

Chapter 3

Landscape reconstruction and description of the research areas:

Salento Isthmus, Pontine region, and Sibaritide

Land systems, landforms and soils

3.1 Introduction

This chapter describes the various land systems, which were classified for the three research areas. As has been explained in section 2.2.2 (land systems, land mapping units and land qualities), the areas had to be remapped into land systems: *an area or group of areas with a recurring pattern of landforms, soils and vegetation* (CSIRO 1963). The reasons for remapping were threefold:

- It turned out to be the solution for comparing the three areas, which were mapped according to different research methods. The Pontine region area was mapped in physiographic units, roughly following the soil map of Sevink et al. (1984) and expressing their genesis. For example: alluvial fan unit, fluvio-colluvial unit, limestone unit and beach ridge unit. The same method was used in the Sibaritide. However, the Salento peninsula was mapped (as was explained before in chapter 2) into geomorphological units, because this type of mapping proved to be the best method (in terms of time available) in an area, which had never been mapped (apart from geologically) before, especially when the size of the area is taken into account. Remapping the Pontine Region and the Sibaritide area provided a chance to compare them within one system.
- It is a more realistic way in judging landscapes for (archaeological) land use, because people would have cultivated (if they had the opportunity) various soils for various LUTs. They probably valued the entire landscape for its capabilities instead of a single part of it.
- A land system expresses all natural processes and forms related to each other. A coastal land system, for instance, includes beaches, dunes and lagoons lying behind beach ridges.

For each land system, various landforms were examined according to the guidelines explained in the previous chapter. However, some landforms enclosed sub-units because of, for example, varying soil depths or differing slope percentages. These sub-units have not been mapped, but are described in the sections below.

A few terms, which were used in the text below, need some explanation before proceeding.

Vegetation

In the description concerning vegetation, the terms *maquis and garrigue* occur. Maquis and garrigue are indicative vegetation types characteristic for the Mediterranean basin (Burnie 1995). Both are the result of fire incidents and deforestation for creating pasture and form the first indications of regeneration of the vegetation. In the maquis, *Arbutus unedo* and myrtle (*Myrtus communis*) are common. In rocky areas, garrigue refers to a vegetation type, which barely reaches 50 cm in height, such as thymes (*Thymus*) and cistes (*Cistus*).

Soils

Shallow soils commonly have an A/C profile and have a depth to hardrock of less than 30 cm. Deeper soils are over 30 cm thick.

Stoniness

In the proceeding text of this thesis (chapter 2), stoniness is a well-defined land characteristic, indicating a precise percentage of gravel in a matrix of, for instance, sand, silt or clay. It is noteworthy to say that stoniness of a field is just an indication of (some) dispersed stones.

Structure of this chapter

Section 3.2 starts with an overview of the literature concerning landscape changes due to either natural causes or human-induced factors or both. The land systems of the Salento peninsula are described in 3.3. Next, section 3.4 starts with a landscape reconstruction of the Pontine region from roughly 4000 BP onwards and proceeds with the land systems. The Sibaritide land systems are dealt with in 3.5. Finally, the last section shows an explanatory table of all soil types mentioned in the text below.

3.2 Landscape reconstruction

Landscape reconstruction forms the basis for archaeological land evaluation. In the Pontine region especially, much research was done in order to get a better grip on the cyclic erosion and deposition events and on the factors which triggered them. In the literature dealing with these subjects, there is much disagreement. The different views are summarised below.

Bintliff (2000) summarises Vita-Finzi's *Mediterranean valleys* (1969): a pioneer investigation on the (possible) causes of alluvial episodes in the Mediterranean basin figure 3.1).

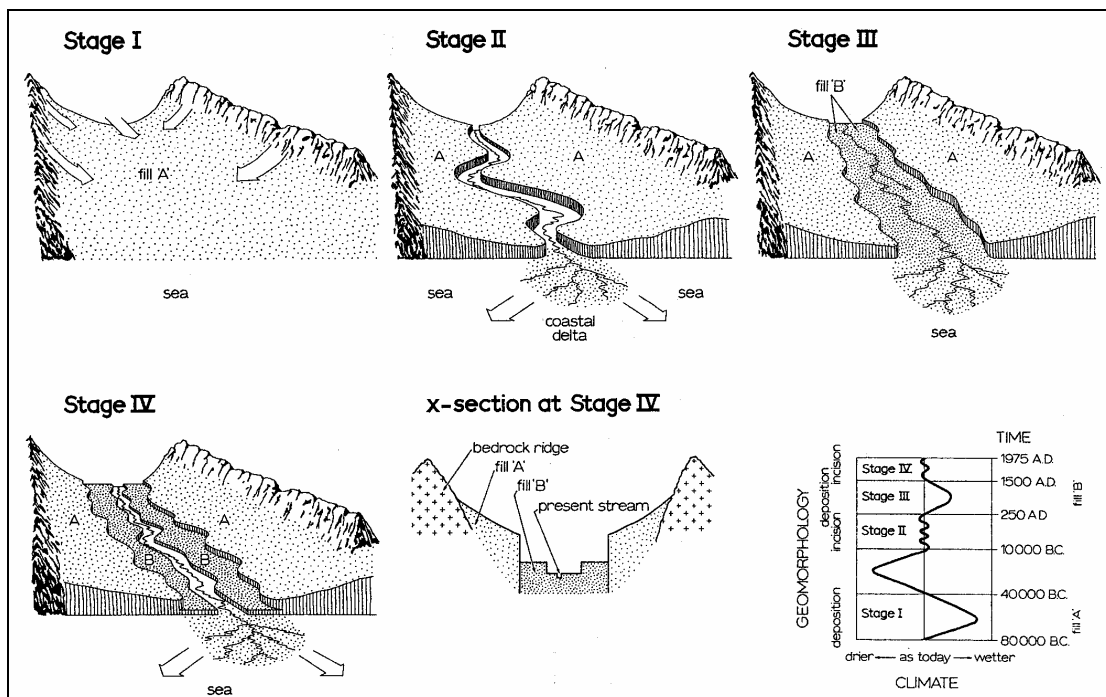


Figure 3.1 Alluvial episodes in the Mediterranean basin (after Vita-Vinzi 1969 and Bintliff 2000)

The Older Fill (stage 1) represented massive slopewash and colluviation during the last glacial period, reflecting a very different, periglacial regime in the Mediterranean region to that of today. During the early to mid Holocene there was little aggradation in the valleys, whilst the erosion of the Older Fill and small-scale soil erosion contributed to competent stream systems whose bedloads were primarily concentrated in coastal delta formation (stage 2). From later Roman Imperial times to the

Middle Ages, and locally beyond into the early Post-Medieval era, a renewed phase of generalized aggradation occurred throughout the Mediterranean river systems- the Younger Fill (stage 3), to be followed by a recent tendency for reduced alluviation and downcutting through the second fill series. This recent aggradation is attributed to a phase or phases of wetter and cooler climate in the Mediterranean, including the well-attested global downturn of climate known as the Little Ice Age (16th – 18th centuries AD).

Bintliff claims, that *the implication of this scheme was that under the 'normal' long-term regime of the Mediterranean climate, despite a history of intense human settlement, erosion was surprisingly limited, with landscape modification occurring in two long-spaced episodes.*

On the contrary, Van Andel and co-workers (1990) claim that since the Early Neolithic in Northern and Southern Greece all major erosional events are attributable to anthropogenic 'use and abuse' of the landscape. Brückner (1986) summarises the probable causes: *Foundation and expansion of settlements, colonisation, destruction of the protective vegetational cover, deforestation, cultivation of grain and olive trees, widespread goat-keeping, latifundia-systems and overpopulation.* He studied south Italian landscapes and concluded that the ecologically unstable Mediterranean environment (heavy rainfalls, steep relief, and easily erodable sedimentary rocks) was very susceptible to human interference.

