2.2 Landscape transformations in North Coastal Etruria

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ABSTRACT

This paper concerns North coastal Tuscany (ancient *Etruria*), Italy. Multidisciplinary diachronic research provides evidence of palaeo-environmental changes, of water and risk management practices and of rural and urban landscapes both in the coastal district and the hinterland. From north to south the littoral is articulated in three sections: the Luni – Livorno shoreline, which prograded westwards from the 2nd-1st cent. BC up to about 1830; the Livorno terrace and Livorno-Castiglioncello coastal strip, which are rocky and stable; the Vada – Cecina shoreline, which is low and stable. In the Luni – Livorno district, the coastal and hydrologic evolution strongly affected the sea- and river ports. Three main critical phases are identified, dated to the early 5th century BC, the late Republican- early imperial period and late Antiquity. The cities Pisa, Volterra, Lucca and Luni are examined in their changing landscapes.

KEYWORDS

***north coastal Tuscany; Etruria; coastal progradation; Magra, Serchio, Arno, Cecina rivers;* Portus Pisanus**

TERRITORY AND MULTIDISCIPLINARY RESEARCH

In this paper we study north coastal *Etruria*, focusing on the littoral area from the Magra to the Cecina rivers and the hinterland with the main rivers lower valleys (Magra, Serchio, Arno, Cecina) (figs.1, 3). From the 6th to the early 2nd centuries BC the northern part of this territory was dominated by Pisa, the south-

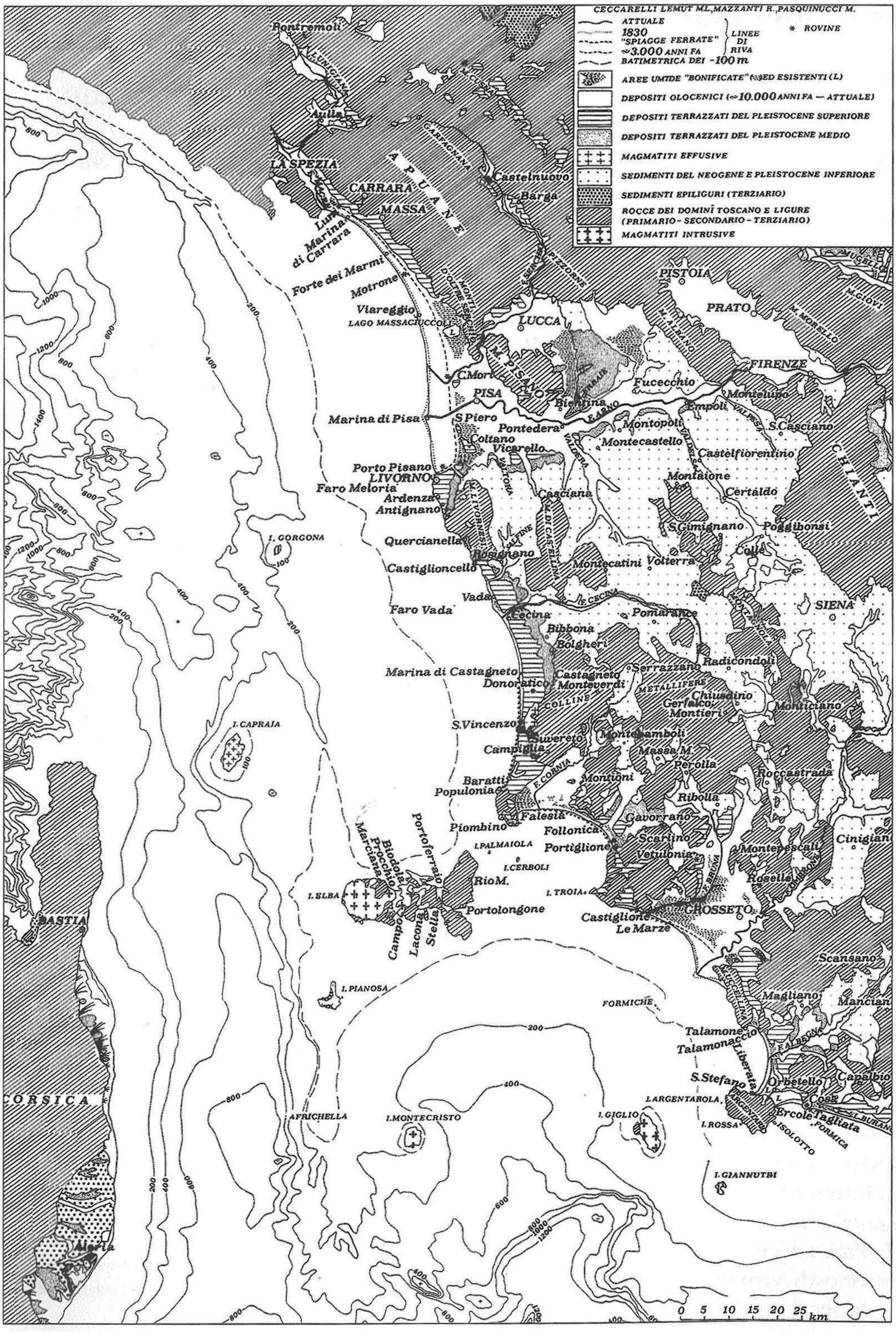
CECCARELLI LEMUT M.L., MAZZANTI R., PASQUINUCCI M.
ATTUALE
1830
"SPIAGGE FERRATE"
≈3.000 ANNI FA
LINEE DI RIVA
BATIMETRICA DEI -100 m
* ROVINE
AREE UMIDE "BONIFICATE" ED ESISTENTI (L)
DEPOSITI OLOCENICI (≈10.000 ANNI FA — ATTUALE)
DEPOSITI TERRAZZATI DEL PLEISTOCENE SUPERIORE
DEPOSITI TERRAZZATI DEL PLEISTOCENE MEDIO
MAGMATITI EFFUSIVE
SEDIMENTI DEL NEOGENE E PLEISTOCENE INFERIORE
SEDIMENTI EPILIGURI (TERZIARIO)
ROCCE DEI DOMINÎ TOSCANO E LIGURE (PRIMARIO - SECONDARIO - TERZIARIO)
MAGMATITI INTRUSIVE
Pontremoli
LUNIGIANA
Aulla
LA SPEZIA
CARRARA
MASSA
APUANE
GARFAGNANA
Castelnuovo
Barga
Luni
Marina di Carrara
Forte dei Marmi
Motrone
Viareggio
LAGO MASSACIUCCOLI
PISTOIA
PRATO
LUCCA
FIRENZE
M. PISANO
C.Morto
PISA
Bientina
Fucecchio
Montelupo
Empoli
Marina di Pisa
S.Piero
Pontedera
Montopoli
S.Casciano
Coltano
Montecastello
Vicarello
Castelfiorentino
CHIANTI
Porto Pisano
LIVORNO
Faro Meloria
Montaione
Ardenza
Antignano
Casciana
Certaldo
I. GORGONA
S.Gimignano
Poggibonsi
Quercianella
Rosignano
Castiglioncello
Montecatini
Volterra
Colle
Vada
Faro Vada
Cecina
F. CECINA
Pomarance
SIENA
Bibbona
Bolgheri
Radicondoli
Serrazzano
Marina di Castagneto
Castagneto
Donoratico
Monteverdi
COLLINE
METALLIFERE
Chiusdino
Gerfalco
Montieri
Monticiano
I. CAPRAIA
S.Vincenzo
Suvereto
Campiglia
Montebamboli
Massa M.
Perolla
Roccastrada
Baratti
Populonia
F. CORNIA
Montioni
Ribolla
Piombino
Falesia
Follonica
Gavorrano
Portoferraio
Biodola
Procchio
Marciana
I. PALMAIOLA
I. CERBOLI
Portiglione
Scarlino
Vetulonia
Montepescali
Cinigiano
Rio M.
I. ELBA
Portolongone
I. TROIA
Roselle
Castiglione
GROSSETO
Le Marze
BASTIA
Campo
Lacona
Stella
Scansano
I. PIANOSA
FORMICHE
Magliano
Manciano
Talamone
Talamonaccio
S.Stefano
Liberata
Orbetello
Capalbio
CORSICA
I. ARGENTAROLA
I. ROSSA
ISOLOTTO
Cosa
Ercole
Tagliata
FORMICA
AFRICHELLA
I. MONTECRISTO
I. GIGLIO
I. GIANNUTRI
Aleria
0 5 10 15 20 25 km

