the diffusion of settlements. The preservation of settlements and infrastructure is conditioned by environmental evolution and by the human ability to face them. By using the multidisciplinary approach described above we can reconstruct the original environment, we can highlight the impact of human activities on the landscape or the influence of natural transformations on an anthropised landscape, we can plan with greater awareness our strategies to study a particular area, and we can set the archaeological sites in their natural context.

Department of Storia Culture Civiltà, University of Bologna

Bibliography

Ancient Sources

Livy (translated by F.G. Moore). *History of Rome*. London: W. Heinemann; Cambridge: Harvard University Press.

Pliny (translated by H. Rackham 1961). *Natural History*. London: W. Heinemann; Cambridge: Harvard university press.

Polybius (translated by W.R. Paton). *History*. London: W. Heinemann ; New York: G.P. Putnam's Sons.

Strabo (translated by H.L. Jones). *Geography*. London: W. Heinemann; Cambridge: Harvard university press.

Modern Sources

Alfieri, N. 1994. Le fonti letterarie antiche. *Journal of Ancient Topography* IV: 9–22.

Andreani, M. 2006. Tracce di centuriazione alla foce del Garigliano. *Agri Centuriati* 3: 59–72.

Anthony, E.J., Marriner, N. and Morhange, C. 2014. Human influence and the changing geomorphology of the Mediterranean deltas and coasts over the last 6000 years: from the progradation to destruction phase? *Earth–Science Reviews* 139: 336–361.

Bellotti, P., Caputo, C., Dall'Aglio, P.L., Davoli, L. and Ferrari, K. 2009. Insediamenti umani in un paesaggio in evoluzione: interazione uomo–ambiente nella Piana di Sibari (Calabria Ionica). *Il Quaternario* 22 (1): 61–72.

Bellotti, P., Celderoni, G., Di Rita, F., D'Orefice, M., D'Amico, C., Esu, D., Margi, D., Preite Martinez, M., Tortora P. and Valeri, P. 2011. The Tiber river delta plain (central Italy): coastal evolution and implications for the ancient Ostia Roman settlement. *Holocene* 21 (7): 1105–1116.

Bellotti, P., Calderoni, G., Dall'Aglio, P.L., D'Amico, C., Davoli, L., Di Bella, L., D'Orefice, M., Esu, D., Ferrari, K., Bandini Mazzanti, M., Mercuri, A.M., Tarragoni, C. and Torri, P. 2016. Middle to Late Holocene environmental changes in the Garigliano delta plain (Central Italy). Which landscape witnessed the development of the Minturnae roman colony? *Holocene* 29 (9): 1457–1471.

Berger, J.F. and Jung C. 1996. Fonction, evolution et «taphonomie» des parcellaires en moyenne vallée du Rhône. Un exemple d'approche intergée en archéomorphologie et en géoarchéologie. In G. Chouquer (ed) *Les formes des paysages 2. Archéologie des parcellaires. Actes du colloque d'Orléans (mars 1996)*. Paris: Errance: 95–112.

Bini, M., Chelli, A., Federici, P.R., Pappalardo, M. and Biagioni, F. 2009. Environmental features of the Magra River lower plain (NW Italy) in Roman Times. In M. De Dapper, F. Vermeulen, S. Deprez and D. Taelman (eds), *Ol' man River. Geo–archaeological aspects of Rivers Plains*, New York : Academia press scientific publishing: 111–126.

Bini, M., Brückner, H., Pappalardo, M., Da Prato, S. and Gervasini, L. 2012. Palaeogeographies of the Magra Valley coastal plain to constrain the location of the Roman harbour of Luna (NW Italy). *Palaeogeography, Palaeoclimatology, Palaeoecology* 337–338: 37–51.

Bradley, G. 2014. The nature of Roman strategy in Mid-Republican colonization and road building. In T.D. Stek and J. Pelgrom (eds) *Roman Republican Colonization. New Perspectives from Archaeology and Ancient History*. Roma: Palombi: 61-72.

Brigand, R. 2011. La dynamique parcellaire des paysages centuriés de Vénétie centrale (Italie). *Les nouvelles de l'archéologie* 125: 18–23.

Campagnoli, P. and Giorgi, E. 2009. Centuriazione e assetti agrari nelle valli marchigiane. Il rapporto tra persistenza e idrografia. In P.L. Dall'Aglio and G. Rosada (eds) *Sistemi centuriati e opere di assetto agrario tra età romana e primo medioevo. Aspetti metodologici, ricostruttivi e interpretativi. I.* Agri Centuriati 6. Pisa–Roma: Fabrizio Serra Editore: 299–311.