Moreover, Lyrantzis and Papanastasis (2000) conclude from their research in Crete concerning human activities and desertification (natural processes which influence gradual land degradation) that:

- Desertification is a cumulative phenomenon having developed after a long period of environment perturbation caused by human activities,
- Human activities, namely pastoralism, farming and hunting, have destroyed the environment in the Neolithic period. Since then, a dynamic equilibrium among these activities has been established (...).

Also, from the Biferno valley study (central southern Italy, Barker 1995), one of the most striking result was the repeated correlation between human activity and valley sedimentation. Barker concludes that *human land use practices were the major agents of landscape change during the later Holocene.*

According to Bintliff (1992, 2000), between the models of Vita-Finzi and Van Andel et al. *lies a wider range of multicausal possibilities*, because erosion events do not seem to fit in well with human environmental impacts. He proposes an interactive model that investigates *the many ways in which natural and human impact factors interact to encourage or inhibit erosion and alluviation in Greece and the Mediterranean.*

The model requires:

- a clear understanding of both settlement and land use history,
- a climate reconstruction, preferably including extreme storms and rainfall events
- knowledge concerning the natural erosion susceptibility of the eco-zone (including the natural relationship between slope stability and valley fill) and,
- a close look at levels of erosion in earlier Interglacials.

In making the subject even more complex Brown and Ellis (1995) stress that *...both high and low population pressure can cause accelerated erosion – high population through the continuous cropping without nutrients returns and cultivation of unsuitable marginal areas and low population through the abandonment of agricultural landscapes, soil sealing, scrub invasion and gully formation* (with references).

Socio-technological changes (such as abandonment of farmed fields, colonisation and the use of heavy machinery) and climatic changes (for example, periods of drought cause failure of crops), they claim, are far more responsible for phases of accelerated erosion than population increase or decrease alone.

Recent studies in the Valdaine Basin (France, Berger 1995), in the Vera Basin (south-east of Spain, Castro et al. 1995, Fedoroff and Courty 1995) emphasise the important correlation between both natural and anthropogenic factors in environmental change during the last 5000 years (see also: Thornes 1999).

In the following sections, landscape reconstruction is discussed. However, only little information is available for the Salento peninsula and the Sibaritide. But in the Pontine region the Late-Holocene landscape development can be reconstructed more convincingly. Climatic changes, socio-technological development and hinterland geology are examined.

3.3 Land systems in Salento Isthmus (South Italy)

3.3.1 Human interference in the landscape

Although no environmental reconstruction of the research area in the Salento peninsula is possible yet (mainly due to a lack of detailed sedimentological information and radiocarbon dates), it is unmistakable that the present-day landscape underwent anthropogenic changes. For example, small hills may have been levelled (figure 3.2) and removed and fertile soils are excavated and deposited elsewhere. However, these changes cannot be considered as very significant compared to the large scale of the research area and its landforms, since they did not alter the overall geomorphology of the area nor did they lead to large-scale modification of the earlier, ancient land surface (2.4.1).

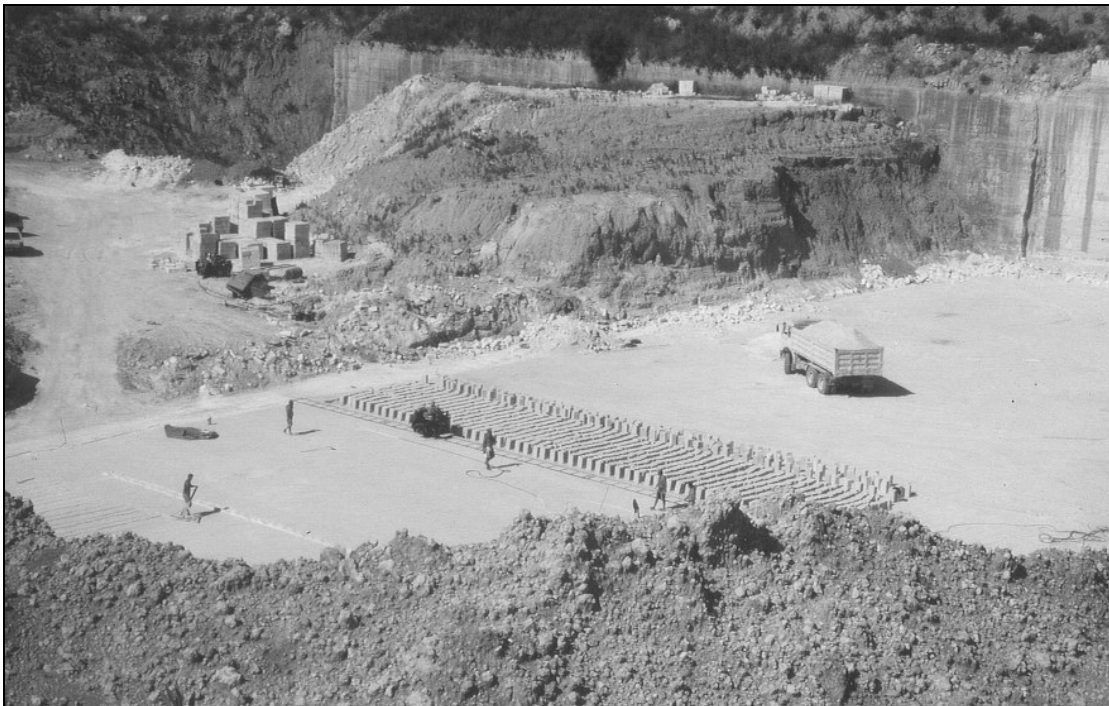


Figure 3.2 Anthropogenic influence in the landscape: a quarry near Roccaforzata

3.3.2 Description of the land systems

In the Salento research area, five land systems were distinguished based on their different geomorphology (the criteria are individually described below):

- the *Murge land system* in the north-west (figure 3.4),
- the *Taranto coastal land system* along the coast in the north and the south (figure 3.5),
- the *Brindisino-plain* land system in the east (3.6),
- the *Mottola undulating sloping land system* (figure 3.8) and
- the *Palagiano sloping land system* (figure 3.12), scattered over the rest of the area.

Figure 3.3 shows the locations of the landforms, which were distinguished.

The geological aspects of the Salento Isthmus were described using six geological maps (carta geologica d'Italia 1960): Foglio 190 (Monopoli), Foglio 191 (Ostuni), Foglio 202 (Taranto), Foglio 203 (Brindisi), Foglio 204 (Lecce) and Foglio 213 (Maruggio).

The fieldwork reports of Timmerman and Vonk (2000) and Foeken and Gietema (2000) are incorporated in the results of the research I did with Bas Bijl and Jan Delvigne in the Salento area.