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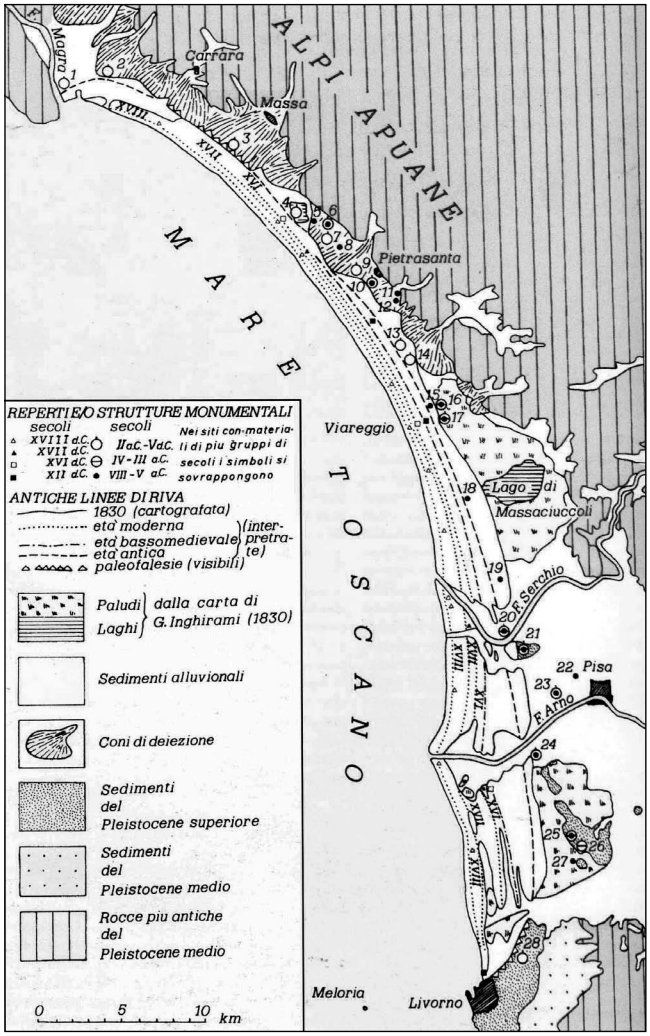
Figure 1. North-west Tuscany: geomorphologic schematic map (by Renzo Mazzanti, Pisa).



Right
Figure 2. The Luni-Livorno shoreline (after Mazzanti 2003).

ern by Volterra. In the early decades of the 2nd century and the late decades of the 1st century BC the establishment of colonies changed the settlement patterns and had a strong impact on the rural landscapes and the coastal progradation (fig.2).

In this area and its hinterland we run an intensive 'total archaeology' research project (Darvill 2001, 36). Diagnostic techniques include geomorphology, palaeogeography, remote sensing, geophysical surveys, archaeological research (including intensive surveys and monitoring of surveyed areas, stratigraphic excavations, underwater archaeology), archaeometric and archaeological studies of finds (metals and pottery), bioarchaeology, the study of ancient and medieval epigraphy, literary sources and toponyms and historical cartography.

The archaeology dates from the late Bronze Age up to the early Medieval period, with our main focus on the late Etruscan, Roman and Late Roman period. At the time of writing the research was still in progress: in this paper we present just part of the results, a few *tesserae* of a larger mosaic. In order to pro-

