

Sailing Along the Coast of North Etruria: Ancient Perceptions Versus Multidisciplinary Coastal Landscape Studies



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Abstract Aim of this contribution is to demonstrate how digital methods, in combination with traditional sources, can effectively contribute to reconstruct a narrative of the past based on a sensory account of a few coastal landscapes in Northwestern Etruria as they were perceived and described by ancient authors. A few passages by Strabo (Geogr. 5.2.5, 222C, Augustan period) and Rutilius Namatianus (*de reditu suo*, early fifth-century CE) are examined, in order to understand how these authors perceived, either through previous sources or by autopsy, the river network and some coastal landscapes in Northwestern Etruria. The study of these passages is compared with the output of recent integrated research in the same districts described by the ancient authors. Areas of particular interest have been selected, for which landscape archaeology provides evidence of their long-term history, based on integrated palaeogeographic, historical and archaeological research including geomorphologic and palaeoenvironmental changes, exploitation of natural resources, urban forms, type and distribution of settlements. As for Strabo and Claudius Rutilius Namatianus, both authors relayed on their personal experience and on previous writers, but certainly chose to describe specific aspects characterising our case-study areas. In the frame of different literary genres, they provide descriptions based on their perceptions and also on their culture.

Keywords Coastal landscape · Ancient harbours · Ancient sources · Remote sensing · Satellite imagery

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1 Research Overview

Starting from the 1980s, research conducted by the University of Pisa has enabled the acquisition of a significant amount of geospatial data, producing a source of information to validate and complement what was described by ancient authors' accounts. A series of integrated methods were employed to investigate the study areas, which include the harbour sites of Vada Volaterrana and Portus Pisanus; they consisted of satellite remote sensing, GIS-based analysis, geophysics and geo-archaeology. The digital output derived from these analyses dramatically increased our understanding and interpretation of the landscape as it was described by the ancient authors.

Similarly, interdisciplinary projects run by the University of Siena in the Populonia District provided relevant data to the long-term history of the district, the variety of natural environments, changes in human settlements, farming landscapes, exploitation of resources and differing political strategies (Bianchi and Gelichi 2016; Bianchi and Hodges 2018).

1.1 North Coastal Etruria: Palaeogeography, Landscapes and Settlements

The studied district (Fig. 1) consists of river valleys (Magra, Serchio, Arno, Fine, Cecina, Cornia and minor ones) with their alluvial plains, mountain and hill districts (Apennines, Apuan Alps, Monti Pisani, Colline Livornesi, Colline Metallifere, etc.). In the Etruscan and Roman periods, the local economies were based primarily on agro-pastoral activities, woodland exploitation, mining and quarrying, manufacturing and trading activities (Pasquinucci and Menchelli 2017). The coastline (Fig. 2) consists of different morphological features which shaped the location and activities of ports and landings. The Luni-Livorno segment is characterised by a low shoreline; it was almost stable from the eighth to the second-first centuries BCE, then prograded until c. 1860. The Livorno terrace and Livorno-Castiglioncello coastal strip are rocky and stable; the Vada-Cecina shoreline is low and substantially stable (Pasquinucci and Menchelli 2012) except for the ancient Cecina River Delta (Bresci et al. 2006; Benvenuti et al. 2008). In the Populonia/Piombino District, the high rocky Populonia promontory dominates the Baratti Bay and alluvial plains resulting from the progressive geomorphological evolution in the district (Pasquinucci et al. 2004; Giroladini 2012).

In the Etruscan and Roman periods, the coast was dotted with ports and landings located in sites (gulfs/bays, inlets, coastal lagoons) naturally protected from the prevailing winds and waves, nearby the ancient rivers mouths and in other suitable sites where the boats could land/dock, load/unload wares and/or stock up on food and water. Coastal and inland navigation had to conform to the seasonal floods and to the constant and usually intense geomorphologic evolution which characterised some coastal districts and river courses. Sea and river routes were sailed by vessels and



Fig. 1 Study area including river valleys and their alluvial plains, mountain and hill districts (map by Giacomo Bonino)

boats/crafts of various typology, size and draught and were connected by a hierarchy of roads.

From the seventh/sixth to the early second-century BCE, Northwestern Etruria was dominated by three city-states, Pisa (Pisae), Volterra (Velathri, Volaterrae) and Populonia, with their territories dotted with minor settlements (including ports and landings, rural sites, etc.).

The Roman conquest of the early third-century BCE had a strong impact on both major and minor settlements, territories and related economies. Moreover, in the early second-century BCE two “new” cities, Lucca (Luca, Latin colony, 180 BCE) and

Fig. 2 Coastline characterised by different morphological features in which activities of harbours and landing places were located (map by Giacomo Bonino)



Luni (Luna, a citizen's colony, 177 BCE), were founded North of Pisa in the frame of the Roman wars against the Ligures. The Roman road network, in part following previous itineraries, was constructed on stable soils with attention paid to the local morphology, and provided efficient North–South and East–West connections which linked the sea- and river waterways (Pasquinucci 2014a, b) (Fig. 3).

Later, in the last decades of the first-century BCE, areas of North Etruria were affected by intense veteran colonisation that shaped or re-shaped the rural districts and marked the beginning of new manufacturing activities both in the coastal district (Luni, Pisa) and in inner Etruria, especially in the Serchio and Arno Valleys (Ciampoltrini 1981; Pasquinucci and Menchelli 2003, 2017). As was usual in the Roman colonisation process, such territories were in large part centuriated and assigned to the colonists. The practice entailed deforestation, increased agricultural and manufacturing activities, construction of roads and channels, therefore induced soil erosion. The marked increase in alluvial sedimentation from the second-first-century BCE caused the westwards progradation of the Luni-Livorno coastline



Fig. 3 Roman road network developed in connection to the conquest of Northwestern Etruria (map by Giacomo Bonino)

(Fig. 2), mostly in relation to the Arno mouth (Pranzini 2007; Pasquinucci 2008; Pasquinucci and Menchelli 2012; Kaniewski et al. 2018). Scholars agree that in this period characterised both by sea level rising and by the absence of drastic climatic changes, the coastal progradation was largely caused by anthropogenic factors (Pranzini 2007; Morhange et al. 2015) and mainly by Roman colonisation. As for the river network, Northwestern Etruria was characterised by a particularly complex hydrogeologic evolution. In particular, the present courses of the Arno and Serchio rivers result from complex natural transformations and anthropic actions taken over the centuries, ranging from the straightening of river meanders to the construction of embankments, dikes and canals (Pranzini 2007; Pasquinucci 2008). It is to be noted that the toponym Pisa derives from the ancient perception of the district: in fact it is of Indo-European origin and plausibly means rich in water, both stagnant and fluent (Dini 1996).