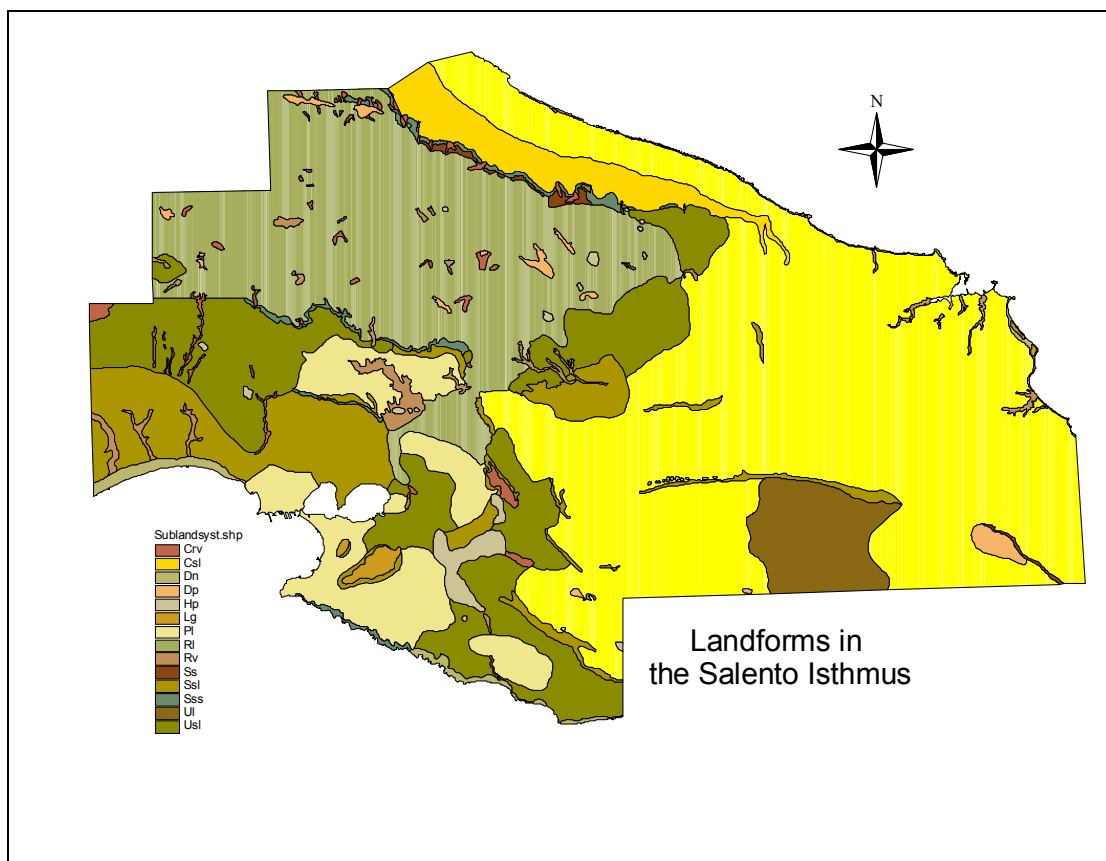


Figure 3.3 Map showing all landforms in the Salento Isthmus research area. Crv = Canyon-like river valley, Csl = Concavely sloping land, Dn = Dune, Dp = Depression, Hp = Hill and peak, Lg = lagoon, Pl = plain, Rl = Rolling land, Rv = River valley, Ss = Singular slope, Ssl = Straight gently sloping land, Sss = Singular steep slope, Ul = Undulating land, Usl = Undulating gently sloping land

A) Murge land system¹

A landscape of alternating stony hills and ridges, and relatively fertile valleys dissected by (steeply) incised river courses and depressions. Steep (concave) slopes, dipping both in northern and southern direction, generally mark the border of the area.

Extent and location: 900 km², northwest of Salento Isthmus research area

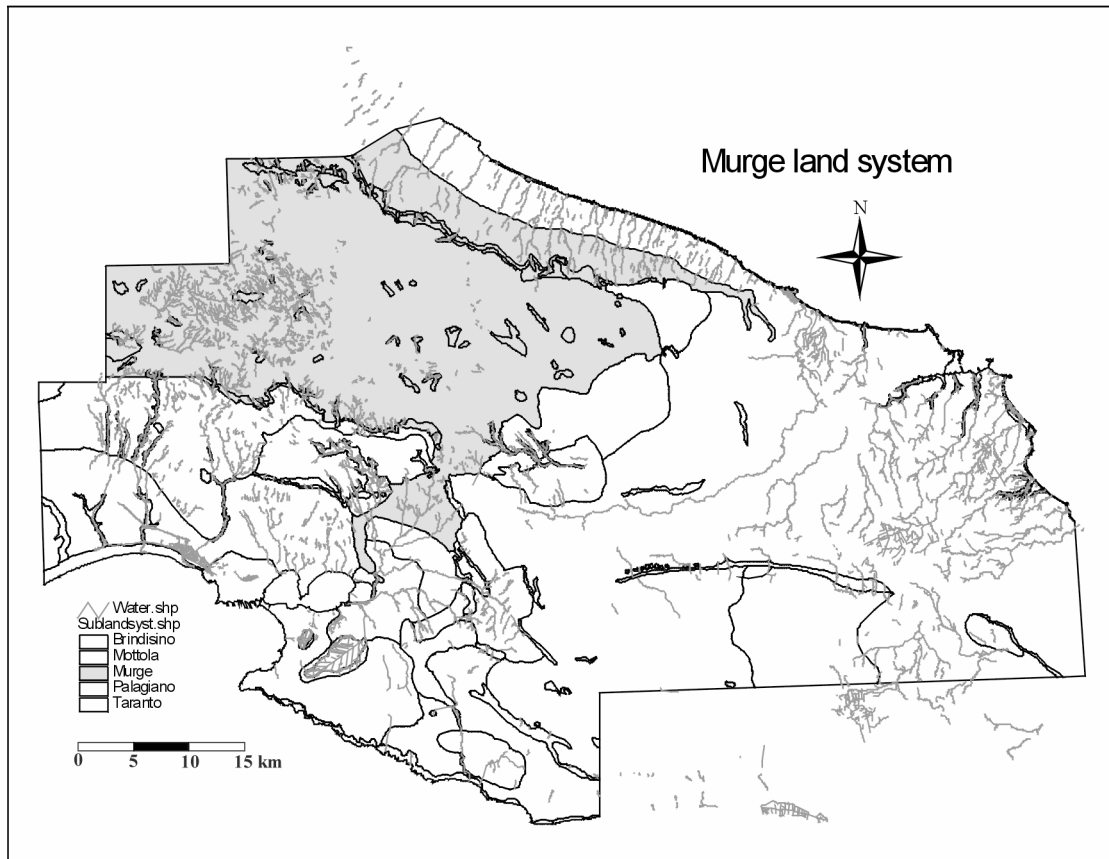


Figure 3.4 Map showing the location of the Murge land system

Geology: gently dipping, Upper and Lower Cretaceous limestone and dolomitic limestone (*Calcare di Altamura and Calcare di Bari*)

Geomorphology: the Murge land system comprises the following landforms: *rolling land* (alternating ridges and valleys, with summits, crests, and slopes), vast *river valleys* (having a width of more than 100 m) and (very) steeply incised *canyon-like river valleys*, flat or almost flat karst *depressions* of at least 500 m width and *hill peaks* with steep slopes, rising up from the surrounding area to at least 10 m; altitude reaches up to 500 m above sea level. Finally, *moderately steep and steep to very steep singular slopes* and one *concave slope* occur in the area.

Land use: in the rolling land, slopes and peaks are cultivated with olive and almond trees, whereas fruit trees grow in the valleys. The soils in the river valleys and depressions are suited for agriculture (especially olive trees, grapes and fruits). Only some forest (pine) is found on the steep slopes of the canyon-like river valleys. The fertile soils of the depressions are used for grapes, fig, pear, tomato,

¹ Most of the information concerning the Murge land system was derived from the field report, written by Foeken and Gietema (2000) of the Free University of Amsterdam, The Netherlands.

almond, and olive and wheat cultivation. Macchia survives on the stony top of the hills, whereas on the less steeper parts of the slopes, olives grow. The singular (steep) slopes turn out to be suitable for grazing by goats only. Undulating sloping land is cultivated with olive trees with undergrowth of wheat or isolated spots of wheat. Finally, large-scale vineyards are found in the depressions.