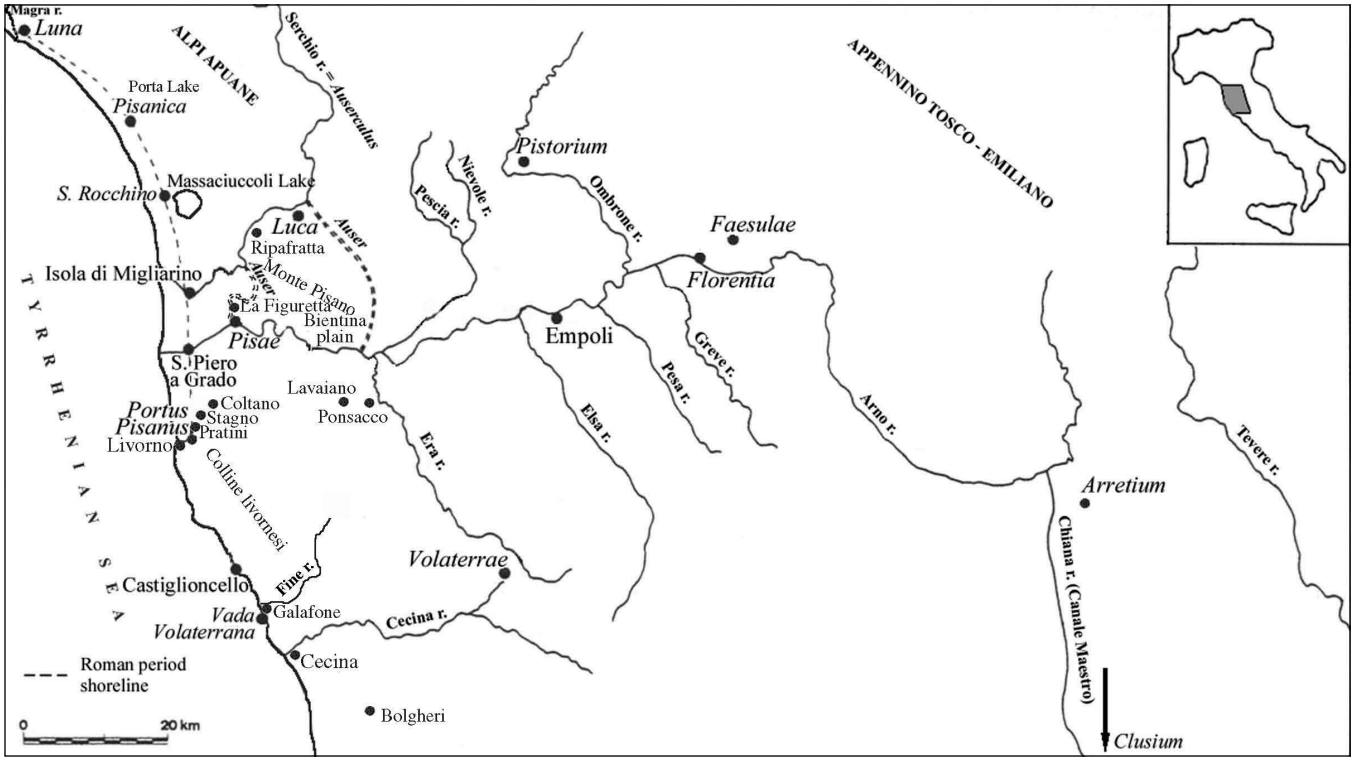


Figure 3. North Etruria: sites and rivers quoted in the text (by Giulia Picchi, Pisa).

vide data for temporal, chronological and transformational frameworks, we will focus on three subjects: evidence for Bronze and Iron Age coastal landscapes, the evolution of the Luni-Pisa littoral and the ancient ports of Luni and *Portus Pisanus*, the main cities in their diachronic rural landscapes.

THE NORTH ETRUSCAN LITTORAL: BRONZE AND IRON AGE LANDSCAPES

The north Etruscan littoral is articulated in three sections (Pasquinucci et al. 2001) (fig. 1):

- The Luni-Livorno shoreline, characterised by strong progradation from the 2nd-1st centuries BC to around 1830 AD;
- The Livorno terrace and Livorno-Castiglioncello coastal strip, which is rocky and stable;
- The Vada-Cecina shoreline, which is low and stable.

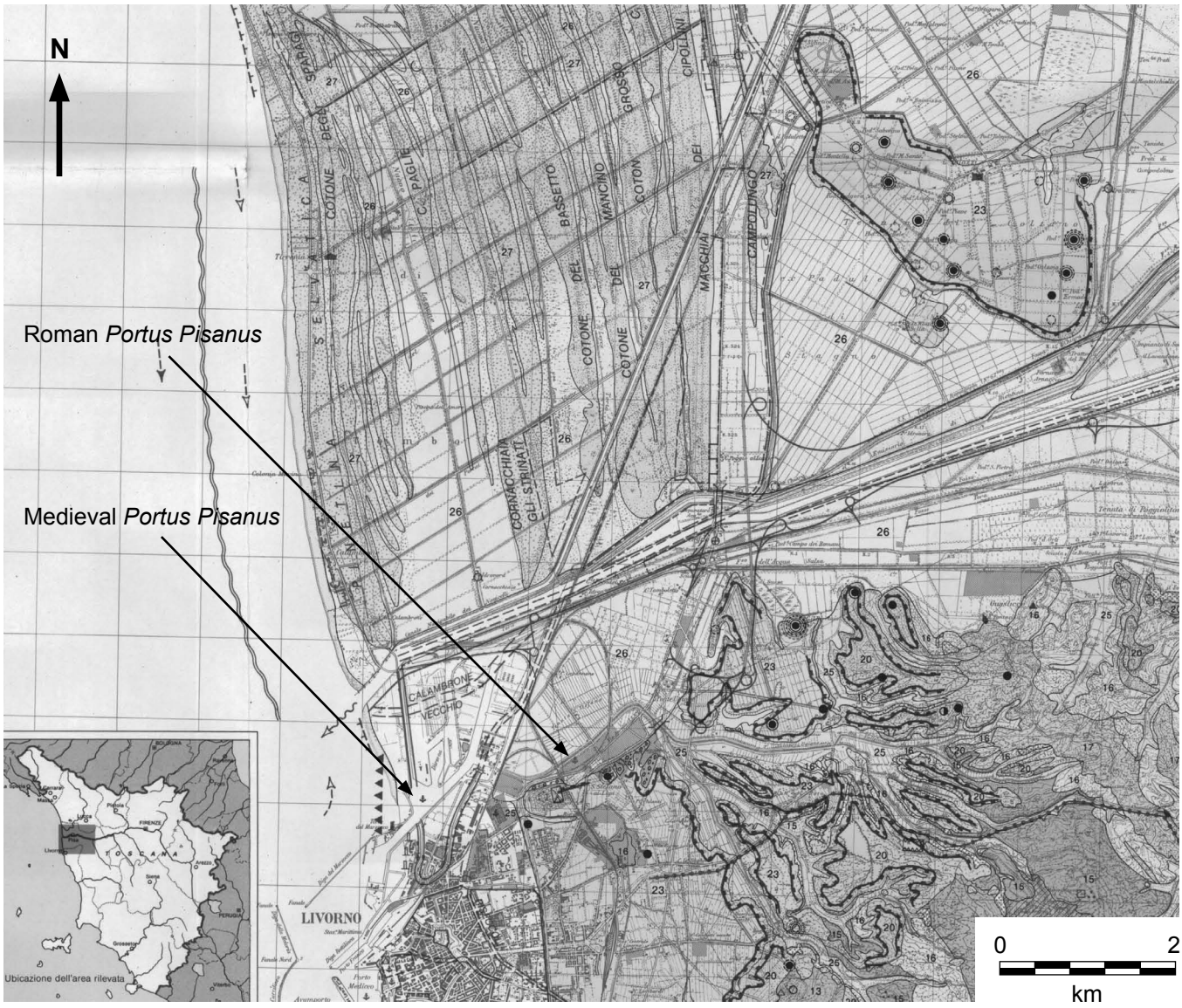
The Luni-Livorno shoreline extends from the Magra river mouth (immediately west of the high and rocky Punta Bianca promontory) to the low and rocky Livorno terrace. It is about 63 km long. In this district the main rivers are the Magra in the north and the Serchio and Arno in the south (figs. 1, 2, 3). In the hinterland are Quaternary plains, the Apuan Alps and the Monte Pisano. The Pisa plain is an alluvial-delta plain formed by the Arno river. A branch of the Serchio (Roman *Auser*) river descending from the north flowed into the Arno at Pisa, as documented by literary and archaeological evidence (Pasquinucci 2003; Camilli