2 Ancient Perceptions: Strabo (5.2.5, 222C)

In the Pisa-Lucca District, this evolution and the long-term human actions aimed at optimising the rivers regime were well known, as clearly documented by Strabo (5.2.5, 222C), after his sources:

Pisa is situated between, and at the very confluence of, two rivers, the Arnus and the Auser, of which the former runs from Arretium, with great quantities of water (not all in one stream, but divided into three streams) and the latter from the Apennine Mountains; and when they unite and form one stream they heave one another up so high by their mutual resistance that two persons standing on the opposite banks cannot even see each other; and hence, necessarily, voyages inland from the sea are difficult to make; the length of the voyage is about twenty stadia. And the following fable is told: when these rivers first began to flow down from the mountains, and their course was being hindered by the natives for fear that they would unite in one stream and deluge the country, the rivers promised not to deluge it and kept their pledge (Strabo 5.2.5, C223: translated by Jones 1960: 350–353).

Strabo (c. 64 BCE–c. 24 CE) was born to an aristocratic family at Amasia, in northeast Anatolia. He was educated in his hometown, resided in Rome and travelled in the Eastern and Western Roman Empire. A Greek man of letters in education and ideological orientation, he drafted most of his *Geography* by 3/2 BCE and revised it under Tiberius. The work was based on previous authors, ancient “maps”, eyewitness description and information provided by local people (Migliario 2017, *passim*, 84 and n. 41). There is no evidence that Strabo travelled North of Populonia (Migliario 2017); his description of the Pisa territory is based on previous writers. The paradoxon of the Auser mounding into the Arno in the outskirts of Pisa is most probably derived (Lasserre 1967, 201–202) from Artemidorus (second-first-century BCE: Lasserre 1967, 14–18). This topos goes back to Timaeus (Lycophron, *Alexandra* 1240: fourth-century BCE: translated by André Hurst and Antje Kolde 2008, 71, 284) and Pseudo Aristoteles (*de mirabilibus auscultationibus* 92, translated by Hett 1936, 276–277) and is reported by several authors until Late Antiquity (Pasquinucci 2008, 152).

The legend of the rivers and their “promise” not to deluge the country most probably has the same origin (Lasserre 1967, 202), corroborated by hydrogeologic instability of the Arno and Serchio River Lower Plains, which is well documented by recent research in the Arno and Serchio River Coastal Plains (Pasquinucci and Menchelli 2012; Pranzini 2007). The integrated study of ancient written sources, mediaeval and modern documents, toponyms, maps and drawings, archaeological (Pasquinucci 2008, 152; Ciampoltrini 2007) and environmental evidence, air photo-interpretation, remotely sensed image processing of medium (Landsat TM) to high (Ikonos and Quickbird) resolution data, a LIDAR survey and sedimentologic studies (Pranzini 2007) document changes in the river courses, individual major floods and broader patterns of change in flood frequency in Pisa, Lucca and other specific areas of the studied district and beyond (Alinne et al. 2016; Walsh 2014, 96 ff., 104). As for the Arno splitting in three branches (Strabo 5.2.5, C223), three coarse-grained lobes were detected in the Pisa coastal district at Le Rene and Chiesanuova through satellite image processing and interpreted as possibly corresponding to Strabo’s description (Della Rocca et al. 1987, 78; Marchisio et al. 2000, 234 and Fig. 23.1; Pranzini 2007, 401). The course of the Roman Via Quinctia is identified in the plain East of Pisa (Fig. 4) based on the location of the itinerary toponyms deriving from the Roman milestones and quoted in Mediaeval deeds (Ceccarelli Lemut et al. 1991, 125f., 127–129; Pasquinucci 2014a, b). The road layout was not straight, as one would expect given the characteristics of the terrain. Evidently it was constructed on the bank of the second-century BCE Arno, on solid river sediments, following the meanders and connecting the river landing places. Remotely sensed image processing provides possible links between a few identified palaeochannels and the ancient viability (Marchisio et al. 2000, 234 and Fig. 23.3). In the northwestern outskirts of Pisa (San Rossore Railway Station) a riverine site (not a fluvial port in a strict sense: Leucci et al. 2014, 272) with several Roman wrecks and their cargoes has been excavated and studied. The sedimentological evidence and pollen analyses document catastrophic flood flows that occurred between the second-century BCE and the fifth-century CE (Benvenuti et al. 2006; Mariotti Lippi et al. 2007). Geophysical surveys (active/induced polarisation electrical methods) of the site, integrated with remote sensing analyses, largely contribute to the study of the site (Leucci et al. 2014). A cool and relatively damp climate phase characterised the Archaic period to the Late Republic, followed by a warm phase up to the third/fourth-century CE (Liebermann and Gordon 2018, 58–62; cf. Lionello 2012, 110–111; for a new approach to the study of precipitation changes, Peyron et al. 2017).

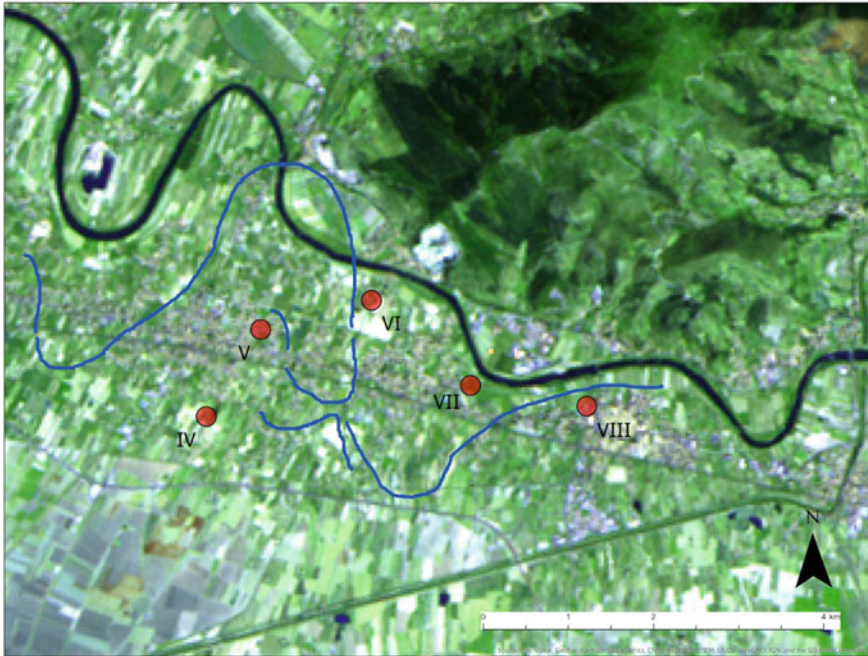


Fig. 4 Landsat TM (acquired on 12 September 1990) colour composite with band combination 7-5-3. Detected palaeorivers are marked with blue lines and spatially related with place names connected to Roman milestones (map by the authors, after Marchisio et al. 2000)

3 Ancient Perceptions: Claudius Rutilius Namatianus

Claudius Rutilius Namatianus was a native of Tolosa (Toulouse) in South Gaul. In his youth, he was well trained in classical rhetoric and literature, most likely in Rome. Like his father Lachanius, he had a highly successful career in the western imperial court (Malamud 2016, 8–9). In 417 CE, in October or early November, Rutilius fled from Rome, where he had held the relevant public offices of *magister officiorum* and *praefectus urbi*, and sailed from Portus (in the present Fiumicino area, north of the Tiber mouth) to his homeland in South Gaul coasting Latium, Etruria and Liguria (Fo 1992; Wolff et al. 2007; Pasquinucci 2020).