Unit	Extent ² in km ²	Landform	Soil	Vegetation and land use
RL	730	Rolling land: alternating hills and valleys. It is subdivided into top of hill or ridge, slope of hill and valley floors.	Fairly to very rocky and fairly stony to exceedingly stony Leptosols. Occasionally Cumulic Anthrosols and Regosols. In the valleys, Nitisols and Luvisols occurred (thickness > 150 cm). Few stones, no outcrop.	Rough grazing land with some wild olive trees
RV	5	A (dry) river valley of which the maximum width between the incised walls measures at least 100 m, with slopes of more than 20 m in height, and possibly having terraces. It is subdivided into river valley floor, river valley wall and terrace.	Fairly stony to stony soils; Leptosols, Regosols and Luvisols	Entirely cultivated
CRV	10	A steeply or very steeply incised (dried-up) canyon-like river valley , at least 20 m deep, with a maximum width of 200 m. It is subdivided into river valley floor and terraces, and valley slope.	Exceedingly stony A/C horizons (soil thickness varies between 5 to 25 cm) Leptosols; fairly rocky.	Pine trees
DP	10	Flat or almost flat depression of at least 500 m in width surrounded by higher areas.	Relatively thick Chromic Luvisols (ca. 1.5 m) and occasionally Regosols. No or very few stones.	Entirely cultivated.
HP	5	Hill: individual form of considerable relief (more than 10 m compared with surrounding area) with steep slopes. It is subdivided into top, (steep) slope and flat parts alongside the slope.	Thin soils on top of the hills (Eutric Leptosols and Eutric Regosols). Very to exceedingly stony slopes, fairly to very rocky.	Macchia
SS	10	Singular slope: area having a sloping to moderately steep gradient (8 – 25%) connecting two areas of different elevations.	In this very stony and fairly rocky unit, only Eutric Leptosols occur.	Macchia
SSS	20	Singular steep slope: steep to very steep area (25 – > 55%) connecting two areas of different elevations. Minimum height is 50 m, at the coast 20 m.	Very to exceedingly stony Eutric Leptosols developed in the thin soils of 30 cm maximum. Rock outcrop varies between rocky to very rocky.	Macchia, with pine trees and some olive trees
CSL	110	Concave sloping land at the base of SSS. Distance between top and foot measure at least 1000 m. It is subdivided into upper part and lower part of the slope.	Soil thickness varies between 10 to 160 cm: especially Lithic Leptosols occur, but also here and there Cambisols, Nitisols and Luvisols have been recorded. The soils are very to exceedingly stony; rock outcrop varies between fairly rocky to rocky.	Entirely cultivated.

Table 3.1 Summary of the characteristics of the present-day Murge land system

² The extent of the land systems and landforms has been roughly estimated.

Description of the Murge land system

Rolling land (RL)

The area lies at an elevation of 180 m to 270 m above sea level. Rolling land is characterised by alternating hills (divided into slopes whose gradient varies between 8 and 16 % and peaks or crests) and accompanying valleys.

The thin soils of the hills mainly consist of loamy clay, silty loam or loam. All soils have been formed in limestone bedrock. Soil colour varies from dark brown to dark red to reddish brown (2.5YR to 7.5YR). Consistency is moderate to firm in all soils. Stoniness in the soil depended on the location of the cores: hilltop cores gave higher stoniness percentages than hillside cores. The peaks and slopes are poorly drained: most water flows superficially.

The relatively thick soils in the valleys (more than 150 cm) have a clay loam to loamy texture with manganese mottles, which is firm to very firm. Soil colour varies from dark reddish brown to dark red (2.5 YR to 7.5 YR). The soils show the poor drainage conditions.

The hills and peaks or crests are not suitable for agriculture, mainly because of the steep slopes, but also because of their high percentages of stones and rocks in the soils and at the surface. Human interference is significant in the rolling land. The thick and probably fertile soil from the valleys is transported uphill to improve the soils. Terraces have been made to prevent the soil to erode downhill. The clay content in the soils is high, and water has difficulty to infiltrate the soil. The valleys especially are often irrigated.

It is clear, that the hilltops and slopes are subjected to (natural) erosion processes, whereas in the valleys the washed-down material accumulates.

River valley (RV)

River valleys are quite dispersed over the land system. Fluvial incisions in the relatively lower flat areas in the rolling land have created the valleys. They can be subdivided into river valley floors and (in places) in man-made terraces.

The soils in the valleys, which have a texture of silty loam, loamy silt and clay loam, measure at least 0.85 m. The dark reddish brown (5YR to 7.5 YR), non-calcareous soils are moderately firm to very firm. The sediment is moderately to poorly drained. At some locations, the fluvial sediment is used in agricultural fields elsewhere.

Canyon-like river valley (CRV)

Most of the canyon-like river valleys are situated along the northern edge of the Murge land system. Sometimes they act as roadways, connecting the Murge with the coastal area.

The thin non-calcareous loamy soils are dark reddish brown (5YR2/3) and mixed with limestone pebbles. Erosion takes place on the steep slopes, whereas the narrow valley floors receive the sediment, especially near the river valley mouths in the coastal area.

Depression (DP)

Four major depressions, probably karst features such as poljes, have formed in the Murge land system, two are located near Ceglie Messapico, and two were found south of Fasano. Elevation levels of the depressions vary between 220 m to 240 m above sea level.

The relatively thick probably colluvial soils (minimum 1.5 m) consist of firm silt loam or loam deposited on a layer of clay, having a brighter red colour. Drainage conditions in these clayey sediments are moderately well.

Hill and peak (HP)

In the Murge land system, eight hills or peaks were distinguished, having steep slopes all-around, accompanied by a micro-relief of rock outcrop. Only thin, well-drained soils occur at the upper parts of the hills and peaks, whereas the lower slopes receive accumulation material and the soils are consequently much thicker. These moderately firm to firm, dark brown (7.5 YR) soils are loamy or clay loamy textured and poorly drained. Human interference is clear from the presence of terraces and irri-

gation practices on the relatively flat fields alongside the slopes.

Singular slope (SS)

The singular slope is situated at the northern margin of the land system. Its elevation is approximately 350 to 400 m above sea level and slopes towards the Murge rolling land. Many small artifacts were found during the archaeological survey (under guidance of professor Attema), indicating former occupation of this singular slope, probably because of its strategic position: the coastal plain can be excellently overviewed from the edge.

Brown (7.5 YR) loamy thin soils have developed in the bedrock, which are well drained. But as a consequence of the steep slopes, superficial runoff and erosion also occurs. Sediments have been deposited on the lower parts of the singular slope.

Singular steep slope (SSS)

In the landscape, the singular steep slopes can be distinguished as prolonged ridges, which separates the low coastland from the higher Murge in the north and the lower undulating sloping landscape in the south. The slopes are concave. The ridge, which is located near Ostuni heading in north-north-western direction, appears to coincide with a former coastline, explaining its steep character.

Only thin soils have been formed in the limestone bedrock. The very dark brown (7.5 YR) silty loams are poorly drained. However, precipitation can infiltrate the limestone through fissures and cracks where it appears at the surface. The consistency of the soils is moderately firm.

Concave sloping land (CSL)

This landform separates the coastal area from the Murge. Elevations vary between 50 and 150 m above sea level. Soil thickness varied between 10 to 160 cm. Two representative soil profiles have been found: a calcareous, reddish brown (7.5 YR to 5 YR) sandy to silty loam A-horizon lying on top of a non-calcareous brighter coloured (5 YR to 2.5 YR) B-horizon, which in some cases is more fine-textured than the overlying A-horizon; and thin soils which have been developed on the limestone and lacking a B-horizon.

Sediment, coming from the eroded singular steep slope, has been deposited on the upper part of the concave sloping land, creating rather thick soils. These soils appeared to be less susceptible to erosion than the lower parts, which have been entirely terraced to prevent soil loss by flowing water.

Appendix A-I shows the data, necessary for land evaluation which is incorporated into ALES

B) Taranto coastal land system

A coastal landscape of mobile dunes, interspersed with lagoons at some intervals, and with occasionally steep or very steep cliffs

Extent and location: 35 km²: the land system marks the margins of the entire research area both in the north and the south, except for the western side (figure 3.5). It develops where enough sand is available for dune formation.

Geology: Holocene sands and Pleistocene/Holocene lagoonal and marshy loams.

As a consequence of the Holocene sea level rise (0.4 m since 2000 BP, Flemming and Webb 1986), the pre-Roman coastal area was probably located in a more seaward direction. According to Bijlsma and Verhagen (1989), *evidence for a transgression phase was found near Torre San Gennaro – northeast of Valesio –, where lagoonal deposits were found below dune sands, thus indicating an inland movements of the lagoonal system.* Therefore, the present-day dunes and lagoons have been formed only very recently and are omitted from the land evaluation. However, it is assumed that they resemble the ancient dunes and lagoons (though located elsewhere), and are described likewise. A more detailed landscape reconstruction is necessary in order to unravel the sedimentary history of the coastal area.