2004; Camilli 2005 (fig. 3). The Livorno terrace and the Livorno-Castiglioncello coastal strip, both rocky and stable, are bordered in the hinterland by the Colline Livornesi (fig. 1).

The Vada-Cecina shoreline (figs. 1, 3) is low and stable. In the hinterland the Cecina is the main river.

In this district some evidence of the coastal environment in the Bronze and Iron Ages is provided by archaeological research. In the Late Bronze-early Iron Age a vast settlement was constructed north-east of Livorno (Stagno, figs. 1, 3) along the shore of a brackish lagoon and on a platform resting on piles driven into the muddy bottom of the lagoon (Zanini 1997: fig. 3 Stagno-Pratini). The platform was made of tree trunks, mostly of elm, more rarely of oak and only in one case of ash; the interstices were filled with bundles of branches lashed together. Abundant traces of leguminous plants, tree fruit and mostly *vitis vinifera* (*sylvestris* and *sativa*) provide evidence at least of selective gathering of certain species combined with

Figure 4. Coltano and *Portus Pisanus* area shown in the lower Arno Valley in a detail of the geomorphological map of Mazzanti (1994). The numbers identify geomorphological units (Mazzanti, 1994) and the colored symbols identify archaeological sites (Pasquinucci, 1994) dated to prehistory (black), archaic and classical period (red), middle ages (violet), and modern times (green). *See also full colour section in this book*



the earliest forms of their cultivation. Domesticated animals were raised (cattle, swine, mostly sheep and goats); hunting (deer, ducks, seagulls) and fishing (sea mullet) were other important activities.

In the Bronze and Iron Ages coastal salt marshes are indirectly documented by archaeological evidence of briquetage salt production (Weller 1998, 282-283) in the ancient coastal strip at Isola di Coltano (south of Pisa, figs. 3, 4) and at Galafone (South of Castiglioncello, fig. 3). At Isola di Coltano surveys and excavations identified a village dated to the middle and final Bronze Age (1600-1200 BC) located on the banks of a coastal lagoon which repeatedly submerged the area. No evidence of huts or waste foods was found. We can infer that the excavated village was a 'manufacturing', not a dwelling one (Pasquinucci & Menchelli 1997, 2002). The anthropic layers were formed by mounds of fragmented coarse vessels (more than 10,000 fragments were collected) and by a few fireplaces near which numerous firedogs were found. A charcoal sample from one of these fireplaces is dated to 1686-1538 BC (C14 analysis by the Centre for Isotope Research at Groningen). The lagoon floods are documented by yellow silt deposits containing molluscs (mostly *Cerastoderma edule*) covering the anthropic layers. These molluscs are characteristic of a low brackish marine habitat, typical of a lagoon. They belonged to various biologic cycles as the identification of different dimension individuals has shown. Their valves were closed: it provides evidence they died *in loco*.

Concerning the chronology of the site, the lower calcrete layers contain vessels dated back to the Middle Bronze age (1600 BC: this datum wholly agrees with the mentioned C14 analysis); some Final Bronze Age items (1200 BC) have been found in the superficial levels. Therefore the village appears to have been in existence for four centuries: the site was submerged by the lagoon at least four times, but it was always reoccupied by people involved in salt making, as shown by the morphological and technical continuity of the ceramics (Di Fraia & Secoli 2002). The frequent reoccupation of the village proves that the site was highly suitable for such economic activity. The selection of the site must have been influenced by the vicinity of the lagoon, the availability of fuel and clay, the proximity to roads and the access to coastal and inland lagoon/river navigation systems, which made it possible to distribute the salt.

In the early Iron Age, the briquetage technique is documented at Galafone, North of Vada (fig. 3). Large mounds of fragmented coarse vessels were identified by intensive surveys, together with layers of ashes and some parallelepiped firedogs, similar to the Coltano ones (Pasquinucci et al. 2002).

It is to be noted that in the Roman and Medieval periods salt production is documented in this same area, but different techniques were used, evidently connected with a changed environment. In fact, in the early 5th century AD the production of sea salt in the Vada area is noted by the poet *Rutilius Namatianus* (*de red*. 1, 475 ff.), who described the saltpans (*salsa palus*) in the area of *Vada Volaterrana* (present Vada: figs.1, 3). According to his description, the seawater entered the marshes through canals, and a drainage ditch irrigated the water basins. During the summer, locks were closed in order to break the communication between the sea and the marsh; the seawater evaporated in the pools, depositing the salt. In the Middle Ages, salt production at Vada is documented by archival evidence from 754 AD up to 1237 (Ceccarelli Lemut 2000; Collavini 2010, 35).