Shortly after the end of this journey, he described it in the poem in elegiac meter “*de reditu suo*”, the last part of which is lost. He intertwined various aspects of his journey with historical and ideological digressions. The “*de reditu*” is relevant for all scholars studying Late Antiquity and is particularly rich in topographical data based on Rutilius’ autopsy. Rutilius precisely and colourfully described several peculiar aspects of the landscapes he saw, the cities and ports he called at, the sea storms he faced, the people he met, etc.

Hereafter, a few examples of verses expressing what he could observe/perceive:

Good examples of visual perceptions:

1. 179–180 *ad naves gradior, qua fronte bicorni dividuus Tiberis dexteriora secat* “At last I make it to the ships, where two-horned Tiber branches and cuts a channel to the right” (Malamud 2016, 48).

1. 189–192 *respectare iuvat vicinam saepius urbem et montes visu deficiente sequi, quaque duces oculi grata regione fruuntur, dum se, quod cupiunt, cernere posse putant.* “To look back at the nearby city is a joy, to trace the hills that we can barely see, and feast our eyes on those familiar regions, while we think that we can see what we desire” (Malamud 2016, 48).

1. 283–284: *nemorosa viret densis vicinia luci pineasque extremis fluctuat umbra fretis.* “Forests clothe the neighborhood with thickset groves; the water’s edge reflects the pine tree’s shadow” (Malamud 2016, 51).

1. 431–434: *Incipit obscuros ostendere Corsica montes nubiferumque caput concolor umbra levat; sic dubitanda solet gracili vanescere cornu defessis oculis luna reperta latet.* “Corsica begins to show her dim mountains. Same-colored shadow lifts her cloudy head, just as the puzzling moon with slender horn will fade and even when found will hide from straining eyes” (Malamud 2016, 55).

1. 531: *contiguum stupui portum...mira loci facies: pelago pulsatur aperto...* “the near-by port amazed me...It’s a sight to see: the open seas and winds from every quarter pound its exposed shores” (Malamud 2016, 58).

1. 639: *Vidimus exciti pontum flavescere harenis* “We Saw the Stirred up Sea-Sands Turn the Water Gold and Belched-Up Waterspouts Submerge the Fields” (Malamud 2016, 61).

2. 63–68: *candentia moenia...nominis est auctor sole corusca soror. Indigenis superat ridentia lilia saxis et levi radiat picta nitore silex; dives marmoribus tellus, quae luce coloris provocat intactas luxuriosa nives.* “...shining walls: the sun’s bright sister gave her name to them...Its native rocks surpass the laughing lilies, the colored stone emits a polished gleam. The earth, so rich in marble and abounding in the color of light, can rival virgin snows” (Malamud 2016, 63).

Audio perceptions:

1. 201–205: *saepius attonitae resonant circensibus aures, nuntiat accensus plena theatra favor, pulsato notae redduntur ab aethere voces, vel quia perveniunt, vel quia fingit amor.* “The Circus often echoes in our startled ears, inflamed applause proclaims the crowded theater: familiar shouts are sent back from the echoing air-do we hear, or only hope we do?” (Malamud 2016, 48).

1. 370 *dum resonat variis vile celeuma modis.* “While the mate shouts out the rower’s beat” rower’s beat” (Malamud 2016, 53).

1. 456 *dirigit et puppim voce monente regit.* “And guides the stern with many a warning shout” (Malamud 2016, 56).

1. 629–630 *Tum responsuros persulta bucina colle fitque reportando carmine praeda levis*; “The sound of the hunting horn dances through echoing hills and singing lightens the spoil we carry back” (Malamud 2016, 60).

Olfactory perceptions

1. 282 *quas premit aestivae saepe paludis odor*. “A swampy stench sits over it in summer” (Malamud 2016, 51).

Taste/olfactory perceptions

1. 251–254 *non illic gustu latices vitiantur amaro lymphaque fumifico sulphure tincta calet: purus odor mollisque sapor dubitare lavantem cogit...* “The hot springs there are not spoiled with bitter taste, no sulphur-tainted waters boil there: a fresh aroma and sweet taste confuse the bather about which use is better for this water” (Malamud 2016, 50).

Multisensory perceptions

1. 313–316 *Necdum decessis pelago permittitur umbris, natus vicino vertice ventus adest. Tenditur in medias mons Argentarius undas ancipitique iugo caerulea curva premit*. “Night’ shades have not yet scattered as we set to sea: a breeze, born on a nearby peak, befriends us. Mount Argentarius juts out into the waves, its twofold ridge confines the turquoise bays” (Malamud 2016, 51–52).

Rutilius’ description of the Populonia, Vada Volaterrana (present Vada, Livorno) District, of the Portus Pisanus Basin (Livorno) and the way he perceived Luni are of peculiar interest (Pasquinucci 2020).

In these areas, landscape archaeology applying excavations, surveys and non-invasive prospecting techniques (remote sensing, geophysical investigations, geomorphologic and palaeogeographic research, bio- and geosciences) provides evidence of the landscapes, the settlements characteristics and patterns, the infrastructures in a long-term perspective.

3.1 *Falesia and Populonia*

In the fourth stage of his journey Rutilius coasted the southern Populonia territory in view of the Elba Island and went ashore in the port named Falesia (de red., 1.371–386, cited from “surname” year: page number; cf. *Itinerarium Maritimum* 501: ‘Falesiae portus’, edited by Cuntz 1929) (Fig. 1). In the immediate hinterland, he watched people celebrating a spring festivity and reached a villa. Here he wandered in a nearby grove (de red., 1.377, translated by Malamud 2016, 53) and observed a fish farm rich in water and fishes. He perceived and vividly described the joyful celebration dedicated to Osiris, the characteristics of the ponds, the abundance of water and the darting fishes (de red. 1, 373–380, translated by Malamud 2016, 53).

Falesia (Falesiae portus) was located ENE of present Piombino, in the Portovecchio area. The present district is a coastal sedimentation basin formed for the

progressive contribution of river debris (Dallai 2016, 94; Dallai 2018). Archaeological surveys and excavations, non-invasive prospecting techniques, historical, cartographic, palaeogeographic and palinological studies document the long-term natural evolution of the territory, the ancient and mediaeval settlements and settlement patterns, the road network, rural and manufacturing economy, the role of fishing, salt production and fish processing (Shepherd 2006; Dallai 2016, 92). In particular, palaeogeographic evidence documents that in Roman and Mediaeval times the district was characterised by permanently flooded areas (some of them deep), alternating with areas just lapped by water and dry ones, linked by major and minor roads: a composite landscape, which provided numerous resources (Dallai 2016, 94–98; Dallai et al. 2018). Although it is impossible to identify the villa and fish farm located not far from Falesiae portus and vividly described by Rutilius (Pasquinucci 2020), landscape archaeology and quantitative researches demonstrate that his verses provide a careful picture of the local environment, settlement and economy characteristics and the way the author perceived them.