Geomorphology: the Taranto coastal land system shows the following landforms: an irregular pattern of forms (dunes) with maximum elevation of 20 m above sea level, which slopes vary between zero and 6 %, flat parts in between the sandy dunes occur. The lagoonal unit usually is flat. Finally, a cliff occurs south-east of Taranto.

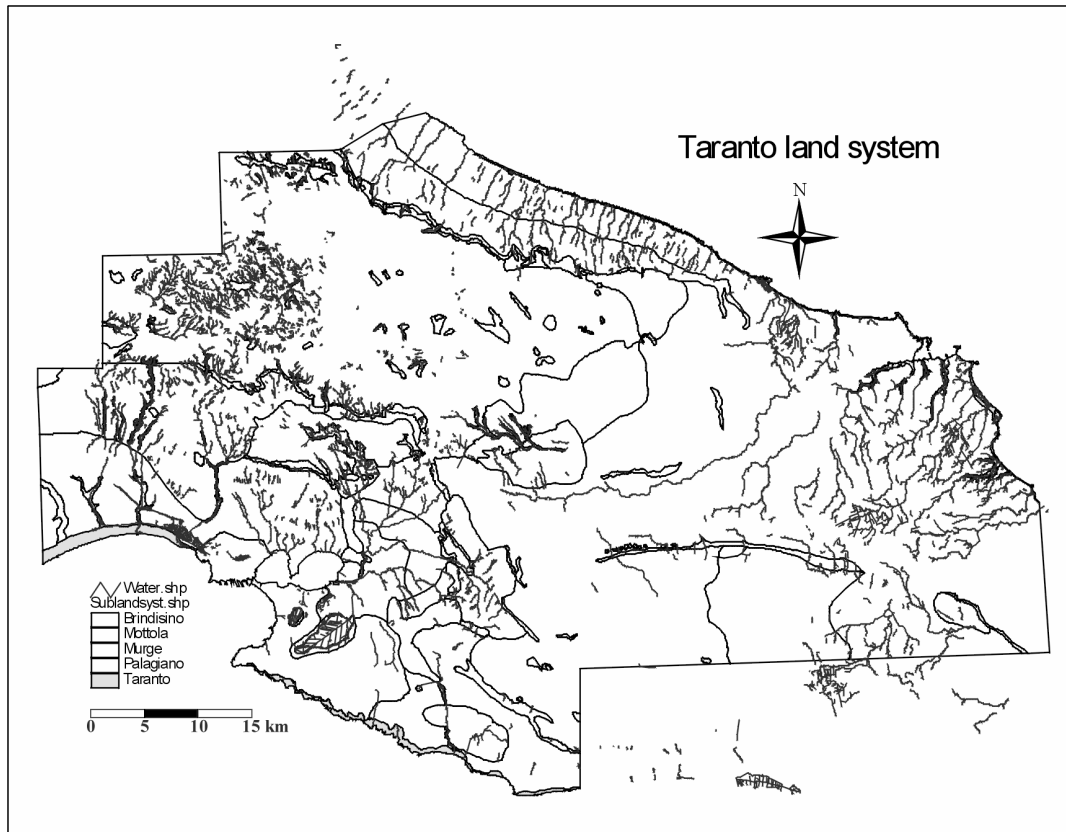


Figure 3.5 Map showing the location of the Taranto coastal land system

Land use: dunes are not suitable for agriculture, due to their low clay content and consequently high infiltration capacity. The soils in the dry lagoons are coloured whitish because of their high salt content, so are also unsuitable for any farming activity. But probably, in the past, lagoons were used for fishing grounds and gathering of shellfish.

Unit	Extent in km ²	Landform	Soil	Vegetation and land use
DN	30	Dune: form of positive relief (less than 20 m) together with relatively flat parts, having an irregular pattern and beaches. The valleys measure 3 m maximum in width and slope percentage is 10% maximum.	Calcaric Arenosols, varying in thickness between 0 to 75 cm. No stones, no rocks to rocky.	Garrigue, maquis, rough grazing land, pine trees
LG	1	Lagoon: a bay inshore lying parallel to the coast (Skinner and Porter 1987). The bay in places is filled with water.	Salic Fluvisol	<i>Salicornia</i> (marsh samphire) and <i>Limonium</i>
SSS*	4	Singular very steep slope at the coast; minimum height is 20 m.	Not available	

Table 3.2 Summary of the characteristics of the Taranto coastal land system

* The cliff near Taranto was defined as a singular very steep slope, formed by marine erosive processes of the plain (PL) landform. Because of its very steep character, direct marine influence and its relatively small presence in the area, this slope will not be incorporated in the research.

Description of the Taranto coastal land system

Many researchers claim that the Salento coastline faced an eustatic sea level rise during the last millennia, but opinions differ concerning the rate of this rise. According to Flemming and Webb (1986), from approximately the Roman Age, sea level has risen about 40 cm. Whether sea level rose 40 cm or more, the present-day coastal zone probably closely resembles the ancient coastal zone with dunes and lagoons (Bijlsma and Verhagen 1989), but the transgressive phase has driven the coastline land inwards. A more detailed fieldwork is necessary in order to reconstruct the exact location of the ancient coastal zone. As said before, at Torre San Gennaro (in the north of the research area) Bijlsma and Verhagen (1989) found the remnants of an older lagoonal systems just below the local dunes. In the case of this thesis, the present-day coastal system is examined, assuming that it resembles the ancient zone, but bearing in mind, that the exact location probably differs.

Dune (DN)

A dune landform is classified as an area with various heights up to 20 m, accompanied by flat or almost flat parts and beaches. The gradient of the dunes varies between gently sloping and sloping. In the light brownish grey (10 YR), medium fine to fine sand, Arenosols have developed. The (very) loose, well-drained soils are very calcareous. Shell fragments and lime concretions may occur.

Lagoon (LG)

South-east of Taranto, two drained lagoons occur: Salina Grande and Salina Piccola. These lagoons have not been investigated during this research, so information shall be drawn from the literature. When these lagoons were drained is uncertain yet, but according to professor Coppola (personal communication), they were used for fishery and gathering of shellfish in prehistory.

In the north-western part of the area, near Masseria Fiume Morello, a small tidal lagoon was found, filled with brackish water and many fishes. The lagoon receives sediment by terrestrial runoff and marine sediment during overflows in stormy periods. In the coastal area near Brindisi, a few lagoons occur.

Appendix A-I shows the data, necessary for land evaluation which is incorporated into ALES

C) Brindisino-plain land system²

A (almost) flat area, showing a variety of soil depths and soil types, predominantly cultivated with cereals and olives

Extent and location: 1760 km², occurring in almost the entire eastern part of the research area, around Taranto and north-east, east and south-east of this city, and near the coast in the northern part of the area (figure 3.6).

Geology: in the vicinity of Brindisi, the most common sediments in the plain are yellow clayey sands, sometimes weakly cemented, of the Pleistocene *Formazione di Gallipoli*. Underneath, clayey sand and grey-blue clay occurs. In southern direction, Balabriano-Pliocene (Sup.?) weakly cemented calcareous sands, limestone, dolomitic limestone and dolomite of the formation of *Galatina* and *Altamura* (Upper/lower Cretaceous) appear. Miocene compact limestone and Pliocene (Sup.-medio?) clayey calcarenite, 'tufi', gravels and breccias appear at the surface in the eastern part of the research area.

In the north, on the abrasive platforms along the coast (chapter 1), calcarenite and calcareous sandy clayey deposits occur (*Tufi delle Murge*).

Pleistocene (*Tirreniano-Calabriano*) calcarenite *di Monte Castiglione* represents the most important geological feature in the south-western plains.

² Most of the information concerning the Brindisino-plain land system was derived from the research report, written by Timmerman and Vonk (2000) of the Free University of Amsterdam, The Netherlands.