In the Iron Age, evidence of coastal landscape transformation is provided by archaeological research at Vada (figs.1, 3). A hut village located on the coastal palaeodunes, dated to the 9th century BC, was submerged by a coastal lagoon (C14 analysis by the Centre for Isotope Research at Groningen). Its remains (wooden posts, pieces of clay daub, coarse pottery) were covered by various layers of sand containing fossils (mostly *Cerastoderma edule*, *Abra alba* and *Gastrana fragilis*) typical of a lagoon environment sedimentation. This event can be referred to a phase of high sea level, probably followed by a relative

drop which caused the drying of the lagoon area. The site was abandoned until the 1st century AD, when a quarter of the Roman settlement *Vada Volaterrana* was built in this area (Pasquinucci et al. 2002).

According to our research, the probably discontinuous Late Iron Age (8th century BC) shoreline from the Magra river mouth to Livorno (fig. 2) was almost stable up to the 2nd century BC. In this timespan a cool and relatively damp climate phase (dated to the 9th-3rd century BC) was followed by a warm phase up to the 4th century AD (Pinna 1996, 121-124). From the 2nd-1st centuries BC up to about 1830 AD the coastline prograded 7 km westwards, mostly in correspondence with the Arno mouth (fig. 2), as a result of a marked increase in alluvial sedimentation (Pasquinucci et al. 2001). In a period characterised both by sea level rise (Lambeck et al. 2004) and by the absence of drastic climatic changes, the sedimentation was most probably due to anthropic causes. Among these, the main elements were the construction of new towns and settlements, deforestation and increased agricultural and manufacturing activities connected with the establishment of colonies in the early 2nd century BC (*Luca*/Lucca and *Luna*/Luni) and in the late 1st century BC (triumviral/Augustan colonies at Luni, Lucca, Pisa, Volterra, Firenze, Arezzo), in particular with the organisation of their territories (*centuriatio* and land allotments) (Ciampoltrini 1981; Ciampoltrini 2004; Pasquinucci & Menchelli 1999; Pasquinucci & Menchelli 2003) (see below and fig. 3).

This phenomenon came to an end around 1830 AD, when the Arno-Serchio rivers were diverted away from the sea and into the lagoon as part of the systematic land reclamations pursued by the Lorena (Barsanti Rombai 1986, 47). The river sediments filled the low-lying lagoon, but the cessation of sediment deposition in the river mouth led to the erosion of the Arno delta, which began in the late 19th century (fig.2). All these phenomena point out the close relationship between the fluvial sediment transport and beach growth.

As for the rivers, remote sensing, geomorphologic and palaeogeographic research, geophysical investigations, archaeological surveys and excavations provide evidence of an extremely complex network of palaeorivers, of Etruscan, Roman and Medieval embankments, channels and ditches (Mazzanti 1994; see below). The Greek and Latin sources mention only the main ones in the district (*Macra*, *Arnus*, *Auser*, *Caecina*) and the *Fossae Papirianae*, a Roman artificial canal documented in the *Tabula Peutingeriana* North of Pisa. Medieval sources mention various rivers and river branches (Magra, Arno, *Auser*, *Auserculus*, *Tubra* flowing across the Pisa plain, Cecina).

The hydrogeological evolution of the Pisa-Lucca territory and the long term human actions aimed at optimising the rivers regime were perceived by the ancients, as documented in the early Imperial period by Strabo, after his sources (5.2.5, 222C):

> 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 waters (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… (translated by H.L. Jones, Loeb Classical Library, 1949).

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 segments and the draining of stagnant waters to the construction of embankments, dikes, *casse di colmata* and the building of canals to channel flood waters (Ceccarelli Lemut et al. 1994).

Of peculiar interest is the complex history of the Serchio (*Auser/Auserculus*/Serchio) river (figs. 1, 3), flowing from the Apennines to the south and the south-west. In Roman times, north-east of Lucca its course divided into two branches. One of them flowed across the Bientina plain into the Arno river, the other westwards across the Stretta di Ripafratta to the coastal plain, where it divided into two branches: one of them (*Auserculus*) mounded into the sea, the other southwards reached Pisa and flowed into the Arno (fig. 3). Recent field researches in the district provide evidence of the flooding frequency of the Arno/Serchio river system. Most probably climatic fluctuations triggered these events (Pasquinucci 2008b; Pasquinucci & Menchelli 2009).

Starting from 400-450 AD and up to the late 8th century, a new humid-cold phase took place (Pinna 1996, 125). Concerning this period, ancient authors describe exceptional rainfalls which caused catastrophic floods. In particular *Paulus Diaconus* mentions the *Diluvium* (the deluge), referring to 589 AD (Paulus Diaconus, *Historia Langobardorum* III, 23; Dall'Aglio 1997).

This climatic crisis explains the origin of the tradition concerning the miracle attributed to Saint Frediano, bishop of Lucca between 560 and 588 AD. In the 6th century AD floods and large marshes affected the plains through which the Serchio flowed. In order to reclaim the soil, actions were taken that were handed on by the medieval hagiography as a miracle attributed to Frediano (Gregorius Magnus, *Dialogi* 3.9; Ceccarelli Lemut & Garzella 2005, 11; Mazzanti 1994). According to this medieval text, the Saint di-

Figure 5. The *Portus Pisanus* late republican seabed (photo by Stefano Genovesi, Pisa).

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Figure 6. Luni in its changing landscape (courtesy of Monica Bini, Pisa).

verted the course of the Serchio river using a rake and prevented the frequent river floods. Most probably the intervention was actually carried out on the initiative of bishop Frediano, who possibly superintended the work too. Actually, in late Antiquity and early Middle Ages the bishops frequently practised not only the religious functions pertaining to their *status*, but also the civil ones that were no longer guaranteed due to the collapsing state structures.

From the Middle Ages up to the Renaissance and in the centuries of vast land reclamation projects which continued up to and even after World War II, many interventions on the Serchio and the Arno courses are documented. For example, in the Middle Ages the Comune di Pisa and later the Medici intervened in the management of the lower Arno and Serchio basins, by cutting a few meanders off these rivers and straightening the Arno's terminal segment (Ceccarelli Lemut et al. 1994).