3.2 *Vada Volaterrana*

Vada Volaterrana was the main harbour of Volterra, located North of the ancient Cecina river mouth along the coastal road (via Aurelia since the third-century BCE), 25 milia from Populonia and 18 from Portus Pisanus (Itinerarium Maritimum, 501: edited by Cuntz 1929) (Figs. 1, 5 and 6). The Etruscan and Roman settlement lies under present Vada and North of it, where a quarter has been excavated and in part prospected by geo-electrical prospections and multichannel Gpr (Pasquinucci et al. 2001, 2012; Baroni et al. 2014; Benetti et al. 2018). Evidently related to the harbour, it includes horrea, two thermae, a schola, a fountain and other buildings (early decades of the first-century CE–early seventh-century CE). The toponym is derived from the large shoals (Latin vadum/vada) in front of the coastal strip centred on Vada (Aiello et al. 1981), which protected the site and determined the town's seaport function since the most remote antiquity (Fig. 5). The shoals were evidently perceived by the ancients as the peculiar characteristic of the site. In antiquity they provided a higher protection since the sea level was about one metre and a half lower (Lambeck et al. 2004; cf. Pasquinucci 2020). Geomorphologic and archaeological research proves the ancient harbour basin was located in the sheet of water in front of the town, roughly in the area where the mediaeval and modern ports were located (Pasquinucci 2020) (Fig. 6). This area is the most protected and therefore suitable for the harbour; anyway evidence of loading/unloading ships a small distance from the coast has been found both North and South of Vada and landing places were scattered along the coast. The Vada hinterland has been thoroughly surveyed. It was dotted by stations/mansiones, villas and farmsteads studied and under study in a long-term perspective (Iacopini et al. 2012; Pasquinucci 2014a, b; Repetto et al. 2018). It was characterised by Mediterranean crops, breeding, manufacturing and commercial activities, and many natural resources (sea- and rock-salt, timber, copper, alabaster). A few rural sites were

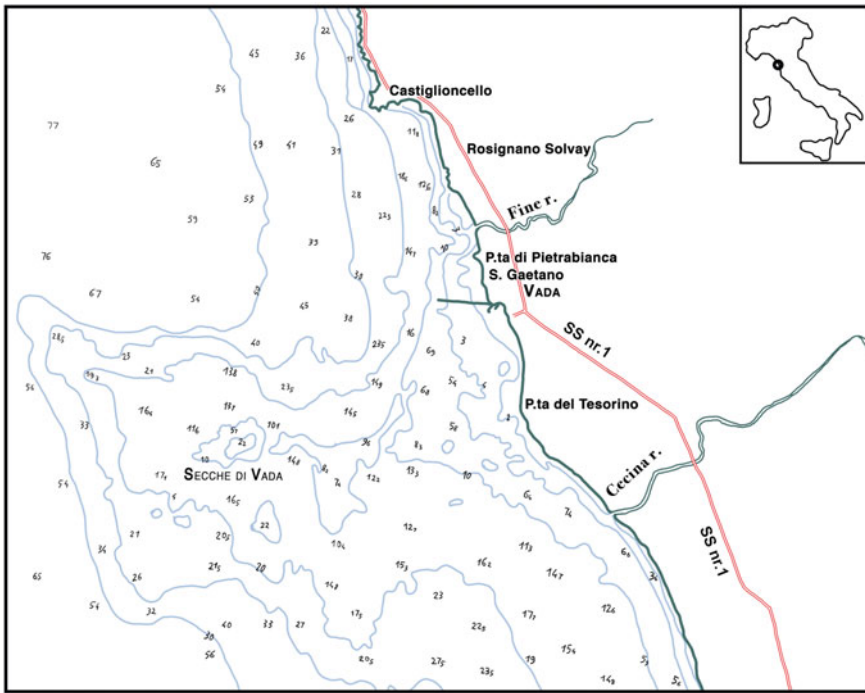


Fig. 5 Large shoals (Latin vadum/vada) in front of the coastal strip centred on Vada (Aiello et al. 1981), which protected the site and determined the town's seaport function since the most remote antiquity (map by Giacomo Bonino)

recently investigated by magnetic prospections employing Fluxgate Gradiometer FM 256 by Geoscan Research as main device; it was used with a dual configuration and a resolution of 0.1 nT (nano-Tesla). In some areas, the Fluxgate data were integrated with a Caesium Gradiometer G-858 by Geometrics, which has been shown more sensitive in detecting weak magnetic anomalies related to archaeological features. Radar survey was carried out with an antenna manufactured by GSSI, with 270 MHz of central frequency. The surveys have been undertaken within a net of georeferenced rectangular grids (20 × 40 m) (Repetto et al. 2018). A GIS has been implemented with data provided by intensive archeological surveys of the area. As for the road network, cost surface analyses (based on slope, altimetry and hydrography) have been applied to the Vada Volaterrana-Pisae pre-Roman and Roman via track. Viewshed analyses prove that a few hillforts built on the Colline Livornesi had a very important strategic role concerning viability thanks to excellent control over large part of the ancient route connecting Vada with Pisa through the Fine and Tora River Valleys which was later run by via Aemilia (Ceccarelli Lemut et al. 1991, 116, 120; Iacopini et al. 2012; Pasquinucci 2014a). Based on these available data, we can deduce that in his description of Vada Volaterrana, Rutilius chose to focus on three aspects, which he evidently perceived as particularly relevant and therefore characterising the area: the



Fig. 6 Probable location of the ancient harbour basin of Vada Volaterrana. This was located in the sheet of water in front of the town (n. 3), roughly in the area where the mediaeval and modern ports were located (map by Giacomo Bonino, after Pasquinucci 2020)

shoals cut through by a narrow canal which provided access to the port, the “nearby” villa belonging to his friend Caecina Albinus and the salt pans visible from Albinus’ villa. The first ones are carefully and colourfully described in the poem (1.453–466): “Entering on the region of Volterra, appropriately called “The Shallows”, I thread my way through the deep part of the treacherous channel. At the bow the look-out watches the water beneath and gives directions to the helm beyond, guiding the stern with warning shouts. A boundary on each side marks puzzling narrows by a pair of trees, and presents a line of piles hammered in there: to these it is the custom to fix tall laurels easy to see because of their branches and bushy foliage, so that, although the shifting bank of thick mud shows its mass of sea-weed, a clear passage may keep the guiding-signs unstruck” (Duff and Duff 1934). After docking, under heavy rain Rutilius reached a villa near the port belonging to his friend Albinus: “There I was driven to make a halt by a tearing North-western of the sort that is wont to shatter the depths of the woods. Scarce safe beneath a roof did we endure the pitiless rains: the neighbouring country-seat of my own Albinus was placed at my disposal!”