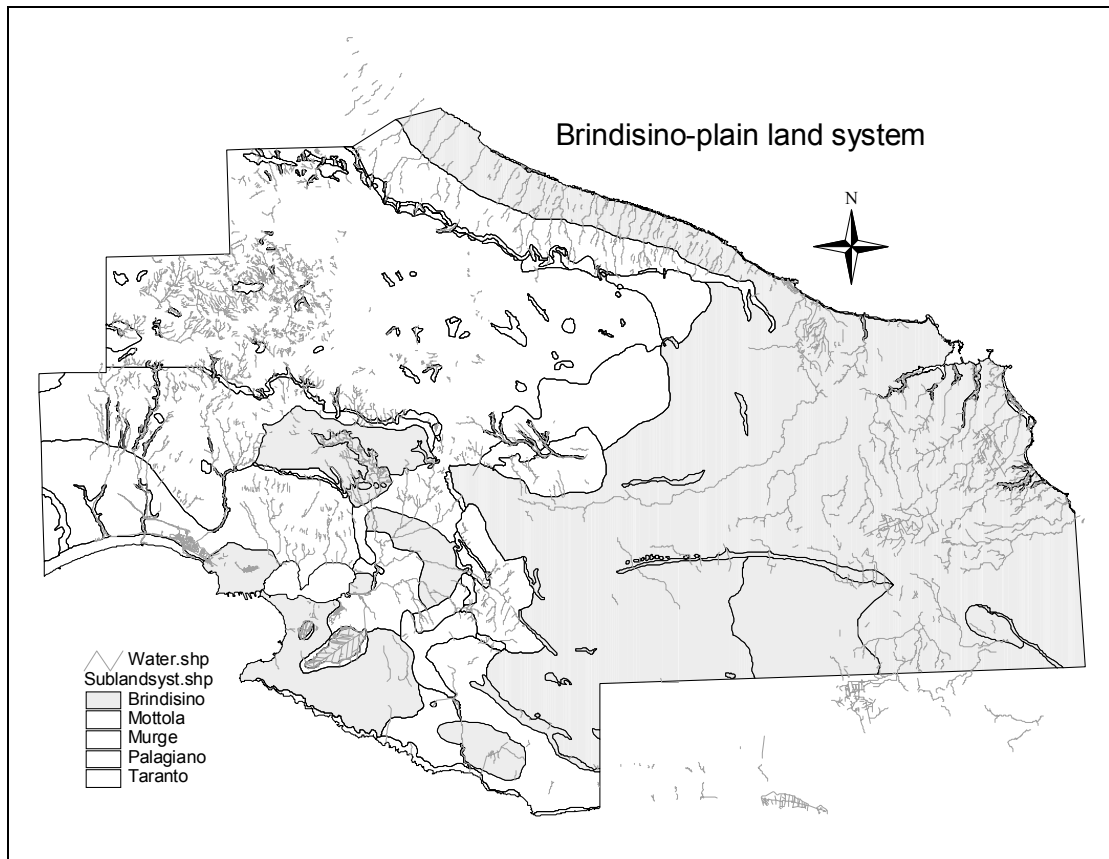


Figure 3.6 Map showing the location of the Brindisino-plain land system (scale: see figure 3.4)

Geomorphology: a flat or almost flat ('terraced') landscape, sloping at a gradient of 2 % maximum, showing no or relatively minor relief in general, intersected by river valleys and depressions. Occasionally, isolated hills occur. Narrow strips of straight gently sloping land separate the 'terraces' of different elevations. These terraces represent former sea levels.

The Brindisino-plain land system comprises the following landforms: plain, undulating land, river valley, depression, hills and straight gently sloping land.

Land use: in the plains, olive trees and grapes are cultivated on the thin soils, cereals (wheat) and grapes grow on the thicker soils. Occasionally, tomatoes, eggplants and melons are cultivated. The valley floors are used for the nurturing of olive, grapes, cereals, citrus and fig, whereas olive trees grow on the river terraces. Olive trees also grow in the undulating landscape, on the slopes and the rather flat parts of some hills. Cash crops are cultivated in the large depression.

Description of the Brindisino-plain land system

Plain (PL)

Plains were defined as relatively large, flat or almost flat areas, situated:

- in the eastern part of the research area (roughly west, south and east of Brindisi; geologically belonging to the *Formazioni di Gallipoli, Galatina and Altamura*),
- near the coast in the north (*Tufi delle Murge: figure 3.7*),
- south of Lizzano (*Calcareniti di M. Castiglione*),
- north and around Pulzano and north-west of Taranto (*Calcareniti di M. Castiglione*),
- west and south of Crispiano (*Formazioni di Galatina and Altamura*), and

Unit	Extent in km ²	Landform	Soil	Vegetation and land use
PL	1600	A plain is defined as an area with relative minor or no relief, which can be some what terraced and slopes 0 to 2% It is subdivided into areas having thin soils and areas having deeper soils.	Ferrallic and Haplic Arenosols, exceedingly stony Lithic Leptosols developed in thin soils, and Calcaric Regosols in thicker soils. Luvisols occur at relatively higher elevations. Stoniness varied between no stones and exceedingly stony.	Rough grazing land, including wild cereals
UL	115	Undulating land is a flat area with relatively small hills and valleys.	Lithic Leptosols developed in thin soils, full of stones (rubble land) and rocks (rocky to very rocky).	Shrubs
RV	20	A (dry) river valley of which the maximum width between the incised walls measures at least 100 m, with slopes of more than 20 m height difference, and possibly having terraces. It is subdivided into river valley floor, valley slope and terrace floor.	At the valley floor, Eutric and Calcic Vertisols or Calcaric Fluvisols occur. This last soil type has also developed in the accompanying terraces.	Maquis, rough grazing land, cactus hedge
DP	10	Flat or almost flat depression of at least 500 m surrounded by higher areas.	In the depression, fairly stony soils occurred. No rocks.	Entirely cultivated.
HP	5	Hill : form of considerable relief (more than 10 m above the surrounding area) with steep slopes.	* see the text below	
SgSL	10	Straight gently sloping land shows minor or no relief, but slopes at a gradient of 2 to 8 %). It is subdivided into areas having shallow soils and areas having deeper soils.	** see the text below	

Table 3.3 Summary of the characteristics of the Brindisino-plain land system

* Only a few very small hilltops occur in this large Brindisino plain and therefore they have not been examined during the fieldwork.

** The relatively narrow strips of straight gently sloping land in the plain land system measure about 250 m to 2 km in width. As said before, they separate areas at different elevations, being part of a large cuesta-landscape (explained further below in the section about straight gently Sloping Land), in which the relatively harder bedrock appears at the surface. But, in geological terms, they are part of the same formation. In this way, and because they represent only a small part of the plain, they will not be included separately into the land evaluation system.

A micro-relief is formed by local rock outcrops and by small river incisions, which were too small to be classified as river valleys. Plains were split into areas having shallow soils (less than 30 cm), and that having deeper soils (more than 30 cm; according to the FAO-Unesco soil description rules).

Areas having shallow soils: the brown (10YR4/6), very calcareous sandy loamy soils were very stony, probably because farmers have ploughed the weathered bedrock underneath for the cultivation of olives. These shallow soils usually lie in the vicinity of hills.

Areas having deeper soils: the plough zone (about 55 cm) consists of brown (7.5YR4/4) or dull yellowish brown (10YR5/4) loose (light) sandy loam. The layer can be calcareous. The lithology of the layers beneath differed from place to place, depending on the kind of bedrock. We found non-calcareous brownish black (10YR2/3) sandy clay, underlain by very calcareous, dull yellow orange (10YR6/3) clay in the vicinity of Pulsano and very calcareous, dull yellow orange (10YR6/4) sand with shell fragments in the vicinity of Lizzano.

Along the coast, the upper calcareous soil layers were relatively coarse textured: sandy loam to sand. More inland, brownish red loam is followed by finer grained and more reddish horizons.

Pottery sherds are found in the cores about 2 km north-west of Faggiano and in those about 3 km north-west of Pulsano³.