TWO ANCIENT PORTS IN THEIR CHANGING ENVIRONMENT: *LUNI* AND *PORTUS PISANUS*

The coastal and hydrological evolution was particularly impressive in the Luni district and in the Pisa territory (*ager Pisanus*) and heavily affected the north Etruscan ports and calls network. The Luni (*Luna*) plain underwent major landscape changes over the last 3000 years (figs. 1, 3). A geomorphologic and archaeological project is studying the palaeogeography of the Luni plain, where the coastline shifted southward and westward; the project is also addressing the long debated question of the location of the *Luna* port(s) (Bini et al. 2009 a, b, c; cf. Bernieri et al. 1983; Delano Smith 1986). Since a few centu-

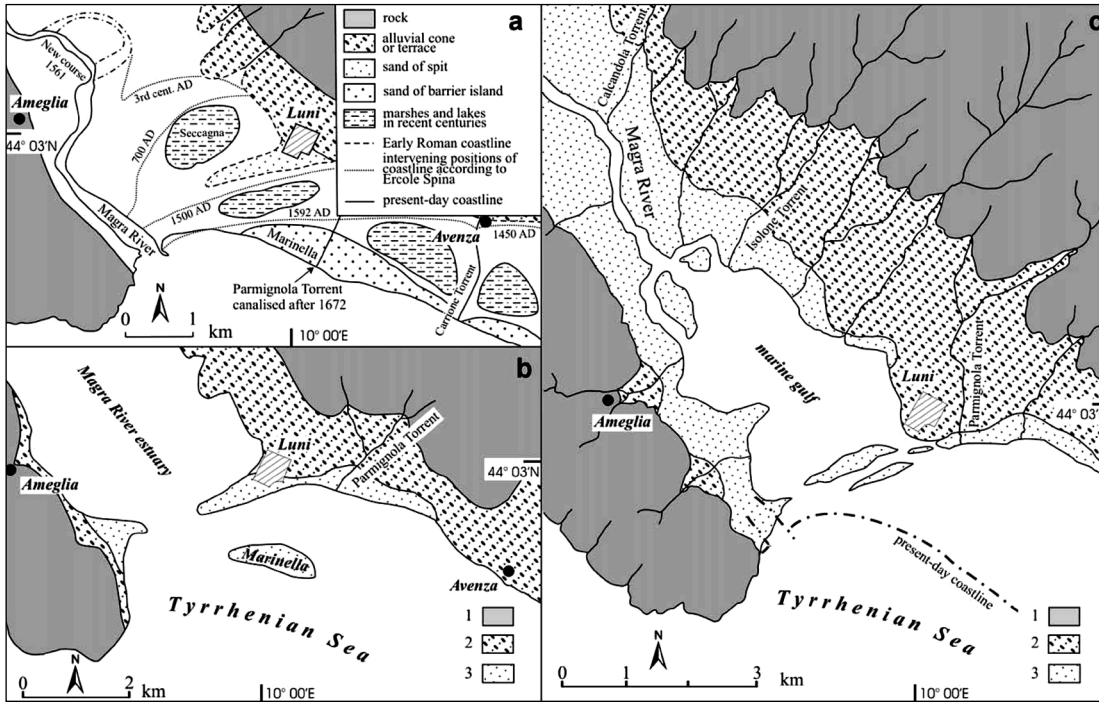

Figure 7. Palaeogeographic scenarios of the Luni territory (after Bini et al. 2009b)

ries before the foundation of *Luna*, the coastal plain had been characterised by a complex architecture of swamps and marshes, limited by dune ridges and fluvial sand bars. The positions of these landforms shifted, mainly depending on the spatial relationship between the coastline and the rivers mouths (Bini et al. 2009 a, b).

Luna (Luni), a Roman colony, was founded in 177 BC (Liv. 41.13.5) in a newly conquered territory in the coastal strip about 3 km south of the present Magra river, between the mouths of the Magra and the Parmignola stream (Bini et al. 2009 a, b) (figs. 6, 7). In Roman times the first was north of *Luna* (Loc. Bocceda, Sarzana: Gervasini 2007, 160). The Parmignola is likely to have changed its position after Roman times, gradually migrating from west to east; it currently flows 1 km east of *Luna* (Bini et al. 2009 a, b).

The new town was founded on an alluvial fan on the eastern side of the marine gulf into which the river flowed (Durante 2010; Bini et al. 2009c). In the territory, the *centuriatio* provided the drainage and road grid. The Seccagna, north-west of Luna, between the town and the Magra, was a vast shallow basin traditionally interpreted as the port of the colony. This was progressively filled by peat, which was rich in Roman pottery fragments, and by dark alluvial clay (Bini et al. 2009b; Durante 2001). In the early 6th century the *Itinerarium maritimum* mentions *Lune*, *fluvius Macra*, providing evidence that the *Luna* port was perceived in connection with the Magra river mouth. The presence of structures interpreted either as docks or as shoreline reinforcements is not confirmed by archaeological research.

As for Pisa, in Antiquity the city and its territory had a well integrated network of sea- and river-ports (Pasquinucci 2003, 2007). The main port was situated NNE of present Livorno. It is denominated *Portus Pisanus* by the *Itinerarium Maritimum* (501) in the early 6th century AD. A harbour station named

Labro by Cicero (*ad Quintum fr.*, 2.5) was probably located in the area (cf. current hydronym Calambrone: Pasquinucci 2003) (fig. 4).

The *Itinerarium* provides the accurate position of *Portus Pisanus*: the harbour was located 23 *milia* from *Vada Volaterrana* and 9 from the Arno river mouth in those times (*Pisae fluvius*). In the 18th and 19th centuries AD conspicuous remains of the Roman harbour settlement were still standing (Targioni Tozzetti 1768; Banti 1943). In this area (figs. 1, 4) the low and rocky ancient coastline (current 'Gronda dei Lupi') was set up south-west/north-east, in the same direction of the prevailing wind (Libeccio). The sea storms were damped down by the wave refraction near the coast and by the Meloria shoals, located 10 km south-west of the Gronda in the offing.

Thanks to its favourable geomorphologic peculiarities, this area north-north-east of Livorno was frequented by ships at least since the late 7th-early 6th century BC to the 6th century AD, as is shown by palaeogeographic and archaeological research. Recent excavations have brought to light evidence of a seabed (fig. 5, see below) and a port settlement served by an aqueduct originating from the nearby hills (Pasquinucci & Menchelli 2010).