Chouquer, G. 2008. Les transformations récentes de la centuriation. Une autre lecture de l'arpentage roamin. *Annales. Histoire, Sciences Sociales* 63e Année, No. 4 (Jul. – Aug., 2008): 847–874.

Dall'Aglio, P.L. 1994. Topografia antica e geomorfologia. *Journal of Ancient Topography* IV: 59–68.

Dall'Aglio, P.L. 2009. Centuriazione e geografia fisica. In P.L. Dall'Aglio and G. Rosada (eds) *Sistemi Centuriati e Opere di Assetto Agrario tra Età Romana e Primo Medioevo. Aspetti Metodologici, Ricostruttivi e Interpretativi. I. Agri Centuriati 6*. Pisa–Roma: Fabrizio Serra Editore: 279–297.

Dall'Aglio, P.L. and Marchetti, G. 1991. Settlement patterns and agrarian structures of the roman period in the territory of Piacenza. In G. Barker and J. Lloyd (eds*) Roman Landscapes: Archaeological Survey in the Mediterranean Region*. Archaeological monographs of the British School at Rome 2. London: British School at Rome: 160–168.

Dall'Aglio, P.L., Marchetti, G., Ferrari, K. and Daguati, M. 2007. Geomorfologia e città di fondazione in pianura Padana: il caso di *Placentia*. In L. Brecciaroli Taborelli (ed) *Forme e Tempi dell'Urbanizzazione nella Cisalpina: 2. secolo a.C.–1. secolo d.C. Atti delle giornate di studio, Torino 4–6 maggio 2006*. Borgo S. Lorenzo: All'insegna del giglio: 85–89.

Dall'Aglio, P.L., Marchetti, G., Ferrari, K. and Daguati, M. 2008. La geografia fisica di Piacenza Romana. *Rivista di Topografia Antica* XVIII: 7–22.

Dall'Aglio, P.L., Marchetti, G., Ferrari, K. and Daguati, M. 2010. Tra Adda e Serio Morto: modifiche ambientali e centuriazione al confine tra Ager Bergomensis e Ager Cremonensis. In P.L. Dall'Aglio and G. Rosada (eds) *Sistemi Centuriati e Opere di Assetto Agrario tra Età Romana e Primo Medioevo. Aspetti Metodologici, Ricostruttivi e Interpretativi. II. Agri Centuriati 7*. Pisa–Roma: Fabrizio Serra Editore: 295–304.

Dall'Aglio, P.L., Pellegrini, L., Ferrari, K. and Marchetti, G. 2011a. Relazioni tra urbanistica e geomorfologia nel settore centrale della pianura padana. *Ocnus* 19: 61–86.

Dall'Aglio, P.L., Pellegrini, L., Ferrari, K. and Marchetti, G. 2011b. Correlazioni tra geografia fisica e urbanistica antica: il caso della Pianura Padana centrale. *Atti della Società Toscana di Scienze Naturali, Memorie, Serie A* 116: 85–94.

Dall'Aglio, P.L., Ferrari, K. and Mete, G. 2012. Dalla città romana alla città tardoantica: trasformazioni e cambiamenti nelle città della pianura padana centro–occidentale. In M. Do Carmo Ribeiro and A. Sousa Melo (eds) *Evolução da paisagem urbana. Societade e Economia*. Braga–Maio: CITCEM: 69–98.

Dall'Aglio, P.L., Ferrari K. and Franceschelli, C. 2014. Centuriazione e geografia fisica: tra teoria e prassi. Pianificazione territoriale e gestione delle acque alla prova di un ambiente naturale dinamico. L'esempio della Pianura Padana. In E. Hermon and A. Watelet (eds) *Riparia, un patrimoine culturel. La gestion intégrée des bords de l'eau. Proceedings of the Sudbury Workshop, April 12–14, 2012*. BAR International Series 2587. Oxford: BAR: 21–38.

Dossena, G. and Veggiani, A. 1984. Variazioni climatiche e trasformazioni ambientali in epoca storica nel cremasco: il Moso e il Lago Gerundo. *Insula Fulcheria* XIV: 27–42.

Ferrari, K. 2016. *Ad ostium Liris fluvii. Storia del Paesaggio Costiero alla Foce del Garigliano*. Bologna: Bologna University Press.

Ferrari, K., Bellotti, P., Dall'Aglio, P.L., Davoli, L., Mazzanti, M. and Torri, P. 2012. Environment and settlements near the Garigliano river mouth: history of an evolving landscape. In F. Bertoncello and F. Braemer (eds) *Variabilites Environnementales, Mutations Sociales. Nature, Intensités, Èchelles et Temporalités des Changements. XXXIIe Rencontres Internationales d'Archéologie et d'Histoire d'Antibes*. Antibes: APDCA: 309–321.