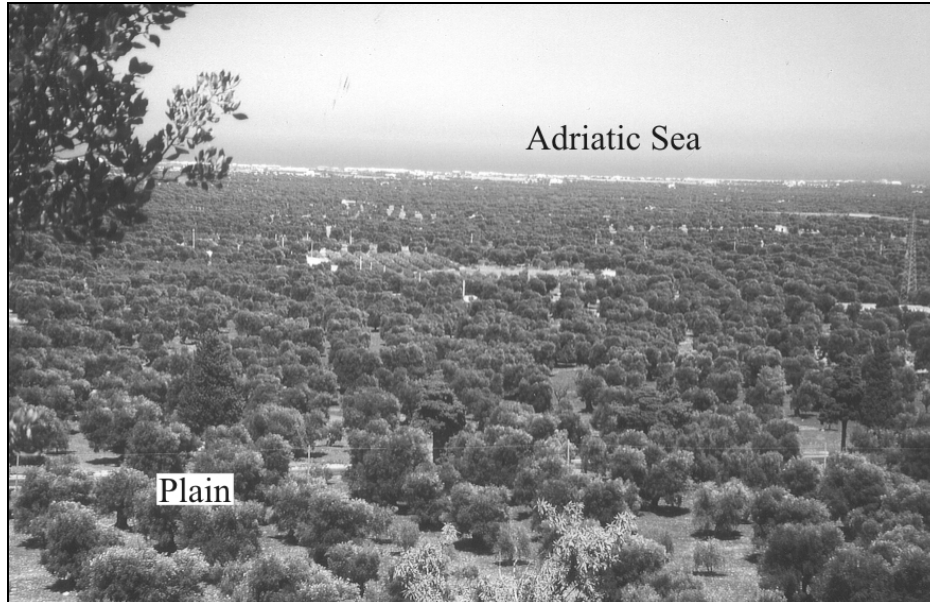


Figure 3.7 Plain covered by olive trees with the Ionian Sea in the far distance

Undulating land (UL)

The undulating land (located around the city of San Pancrazio in an area geologically dominated by *Dolomie di Galatina* and *Calcarea di Altamura* and Pliocene calcareous sands) has the same characteristics as the plain, but the area comprises several small hills and valleys.

It is obvious that augering in exceedingly stony or rubble land is very hard, and even so only the first 10 cm could be examined. The surface lithology was moderately loose, (2.5YR4/4) loamy clay or reddish brown (5YR4/6) sandy loam. We assumed that the soil was levelled by addition of soil from elsewhere, because of disturbed soil profiles.

River valley (RV)

Many small rivers draining the area around Brindisi, merge into larger rivers and flow into the sea. Most of these rivers run dry during the summer.

Depression (DP)

Only one large and a few small depressions occur in this land system. The large one measures 6 km in length and 2.5 in width. Probably, this depression represents a structural hollow, because it is bordered by a faultline.

All soils were very calcareous, also with increasing depth. Dull yellowish brown (10YR5/3) moderately weak clayey loam was found on top of brown loamy clay (10YR4/4) at a depth of around 50 cm. This moderately strong layer contained Fe and Mn pebbles. The topsoil was ploughed.

Appendix A-I shows the data, necessary for land evaluation which is incorporated into ALES

³ According to a local farmer, a necropole is situated in the neighbourhood. Locally, farmers increase soils depth artificially by adding soil from elsewhere.

D) Mottola undulating sloping land system

A landscape of relatively small valleys and hills, all sloping at the same gradient, traversed by canyon-like river valleys and river valleys, with occasionally hills and peaks

Extent and location: 500 km², north-west of Taranto between Crispiano and Mottola, north of Francavilla Fontana between Villa Castelli, S. Michele Salentino and Carovigno (east of Ostuni) and the area around Lizzano (east and south-east of Taranto; figure 3.8).

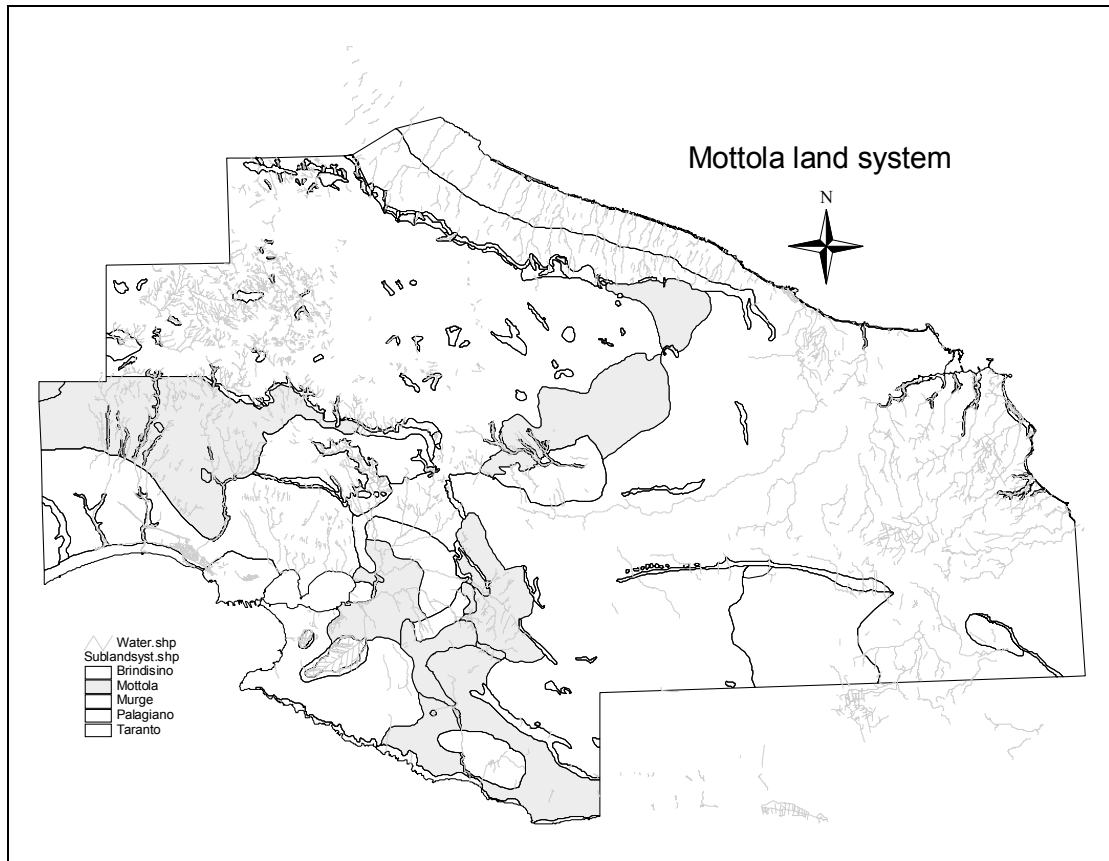


Figure 3.8 Map showing the location of the Mottola undulating sloping land system (scale: see figure 3.4)

Geology: in the undulating sloping land systems, a wide variety of rock formations and sediments occur, probably explaining their chaotic character due to differential erosion.

For the area north-west of Taranto, the geological map shows the following formations: clayey yellow Pliocene calcarenite (fine textured, with white-yellow tuffi and calcareous gravels) of the *Calcarenite di Gravina* formation, Pleistocene weakly cemented sands and grey-blue marl (*Algilla di Bradano*), Pleistocene calcarenite *di M. Castiglione* and Cretaceous dolomite and limestone of the *Calcarenite di Altamura* formation.

Bright grey or white dolomitic limestone and black-brown or dark-grey dolomite (*Dolomie di Galatina and calcarenite di Altamura*) is found in the area north of Francavilla Fontana. The rocks show irregular faults and porous limestone. Red breccias occur.

Holocene alluvial and colluvial sediments and terra rossa have been deposited near the coast in the vicinity of Lizzano, whereas Pleistocene calcarenite and Holocene/Pleistocene well-cemented bioclastic limestone also occur. Pleistocene well-cemented calcarenite (Formazione di Gallipoli), weakly cemented calcareous sands and grey-blue clayey sands and calcarenite of M. Castiglione are also indicated on the geological map of the area.