The first provides evidence of an area that was navigated by appropriate crafts loading and unloading wares at least since the late 7th-early 6th century BC. In the 4th-3rd century BC stone blocks and posts were set up either to reinforce the shoreline or to provide a dock. The stretch of water was progressively and rapidly silted up by alternate sand and *posidonia* (seagrass) layers since the mid-2nd century BC; in the late 1st century BC activities connected with navigation could no longer be performed in this area and were therefore shifted westwards (Pasquinucci 2003, 2004). In the port settlement (2nd-6th century AD) *horrea* and a necropolis were excavated (Pasquinucci & Menchelli 2010).

In the 5th century AD *Rutilius Namatianus* landed at *Portus Pisanus*, both well sheltered *(de red.* 1, 559: *puppibus meis fida in statione locatis)*, busy and rich (*portum quem fama frequentat Pisarum emporio divitiisque maris*). In the hinterland, the nearby hills were covered by woods where *Rutilius* and his companions went hunting boars. The same woods supplied several amphora, brick and tiles and coarse pottery workshops with fuel (Cherubini et al. 2006).

The silting chronology matches the above-mentioned data, which indicates that 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 Imperial, Late Roman and Medieval *Portus Pisanus* were located one after the other westwards of the Roman Republican one, confirming the coastal progradation (fig. 4; see also fig. 2).

THE CITIES AND THEIR TERRITORIES: LANDSCAPES IN A DIACHRONIC PERSPECTIVE

In Etruscan times Pisa (*Pisae*) and Volterra (*Velathri*, *Volaterrae*) were the main cities in north-western Etruria. Their territories respectively included the Magra-Fine rivers and the Fine river- Bolgheri coastal strips and large hinterlands (figs. 1, 3). Volterra was conquered by the Romans in the first half of the 3rd century BC. Pisa became *civitas foederata* in the mid-3rd century BC, and in the 2nd century BC it was a Roman military base during the wars against the *Ligures*. In 180 BC Pisa granted part of its northern territory for the establishment of the Latin colony *Luca* (Lucca). In 177 BC, when the *Ligures* were defeated in north-west Tuscany, the Roman colony *Luna* (Luni) was established (Coarelli 1985-1987; Ciampoltrini 2004).

Between 42 (*Philippi* battle) and 31 BC (*Actium* battle), or after *Actium*, the cities and most plains in north Etruria were remodelled by veterans' colonisation (Ciampoltrini 1981, 2007, 14; Keppie 1983) (fig. 3). The *centuriationes* and the related drainage systems carried out in this period are largely preserved, since they were shaped according to the local geomorphology and hydrology by highly skilled *mensores*. In some areas of earlier colonisation (e.g. *Luca*: 180 BC) the orientation was slightly changed, most probably in order to match the hydrological situation.

In north-western Etruria the triumviral-Augustan colonisation was marked by economic growth in farming, manufacturing and trade (Pasquinucci & Menchelli 1999; Pasquinucci & Menchelli 2003) and had a strong impact on landscape and territory. The landscape remained substantially the same until the mid-6th century (see below).

For what concerns Pisa, recently the toponym (Greek: *Pisa/Pisai/Peisa/Peisai*; Latin: *Pisae*) has been interpreted as Indo-European, meaning a site rich in water, both stagnant and flowing (Dini 1994). In the late 7th century BC the Etruscan town originated in a few settlements separated by major and minor streams, at the confluence of the river *Auser* (an ancient branch of the Serchio) into the Arno (Strab. 5.2.5; Plin. *N.H.*, 3.50; Rut. Nam. 1.566; Schol. Ptol. 3.1.4.) on the right bank of the latter (fig. 2). Pisa was 20 *stadia* far from the seacoast according to Strabo (5.2.5) and his sources (therefore in the late republican-early imperial period). The site was an important crossroad, where the north Tyrrhenian coastal route intersected the route following the Arno and Serchio rivers banks and linking the riverine ports of call. The rivers were a natural defence, a resource and a risk. Both the *Arnus* and the *Auser* were still busy waterways in late Antiquity: in the 6th century *Theodericus* took actions against the fishermen who used to hamper navigation of both rivers by weirs (Cass. *Var.*, 5, 17, 6; 20, 3: referring to 523-526 AD).

The distribution of the archaeological finds demonstrates that the pre-Roman settlement was scattered on several low mounds formed by previously deposited fluvial sediments and separated by river branches and streams. Excavations in the city centre (via S. Apollonia) provide evidence both of a low mound (embanked by means of vertical poles and horizontal planks) and of an adjoining humid zone that was filled by the deposition of peat layers and by the accidental or deliberate accumulation of large amounts of pottery fragments, bones and vegetal elements that consolidated the soil (Corretti & Vaggioli 2003, 57). This evidence is dated from the 7th to the early decades of the 5th century BC, when a silt and clay layer deposited by a river flood covered the previous phases. In the same period (around 480 BC) a flood damaged a large part of the town area (Bruni 1998, 137, 198: evidence in piazza Duomo, piazza Dante). Here, as elsewhere in the town, the streams progressively silted up after the 4th-3rd centuries BC. In the early imperial age the differences in level were filled by residual brick, tile and pottery fragments, in order to provide a suitable urban soil (Corretti & Vaggioli 2003, 60.). In the ancient town suburb (north-west periphery of present Pisa) evidence of the late-Republican to late antique landscape is provided by a few shipwrecks sunken in the *Auser* by floods, one of which is dated around 10 AD (Camilli 2004, 2005; Benvenuti et al. 2006; Martinelli & Pignatelli 2008; cf. Leveau 2008). The wrecks are dated from the second half of the 2nd century BC to the late 6th-early 7th AD.

In the territory, archaeological research provides evidence of dramatic hydrological instability. East of Pisa a flood destroyed an Etruscan settlement at the turn of the 6th to 5th century BC (Pasquinucci et al. 2008, 41-74.) (fig. 3). Etruscan drainage works in the plain east of Pisa are demonstrated by the presence of a 5th-century reclamation channel (Bonamici 1990, 115; Pasquinucci 1994, 189; Maggiani 1990; Pasquinucci 2008a) (fig. 3), which is the clue to Etruscan drainage systems constructed in a period characterised by hydrological instability.

In the last decades of the 1st century BC the colonia *Opsequens Iulia Pisana* was established and a vast *centuriatio* was constructed in the *Pisae* plain. This had a dramatic impact on the town and its territory. The *centuriae* were bounded by a largely surviving grid of roads, ditches and channels. The channels are a characteristic feature of the landscape in the southern part of the plain, providing the area with the necessary drainage. Literary, epigraphic and archaeological sources show a landscape greatly moulded by anthropic activities, where the natural resources were exploited within well organised enterprises. As usual, the colonisation implied deforestation, tillage of previously uncultivated areas, development of the road network, construction of drainage systems.