Ferrari, K., Bellotti, P., Dall'Aglio, P.L., Davoli, L., Mazzanti, M. and Torri, P. 2013a. Wetlands in the river delta plains: evolution, values and functions during the Roman times. *Geocarrefour* 88–4: 273–283.

Ferrari, K., Dall'Aglio, P.L., Bellotti, P., Davoli, L., Di Bella, L., Esu, D., Torri, P. and Bandini Mazzanti, M. 2013b. Holocene Landscape Evolution at the Garigliano River Mouth. *Annali di Botanica* 3: 191–198.

Ferrari, K., Bellotti, P., Dall'Aglio, P.L., Davoli, L., Mazzanti, M. and Torri, P. 2014. La piana di foce del Garigliano in età romana: ricostruzione dell'ambiente antico e utilizzo delle sue risorse. In J.M. Álvarez, T. Nogales and I. Rodà *Centre and Periphery in the Ancient World. Proceedings of the 18th International Congress of Archaeology (Merida 13th–17th May 2013)*. Merida: Museo Nacional de Arte Romano: 183–187.

Ferrari, V. 1992. L'evoluzione del basso corso del fiume Serio in epoca storica e le interconnessioni territoriali derivate. *Insula Fulcheria* XXII: 9–42.

Franceschelli, C. 2008. Dynamiques de transmission de la morphologie agraire: 'pérennisation' et 'effacement' de la centuriation romaine dan la plaine sud du Pô. *Agri Centuriati* 5: 77–105.

Franceschelli, C. and Marabini, S. 2007. *Lettura di un Territorio Sepolto. La Pianura in Età Romana*. Studi e scavi. Nuova Serie, 17. Bologna: Ante quem.

Lerici, M. and Raynei, F.G. 1967. *The Search for Sybaris, 1960–1965*. Roma: Lerici.

Marchand, C. 2003. Des centuriations plus belles que jamais? Proposition d'un modèle dynamique d'organisation des formes. *Etudes Rurales* 3/2003 (n° 167–168): 93–113.

Marchetti, M. 1990. Cambiamenti idrologici nella pianura padana centrale a nord del fiume Po: i casi di «underfit streams» dei fiumi Mincio, Oglio e Adda. *Geografia Fisica e Dinamica del Quaternario* 13: 53–62.

Marchetti, M., 2002. Environmental changes in the central Po Plain (northern Italy) due to fluvial modifications and anthropogenic activities. *Geomorphology* 44: 361–373.

Marchetti, G. and Dall'Aglio, P.L. 1982. Geomorfologia e vicende storiche nel territorio piacentino. 1. La battaglia del Trebbia (218 a.C.). *Atti dell'Istitituto Geologico dell'Università di Pavia* 30: 142–160.

Quilici, L., Gigli, S., Pala, C. and De Rossi, G.M. 1969. *Carta Archeologica della Piana di Sibari*. In Atti e Memorie Atti e memorie della Società Magna Grecia, Nuova Serie IX–X. Roma: Società Magna Grecia.

Pelgrom, J. 2014. Roman colonization and the city-state model. In T.D. Stek and J. Pelgrom (eds) *Roman Republican Colonization. New perspectives from Archaeology and Ancient History*. Roma: Palombi: 73-85.

Robert, S. 2003. Comment les formes du passé se trasmettent–elles? Études *rurales* 3/2003 (n° 167–168): 115–131.

Ruegg, S.D. 1995. *Underwater Investigations at Roman Minturnae*. Goteberg: S. Dominic Ruegg and Paul Astroms.

Simeoni, U. and Corbau, C. 2009. A review of the Delta Po evolution (Italy) related to climatic changes and human impacts. *Geomorphology* 107: 64–71.

Tozzi, P.L. 1990. Gli antichi caratteri topografici di *Placentia*. II. Il territorio. In *Storia di Piacenza 1. Dalle Origini all'anno Mille*. Piacenza: Cassa di Risparmio di Piacenza e Vigevano: 330–344.

Vullo, N. 1995. Interventi di bonifica nell'ager cremonensis in età romana. In L. Quilici, S. Quiligi Gigli (eds) *Agricoltura e Commerci nell'Italia Antica*. Atlante Tematico di Topografia Antica. Supplemento 1: 199–219.

Walsh, K. 2014. *The Archaeology of Mediterranean Landscapes. Human–Environment Interaction from the Neolithic to the Roman Period*. New York : Cambridge University Press.