(de red. 1. 465–466: translated by Duff and Duff 1934). The villa is not described in detail and its location is still debated (Pasquinucci 2020). Capo di Villa (a meaningful toponym) is located 1,5 km North of the ancient Vada Port where Rutilius landed. The site overlooks the Galafone area where protohistoric salt production by briquetage has been identified (see below). At Capo di Villa Roman structures were identified in an area 7,7 h large explored by gradiometer Fluxgate, Caesium Gradiometer and by GPR, but there is no evidence to confirm that they belonged to the building mentioned by Rutilius. As for the salt pans, Rutilius observed them very carefully and perceived their peculiar characteristics (1. 475–490): “We find time to inspect the salt-pans lying near the mansion: it is on this score that value is set upon the salt marsh, where the sea-water, running down through channels in the land, makes entry, and a little trench floods the many-parted ponds. But after the Dog-star has advanced his blazing fires, when grass turns pale, when all the land is athirst, then the sea is shut out by the barrier-slucies, so that the parched ground may solidify the imprisoned waters. The natural incrustations catch the penetrating sun, and in the summer heat the heavy crust of salt cakes, just as when the wild Danube stiffens with ice and carries huge wains upon its frost-bound stream. Let him who is given to weigh natural causes examine and investigate the different effect worked in the same material: frost-bound streams melt on catching the sun, and on the other hand liquid waters can be hardened in the sun” (translated by Duff and Duff 1934).

Salt production has characterised the Volterra territory at least since the late Iron age. It was and still is a relevant source of income. Evidence of briquetage in the coastal strip is provided by archaeological research on the left bank of the River Fine (Galafone: ninth-eighth-century BCE). Saltworks near Vada are documented in the late Antiquity by the above-mentioned passages of the *de reditu* (1. 475–490) and since the mid-eighth-century CE by archive documents (Ceccarelli Lemut and Maria Luisa 2013, 32–35). In the hinterland (at Saline di Volterra, in the inner Cecina Valley), the brine was exploited since remote times, most probably by the Etruscans and Romans, certainly since the early Middle Ages up to now. To sum up, we can find relevant evidence of the fifth-century landscapes and settlements in the *de reditu*, but only “loose” links between the data derived from quantitative researches in the Vada territory and Rutilius’ perceptions. Anyway it is evident that he chose to focus on the aspects he perceived as particularly relevant and therefore characterising the area, and wrote a clear and vivid picture of the local landscapes, as they are outlined by historical, archaeological and quantitative researches.

3.3 *Pisa, Portus Pisanus and Livorno*

In the seventh/sixth-century BCE, Pisa became an urban entity with the merging of Iron age villages separated by major and minor streams, at the confluence of the river Auser into the Arnus (see par. 02 above; Pasquinucci 2008, 152), on the right bank of the latter, 20 stadia from the sea according to Strabo and his sources (most probably Artemidoros, second-first-century BCE: Migliario 2017, 85), at the

intersection of the coastal road with the tracks following the river banks (Figs. 1 and 3). The ancient writers describe the district as rich in agriculture (Pliny, NH 14.39; 18.86–87: translated by Harris Rackham 1961, see below), cattle breeding (Livy 35.3: translated by Sage 1965, 8–9), stone quarries (Strabo 5.2.5: translated by Jones 1960, 352–353), manufacturing activities (ship construction: Strabo 5.2.5: translated by Jones 1960, 352–353) and maritime trade (Rut. Nam. 1.532: translated by Malamud 2016, 58). In particular, the Pisa territory was renowned for the vineyard and grain cultivation (Pliny, NH 14.39: translated by Harris Rackham 2005, 212–13; Pliny, NH 18.86–87: translated by Harris Rackham 1961, 244–245) still widespread today. The archaeological data matches with the literary one and adds evidence of relevant pottery, Graeco-Italic and Dressel 1 amphoras, marble and alabaster artefacts productions (Pasquinucci and Menchelli 2017, 327–330). The city and its territory were served by a well-integrated system of sea and river ports and landings, well connected by the Roman roads system since the mid-third-century BCE (Pasquinucci 2014a, b). The main maritime harbour was situated NNE of present Livorno. The coastal lagoon where it was located was frequented since the archaic period (see below), but the toponym Portus Pisanus is not mentioned before Late Antiquity, when it is documented by Rutilius Namatianus (*de reditu suo* 2.12; cf. 1. 527–540: early fifth-century CE: translated by Malamud 2016, 58) and by the *Itinerarium maritimum* (501, 1–4: early sixth-century CE: Arnaud 2004). According to the latter source Portus Pisanus was located eighteen Roman miles North of Vada Volaterrana (present Vada) and nine Roman miles South of the Arno river mouth of the time: “a Vadis portum Pisarum m(ilia) p(assuum) XVIII, a portu Pisano Pisis, fluvius, m(ilia) p(assuum) VIII”, therefore in the present silted up area ENE of Livorno (Figs. 1 and 2). Recent interdisciplinary research in this district (S. Stefano ai Lupi, La Paduletta, Il Deserto) confirms the ancient Portus Pisanus location and provides evidence of several characteristics of the site in its changing environment, based on palaeogeography, archaeology, geophysical prospections, ancient, mediaeval and post-mediaeval written sources, post-mediaeval drawings and maps (Pasquinucci et al. 2018; Kaniewski et al. 2018).

Following the coastal dynamics, the Mediaeval Portus Pisanus kept the ancient name but developed WSW of the Late Roman one. It was the main port of the Pisan Republic, protected by towers and closed by a chain. South of it, another Mediaeval harbour (porto di Livorno) was located nearby the small settlement (“castello”) Livorno. It coexisted with the Mediaeval Portus Pisanus until the latter was gradually silted up and abandoned. The Florentine Government progressively transformed the Livorno settlement in a new town planned by the preeminent architect Buontalenti and the Livorno Port in a very innovative one (Pasquinucci et al. 2018).