Hydraulic works in the Arno valley must have been very demanding because of drainage troubles mostly due to plain subsidence (Pasquinucci et al. 2001). Drainage canals dated 50 BC-50 AD have been identified in the area north-east of *Pisae* (Bonamici 1989). The *fossae docariae* quoted by medieval archive sources in various sites along the Arno left bank can be connected with the Roman hydraulic works (Ceccarelli Lemut et al. 1994, 420).

Along the *limites*, farmsteads were set up (Pasquinucci & Menchelli 2003). The countryside reorganisation improved the agricultural production, mainly grain and wine crops (Plin. *N.H.* 18, 86-87; 18,109: *siligo*, *alica*; Plin. *N.H.* 18, 109: *Pariana uva*). The north-Etruscan production of wine amphoras (Graeco-italic, Dressel 1, Dressel 2-4, Spello, Forlimpopoli and Empoli types) confirms the importance of the pisan-volaterran viticulture (Cherubini et al. 2006). Olive oil production is archaeologically documented by equipment (an oil press and decanting tanks) excavated in local *villae* (Pasquinucci & Menchelli 2003) and by bioarchaeological data (Motta 1997; Mariotti-Lippi et al. 2006, 2007).

Woods were very important in both landscape and economy of North coastal Etruria: e.g. in the late Republican-early Imperial period the timber was used *in loco* for ship construction and was exported to Rome as building material (Strabo 5.2.5). The Pisan stone-quarries, located in the Monte Pisano slopes, strongly affected the natural landscape (Strabo 5.2.5). The local limestone has been identified in Roman buildings in *Pisae* and its territory.

The Pisa district was characterised by pottery production. River banks and woods were intensively exploited for the raw material (clay and fuel) necessary for the pottery production that included *terra sigillata*, bricks and tiles, wine amphoras, coarse vessels and *dolia*. In the Augustan period the ceramic activities reached their peak with the *terra sigillata* vessels: it was the main phenomenon in the north Etruscan economy and one of the most important in the history of Roman pottery (Menchelli et al. 2001).

Population pressure, soil erosion caused by ploughing and woodcutting increased the fluvial sediment transport and caused remarkable changes in the north Etruscan coastal landscape (see above and Grove & Rackham 2001). In the Late Roman period (5th-6th century AD) a progressive degradation and depopulation is documented in the Pisa territory, but in different ways and times according to the geographical areas and the socio-economic contexts. Already during the 3rd century AD, in the Eastern Pisa plain (Lavaiano area) a spreading marsh caused some early imperial farmsteads to be abandoned (Pasquinucci et al. 1997, 241).

In many sectors of the Pisa plain the small and middle-sized farmsteads continued in use up to the end of the 5th century. The rural settlement patterns appear to document a still remarkable agricultural production; the imported vessels and amphoras found in the farmsteads and villas provide evidence they were producing not only for subsistence but also a surplus to be traded. The 'Empoli' type amphora proves that the local wine production continued conspicuously at least up to the end of the 5th century.

Economic activities such as shipbuilding (cfr. Claudian, *Bell. Gild* 483) and vessel ceramic production are documented all through Late Antiquity (Cherubini et al. 2006).

In the 6th century the ecological and economic situation started to change. The small/middle-size farmsteads disappeared; a large villa at Massaciuccoli (figs. 1, 3) was still active but was occupied by a Pieve (Parish), which became the centre of the church's management of the territory (Ciampoltrini 1994). The *saltus* landscape spread, mainly in the inner valleys and mountainous areas where forestry and sheep-breeding were always prevalent. Hunting and fishing (e.g. Cassiodorus, *Var.* 5.17 and 20) were important economic activities.

During the Goth-Byzantine war (535-556 AD) destruction, epidemics and famine likely affected the district. Lacking State control, the hydraulic works necessary for the plain drainage were abandoned and wide marshes started spreading in areas which had undergone *centuriatio*. Many Medieval documents mention toponyms referring to forests (e.g. *Selva*, *Travalda*) and marshes (e.g. *Stagno, Putrido*) (Ceccarelli Lemut 1994, 415) in areas which were intensively occupied by farmsteads and villas in Roman times. In the late 6th century *Pisae* still kept an important role, in the context of the Byzantine sea routes which focused just on the strategic areas that were necessary for the Empire's defence. At the beginning of the 7th century the Lombards conquered the coastal strip: the Late Roman cultural landscape changed into the Medieval one.

A new town, the Latin colony *Luca* (Lucca), was founded in 180 BC (Liv. 40.43.1) on the left bank of the *Auser* (Serchio) river (figs. 1, 3). As elsewhere, the river was a natural defence, a resource and a risk. The eastern segment of the northern city walls is curving in plan, most probably because it ran parallel to the *Auser* (a palaeochannel is identified in the aerial photographs of the area). This portion of the fortified perimeter was particularly at risk, being close to the river at the time. Archaeological research provides evidence that here a portion of the outer face of the city walls was mended after damage produced by a flood in Triumviral – early Augustan times. A flood dated between 10 and 20 AD is documented in the eastern suburb of the town (Ciampoltrini 2007).

The *Luca* 2nd-century *centuriatio* reclaimed land in the *Auser* plain and was oriented north-south. Evidence of several floods dated to the 2nd and 1st century BC is provided by archaeological research in the territory (Ciampoltrini 2007). Possibly because of such hydrological instability the later *centuriatio* dated to Augustan times was oriented north-north-east, like the town plan. A few streams were canalised. In-mid imperial times, at least the marginal areas of the plain started becoming marshy: on the eastern plain a *decumanus* underwent several episodes of maintenance before it was replaced by a wooden viaduct in the mid-imperial period (Ciampoltrini 2007, 42). In the Middle Ages the *centuriatio* survived several ecological crises in many areas of the *ager Lucensis*, mainly south and east of the town.

RESULTS AND FURTHER RESEARCH

Our multidisciplinary diachronic research provides sound evidence for temporal, chronological and transformational frameworks in north-western *Etruria*. We will further develop this intensive 'total archaeology' project in the next years, in order to outline the palaeogeography, the settlements patterns and the changing landscapes in the district.

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