4 Portus Pisanus: Archaeological Evidence

In 2004–2009, rescue excavations carried out in the NNE outskirts of Livorno by the Soprintendenza per i Beni Archeologici della Toscana and the University of Pisa have identified some small but very meaningful areas of the ancient Portus Pisanus Basin and of a few structures belonging to the port facilities and settlement (Pasquinucci et al. 2018). A few zones of a well-preserved sandy seabed were brought to light, covered with artefacts (pottery fragments, amphorae, ballast stones, etc.) dated from the late seventh/sixth-century BCE (bucchero, Samian and Etruscan wine amphorae) to the second-century BCE; the finds layout shows that the coastline prograded westwards and the loading and unloading of goods progressively followed this progradation (Pasquinucci et al. 2018). Since the mid-second-century BCE the ancient stretch of shallow water was progressively and rapidly silted up by alternate sand and *posidonia* layers. A few artefacts date this specific silting up phase between the first half of the first-century BCE and the fifth-century CE. In the late first-century BCE activities connected with navigation could no longer be performed in this area and were therefore shifted westwards. The silting chronology matches the above-mentioned data (par. 02) according to which the North Etruscan coast progradation was a consequence of the late Republican colonisation impact on the hinterland and possibly of a phase characterised by intense rainfalls. The presence of clay deposits testifies to a gradual process of continentalisation which started in the early Middle Ages (Kaniewskii et al. 2018) and came to an end only during the eighteenth–nineteenth centuries. A few Roman buildings were also excavated in the area. They are located immediately below the edge of the natural terrace called Gronda dei Lupi, on a sandy soil that can be interpreted as an ancient shoreline. The oldest structures date back to the third-second-century BCE: some walls line two rooms, whose function is hard to identify. Around the mid-first-century BCE this building was replaced by a new one, characterised by an open courtyard and a porch surrounded by at least 13 rooms, for commercial and warehousing use. The different orientation of the structures is perhaps due to a change in the shape of the shore where the buildings lay (Pasquinucci et al. 2018). The building entered a crisis in the second quarter of the fifth-century CE, shortly after Rutilius Namatianus' journey. As documented by a small coin hoard of the Emperors Anthemius (AD 467–472) and Leo I (AD 452–474) hidden inside the southwest corner of a room used as a *Mithraeum*, and by other data, this room and the whole commercial building were abandoned around the mid-fifth-century AD. A few fragments of pottery show a weak recovery between the end of the fifth- and the mid-sixth-century CE. Links with the main trade routes coming from Rome and Ostia had not yet completely dissolved in the sixth-century CE, as proved by the presence of African amphorae, South Italian Keay 52 and Eastern Late Roman 2 type amphorae. This phase was followed by the final abandonment of the building and, presumably, of other port facilities.

As for the environmental changes, between the fifth- and the sixth-century CE, the silting process went on (Kaniewski et al. 2018; Pasquinucci et al. 2018). Summing

up, based on written sources, archaeological and geoarchaeological evidence Portus Pisanus was a large and probably not so deep coastal lagoon opened directly to the sea from the seventh-sixth-century BC to the sixth-century CE. This stretch of shallow water was navigated by appropriate crafts in order to load and unload wares. The port structures and buildings (wooden piers, warehouse, etc.) were located along a sandy shoreline, as proved by archaeological research. The ancient landing area and port activities were progressively shifted westwards due to the remarkable Luni-Livorno coastal progradation dated from the second-first-century BCE to around 1830 (see above par. 02); Pasquinucci and Menchelli 2012).

4.1 *Portus Pisanus: Claudius Rutilius Namatianus versus Palaeogeographic and Archaeological Evidence of the Site*

In the seventh stage of his journey Rutilius left Vada Volaterrana and sailed North in view of the Gorgona Island. While coasting the Livorno rocky promontory northwards, he watched (on his right) a villa maritima (Triturrita) overlooking the sea (1, 527–531: *sic villa vocatur, quae latet expulsis insula paene fretis*: translated by Malamud 2016, 58), evidently located at the NW edge of the promontory, most probably in the area of the present graveyard Cimitero dei Lupi (Livorno) (Fig. 8). Immediately later he saw the harbour Basin which he defined well sheltered and impressive (1. 533–540; 1. 559). He perceived and described Portus Pisanus as a wide open sea basin, a “maritime” port with windswept beaches and port facilities (de reditu 1. 527–540) and a safe one (1. 559). Of particular interest is the mention of the extensive seagrass meadows through which his boats (cymbae) navigated to reach the landing area (see below). The description is lively and detailed:

From there we make for Triturrita: that is the name of a residence, a peninsula lying in the wash of baffled waves. For it juts out into the sea on stones which man’s hand has put together, and he who built the house had first to make sure building ground. I was astonished at the haven close by, which by report is thronged with Pisa’s merchandise and sea-borne wealth. The place has a marvellous appearance. Its shores are buffeted by the open sea and lie exposed to all the winds: here there are not sheltering piers to protect any inner harbour-basin capable of defying the threats of Aeolus. But, fringing its own deep-water domain, the tall sea-weed is like to do no damage to a ship that strikes it without shock; and yet in giving way it entangles the furious waves and lets no huge roller surge in from the deep (de red. 1. 527–540) ... So, then I moor my ships in the safe anchorage (1. 559) (Duff and Duff 1934).

4.2 *Satellite Remote Sensing Contribution*

Indeed, a series of integrated methods of archaeological prospection confirms what Rutilius Namatianus observed for this complex landscape. His verses provide important clues about the appearance of the natural environment in which the harbour was

located. Whereas it is now apparent the contribution provided by satellite remote sensing to the investigation of archaeological landscape (Campana 2002; Lasaponara and Masini 2012; Parcak 2009; Mozzi et al. 2016; Kaimaris et al. 2017, 2018), the Pisa coastal plain has been one of the pioneering case studies for the application of multispectral imagery-based techniques.

Multispectral images were employed to identify the presence of palaeolagoons characterising the Portus Pisanus Harbour System in antiquity (Marchisio et al. 2000). Based on the capability of sediments to retain water that strongly reduces bare soil reflectance, lithological recognition allowed scientists to detect and define areas with different levels of soil wetness. The importance of using infra-red spectral bands resided in their suitability to capture any small variation in moisture presence. The combination of different bands allowed to better mark those swampy areas that formed the lagoon system in which several landing points developed in antiquity (Fig. 7). Bright colours indicate concentrations of fine sediments which can be related to the presence of swampy areas. Different algorithms including PCA and NDVI allowed to confirm the presence of palaeolagoons and channels in the area between Pisae and its harbour Portus Pisanus (Marchisio et al. 2000).

4.3 GIS-Based Legacy Data Integration

Around 1760 the Florentine medicine doctor and naturalist G. Targioni Tozzetti saw ancient ruins and abundant artefacts in this area which he correctly attributed to the Portus Pisanus Harbour settlement based on his excellent knowledge of the Latin sources. He commissioned the engineer A. Morozzi a map showing the location of the Portus Pisanus settlement ruins and the Roman age hypothetical coastline in comparison with the late ones (Targioni Tozzetti 1768). The same district is visible in several seventeenth and eighteenth-century maps illustrating the basin undergoing a slow but constant silting up process and the Mediaeval and Modern ports of Livorno (Fрати 2000). As usual in the *de re ditu*, Rutilius didn't describe the port settlement in detail but observed a "villa" placed on a promontory and partially constructed on stone blocks projecting into the sea (*de red. 1. 527–531*) as in a proximal position to the harbour Portus Pisanus. By integrating multiple map sources in a GIS environment it was possible to spatially connect different layers providing an accurate picture of the area occupied by the described villa and the harbour structures located in its closest proximity (Fig. 8). What is particularly worth to mention is the impressive correspondence between the small peninsula's contour line drawn by Morozzi (Targioni Tozzetti 1768) and the same contour line clearly visible in a historical orthorectified aerial image of the area acquired during the 1950s. The possibility to visualise in a diachronic perspective multiple cartographic sources allows us to detect important features of the landscape that are no longer visible. The case of Portus Pisanus area is emblematic in this respect, as the area nowadays lies in the very densely urbanised portion of Livorno, where it is almost impossible by looking at present-day satellite imagery to discern those features that characterised the ancient landscape.

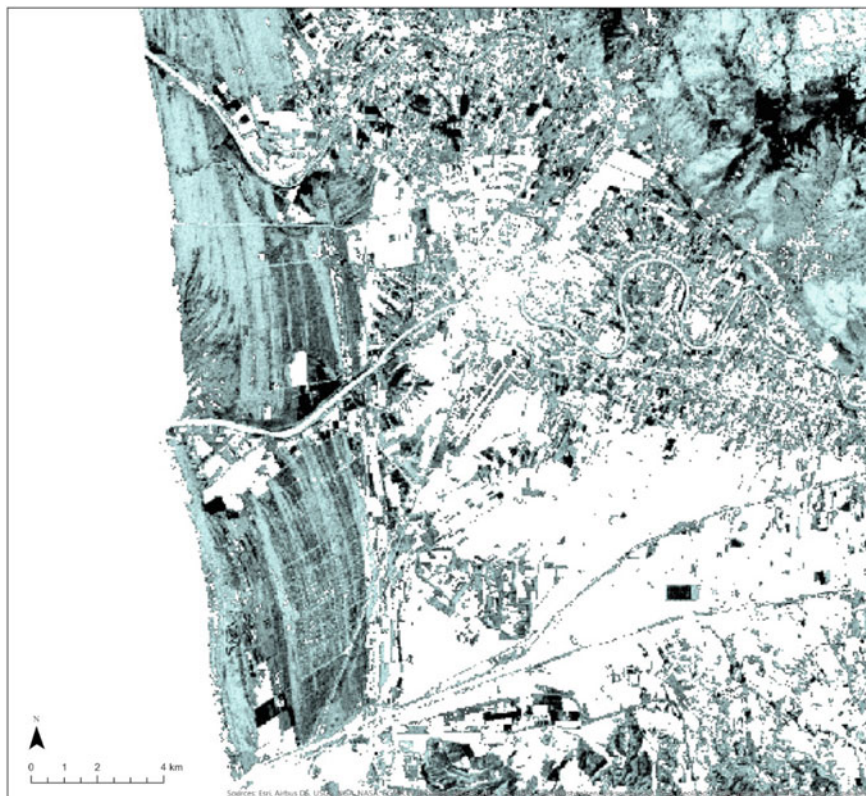


Fig. 7 Landsat TM image resulting from the difference between Principal Component Analysis (PC2) and Vegetation Index. Bright colours indicate fine sediment areas corresponding to ancient swamps (map by the authors, after Marchisio et al. 2000)

4.4 Geophysical Prospecting

Between the third- and the mid-fifth-century CE the Portus Pisanus lived an intense phase of commercial activities. The high number of amphora fragments reveals the relevant trade with the African provinces, the Iberian Peninsula and the Eastern part of the Mediterranean Sea (Genovesi 2010; Ducci et al. 2011; Genovesi 2014).

An important contribution to investigate the extension of this commercial area was provided by Ground Penetrating Radar (GPRS) technology that was intended to provide a complete map for interpreting the original function of the building (Pasquinucci et al. 2012). Geophysics has been widely applied in urban contexts and this is due to the clear advantages it brings on when it comes to the possibility of prospecting areas with no chance of undertaking stratigraphic excavations (Basile et al. 2000; Papadopoulos et al. 2009). Combined use of geophysical prospecting and aerial photo-interpretation has also been extensively presented and discussed (Campana

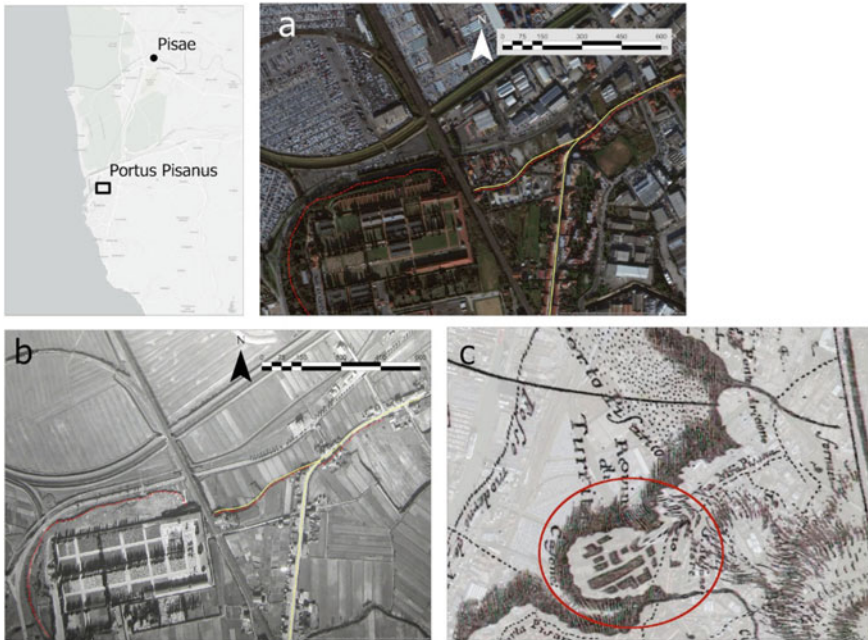


Fig. 8 Portion of the ancient Portus Pisanus area located in northern outskirts of Livorno (a). Historical aerial imagery (b) clearly shows the Pleistocene terrace profile (red line) named Gronda dei Lupi that was observed and described by Targioni Tozzetti (c). The crossroad of two historical roads probably datable to the Roman time is also visible (yellow line, map by the authors)

and Forte 2001; Sarris et al. 2013; Verdonck et al. 2012). Such an integration, in which satellite remote sensing provides an additional contribution, allows archaeologists to explore more effectively issues connected to the landscape palaeoenvironmental evolution (Keay et al. 2014). Concerning the area of Portus Pisanus, GPRS was employed to prospect an area of about 2000 m² where linear elements were interpreted as wide walls shaping a sequence of rooms (Pasquinucci et al. 2012). Interestingly, this prospection seems to confirm what has been observed and described by Rutilius Namantianus, who mentions an intense commercial activity while he approached the harbour as recalled by the use of the terms “emporio divitiisque maris” (Fig. 9) “port... full...with Pisa’s stores and riches gained at sea” (de red. 1. 531–532; Malamud 2016, 59). By observing the data collected in the archaeological excavation, commercial activities are documented by the artefacts and by this commercial building, which was interpreted as an horreum (Pasquinucci and Menchelli 2010; Ducci et al. 2011, 43–45, Fig. 3). This was articulated in a central courtyard lined by a portico faced by quadrangular rooms. It is dated to the first-century BCE–sixth-century CE and was constructed on a previous building (third–second-century BCE) (Ducci et al. 2011, 43–45).

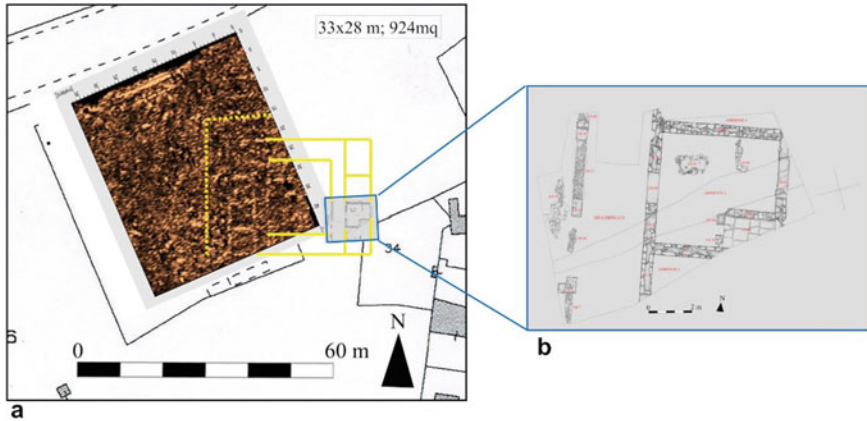
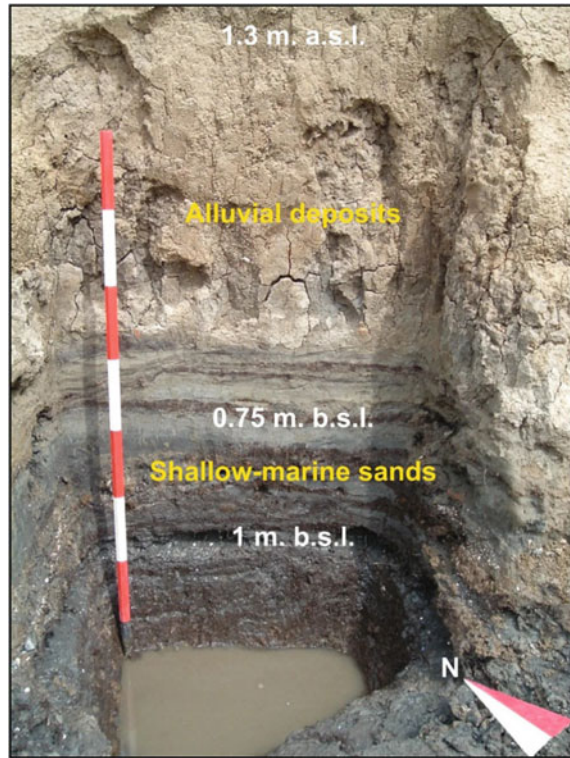


Fig. 9 Area of the geophysical prospection performed by using a Ground Penetrating Radar (GPR). The excavated portion of a commercial building (interpreted as a horreum) consistently matches the linear anomalies identified during the prospection and interpreted as possible walls (map by the authors, after Pasquinucci et al. 2012; Ducci et al. 2011).

4.5 *Geoarchaeology Contribution*

Concerning further observations made by Rutilius, it is worth to underline the description of the *Posidonia* seagrass. Geoarchaeological prospection in the *Portus Pisanus* area and archaeological excavations confirmed its presence at different chronological stages in the stratigraphic sequence. Recent geoarchaeological research (Alinne et al. 2016; Kaniewski et al. 2018) based on coring confirms the major changes in the geomorphological asset of the area. Cores have been extracted both in the area immediately West of the mentioned archaeological excavations and North of it. The presence of a large lagoon in the Etruscan and Roman time period is confirmed by the above-mentioned (par. 4) excavations. Based on the most recent study (Kaniewski et al. 2018), within the end of the second millennium BCE, the area West of the harbour settlement was occupied by sediments likely to be due to the existence of a marine bay protected from the main waves of the open sea. As the archaeological excavations show, at least since the Etruscan age (seventh-sixth-century BCE) the area with sandy seabed proved to be a good landing area for the boats sailing along the North Tyrrhenian Coast. This marine area, characterised by the presence of *Posidonia* and substantial fluvial deposits, would have tended to silt up in later centuries, to be interested by a major continentalisation process starting during the early Middle Ages (Fig. 10) (Kaniewski et al. 2018).

Fig. 10 Section of a natural sequence showing continentalisation process in the basin area of Portus Pisanus (photograph by the authors)



5 From Ancient Perception to Archaeological Interpretation: A Multidisciplinary Investigation

This chapter has sought to demonstrate the importance of connecting narratives of ancient authors to the archaeological evidence retrieved through combined approaches based on conspicuous amounts of digital data. The accounts of Strabo and Rutilius Namatianus, who provided insightful descriptions of the coastal regions examined in this study, have been compared against the data collected in over 30 years of archaeological investigation conducted by the authors of this contribution. Some case-study areas located along the North Coastal Etruria were chosen as they were described by these authors who used either their own perception or previous authors' descriptions to make a detailed account of important features connected to the natural environment and the social landscape. The Portus Pisanus area, in particular, was intensively investigated in the last 15 years and the collected data seem to confirm the picture drawn by Rutilius Namatianus in his poem, who described with his own eyes a lively and prosperous harbour strategically positioned in a wide coastal lagoon. The complexity of the transformations that affected those spaces through the centuries is enormous and therefore it is crucial to reflect on the urgency of defining innovative

Fig. 11 Predictive model for the alluvial coastal plain between the ancient city of Pisa and the main harbour site of Portus Pisanus. Red-coloured areas express higher archaeological risk/potential and are quite expectedly spatially related to that portion of land along the ancient coastline viewed and described by Rutilius Namatianus (map by the authors, after Landeschi and Carrozzino 2011)



strategies for dealing with uncertainties due to the lack of information in areas that are nowadays heavily urbanised and affected by new development. In this respect, the data collected through multiple and integrated methods and techniques in more than 30 years of research allowed also to define an interpretative predictive model that was used to better understand the archaeological potential in the southernmost portion of the Pisa alluvial coastal plain (Fig. 11) (Landeschi and Carrozzino 2011). Interestingly, areas with higher archaeological potential matched very well with the portion of the landscape described by Rutilius as being part or at least proximal to the harbour system and the villa, and located on the Pleistocenic terrace boundary known as “Gronda dei Lupi” (Ciampalini et al. 2006). To sum up, multidisciplinary methods of investigation have proven to be crucial in confirming the account made by Strabo and Rutilius Namatianus, by enabling archaeologists to get a deeper insight into the ancient landscape not just as a physical space but also as a lived-in, social landscape made by people, encounters and relations. By combining traditional and digitally based methods it is possible at least to attempt to simulate that “sense of place” as it has been described in the “de reditu”. The experiential approach to the space/place is mediated through the eyes of an ancient traveller/author who provides us with an invaluable source of information for understanding significant transformations

which occurred in the observed landscape. Accounts from ancient authors/travellers are an invaluable source of information about the mindset of people living in a certain context. It is indeed the emotional and affective dimension that it is quite hard to grasp and an important contribution that quantitative and digital methods can provide is the possibility to identify and re-connect to these accounts the conditions and affordances that the ancient environment fostered.

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