Geomorphology: in general, geomorphological features comprise irregular stony slopes and irregular hill tops and ridges, separated by narrow and wide valleys with alluvial floodplains, steeply incised river courses or just by dry valleys. In the relatively wider valleys, residual hills occur, having steep slopes and elevations measure more than 10 m above the surrounding area.

Land use: in the valleys, olive, citrus, watermelons, fig and cereals (oats) are cultivated. Sporadically, grapes grow on top of the hills, which are remarkably rocky. In the river valleys, people cultivate cereals, olive and grapes. Some slopes of the residual hills (HP) have been terraced for olive cultivation, for example near San Crispieri.

Unit	Extent in km ²	Landform	Soil	Vegetation and land use
UgSL	450	Undulating gently sloping landscapes comprise relatively small hills and valleys, which all slope between 2 and 8%	In the valleys, Eutric and Calcaric Regosols and Luvisols occur (stoniness varies between no stones and stony), whereas at the slopes and tops of the small hills, very stony Lithic Leptosols prevail.	Pine forest, low garrigue and maquis grow at the tops of the hills.
CRV	20	An steeply or very steeply incised (dried-up) canyon-like river valley (25 – 55%, and > 55%), at least 20 m deep, with a maximum width of 200 m	No information available, because of the inaccessibility of these canyons.	Forest and maquis
RV	5	A (dried-up) river valley of which the maximum width between the incised walls measures at least 100 m, with slopes of more than 20 m in height, and possibly having terraces	At the valley floor, Eutric and Calcaric Vertisols or Calcaric Fluvisols occur. This last soil type has also been developed in the accompanying terraces.	Rough grazing land
HP	25	Hill: form of considerable relief (more than 10 m above the surrounding area) with steep slopes	Lithic Leptosols developed in the limestone tops of the hills. No stones were found in the thin soils, but at the surface the tops were fairly rocky and exceedingly stony. Very stony Lithic Leptosols occur on the slopes (rock outcrop up to extremely rocky), whereas Regosols developed on the flatter parts with deeper soils, which were very stony, but lacking any rock outcrop.	Rough grazing land and garrigue

Table 3.4 Summary of the characteristics of the Mottola undulating sloping land system

Description of Mottola undulating sloping land system

Undulating gently sloping land (UgSL)

The UgSL can be divided into top and slopes of relatively small hills and relatively small valleys.

Top and slopes of relatively small hills: most soils are shallow (about 10 cm) and composed of reddish brown (5 to 7.5YR), loose to very firm non-calcareous loam or clay loam. Rock outcrop percentages of these hills and slopes can vary considerably: from rocky to rock outcrop.

Relatively small valleys: the valleys south-east of Pulsano are lithologically composed of dull yellowish brown (10YR5/3), fine sand (probably aeolian), very calcareous brown (7.5YR) light sandy loam or greyish olive (5Y4/2) loamy sand. Anthropogenic influence can be seen in ploughing of the soil and addition of limestone fragments. Rock outcrop and stoniness are zero (except for the recent deliberately added limestone fragments). The UgSL valleys near Palagiano are lithologically composed of loose, dark reddish brown (5Y3/4), light sandy loam. The area east of Mottola has been dis-

turbed considerably. Probably soil has been removed or added. In the central part of the research area (the UgSL near Carovigno and north of Villa Castelli), we described a soil profile with two horizons (soil depth 1.2 m minimum): an upper layer of firm red loam and a more clayey layer underneath, with a slightly brighter reddish colour.

Canyon-like river valley (CRV)

Canyon-like river valleys especially occur in the western part of the research area in the undulating gently sloping lands: large ones are *Gravina Capo di Gavito*, *Gravina di Colombato*, *Gravina del Portico del Ladro* (east of Mottola) and *Gravina Gennarini* (west of Statte). The CRV's can be divided into relatively small river valley floors, terraces and river valley walls.

Relatively small river valley floors and terraces: in about 5 % of the canyon-like river valleys, the relief is suitable for agriculture.

River valley walls: these walls are very rocky to rock outcrop. No land use has been observed.

Summarised the CRV landform is composed of very to extremely rocky valley walls, with complete rock outcrop occasionally, and valley floors and terraces. Agriculture is practised in a small part of the landform; the rest is grown by natural vegetation. Human influence can be seen by habitation of water incised caves, which were usually located at the foot of the valley walls. An interesting example was found in the Gravina of Grottaglie (figure 3.9).



Figure 3.9 Photograph of some caves in the walls of the canyon-like river valley near Grottaglie

River valley

Only one large river valley occurs in the undulating gently sloping land: *Vallone Bottari*, east of Villa Castelli. It will not be examined here.

Hill

Their slopes can differ considerably: relatively small hills occur 3 km north-east and 5 km south-south-east of Massafra, and 3 km north-north-east of Torricella (Mont Magalastro). They measure about 500 m to one kilometre in length. Faggiano, Roccaforzata, Monteparano, San Giorgio Ionico and Fragagnano are situated on a relatively large hill, with a total length of 16 km. Mont Scianna forms the last hill in this area, having a length of 3 km.

A typical hill can be divided into three physical geographical units: a flat or almost flat top, a slope, and flat or almost flat parts on the slope. The latter units do not occur on every hill.

Flat or almost flat top: the tops are generally characterised by a thin layer of brown (7.5YR) sandy loam on top of bedrock of limestone (figure 3.10).

Slope: the gradient of the slope can differ considerably; from class 1 (almost flat) near Roccaforzata, to gently sloping to sloping (class 2/3) near San Crispieri, to moderately steep (class 4) between Roccaforzata (figure 3.11) and San Giorgio Ionico. In the thin layers of sandy loam (10 cm), brown (7.5 YR), very calcareous soils occur, which also lie directly on limestone.

Flat or almost flat parts along the slope: in the 60 cm thick soils of sandy loam colour changes from dull yellow (2.5Y6/4) to dark reddish brown (5YR3/6), the upper 10 cm is very calcareous, the lower 50 cm non-calcareous.



Figure 3.10 Very stony, almost flat top of a hill near Roccaforzata

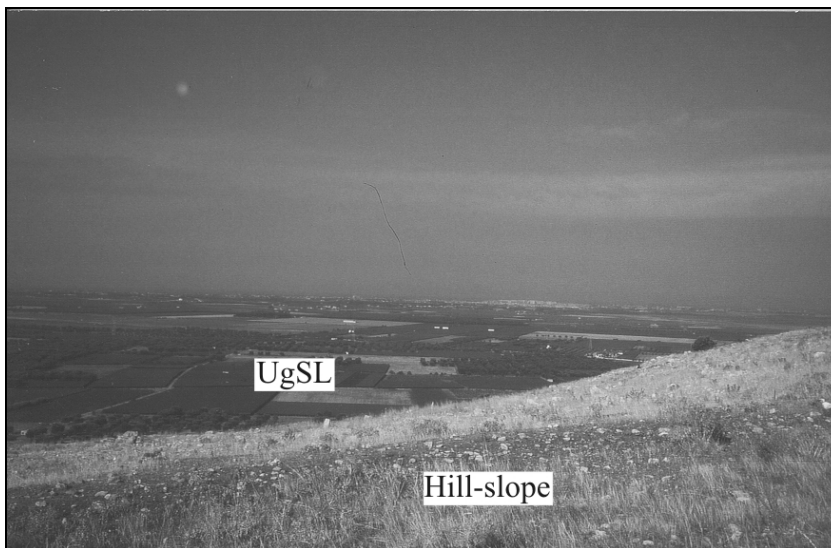


Figure 3.11 Moderately steep, very stony slope near Roccaforzata facing the plain in southern direction

The surface is susceptible to weathering and erosion. A lot of pottery sherds have been found near Roccaforzata. Slopes form the largest part of hills (about 80 %), about 15 % of top and or 5 % of flat parts along the slope.

Appendix A-I shows the data, necessary for land evaluation which is incorporated into ALES

E) Palagiano sloping land system

Extent and location: 250 km², the Palagiano sloping land system covers a relatively large area north, north-west and north-east of Taranto (figure 3.12).

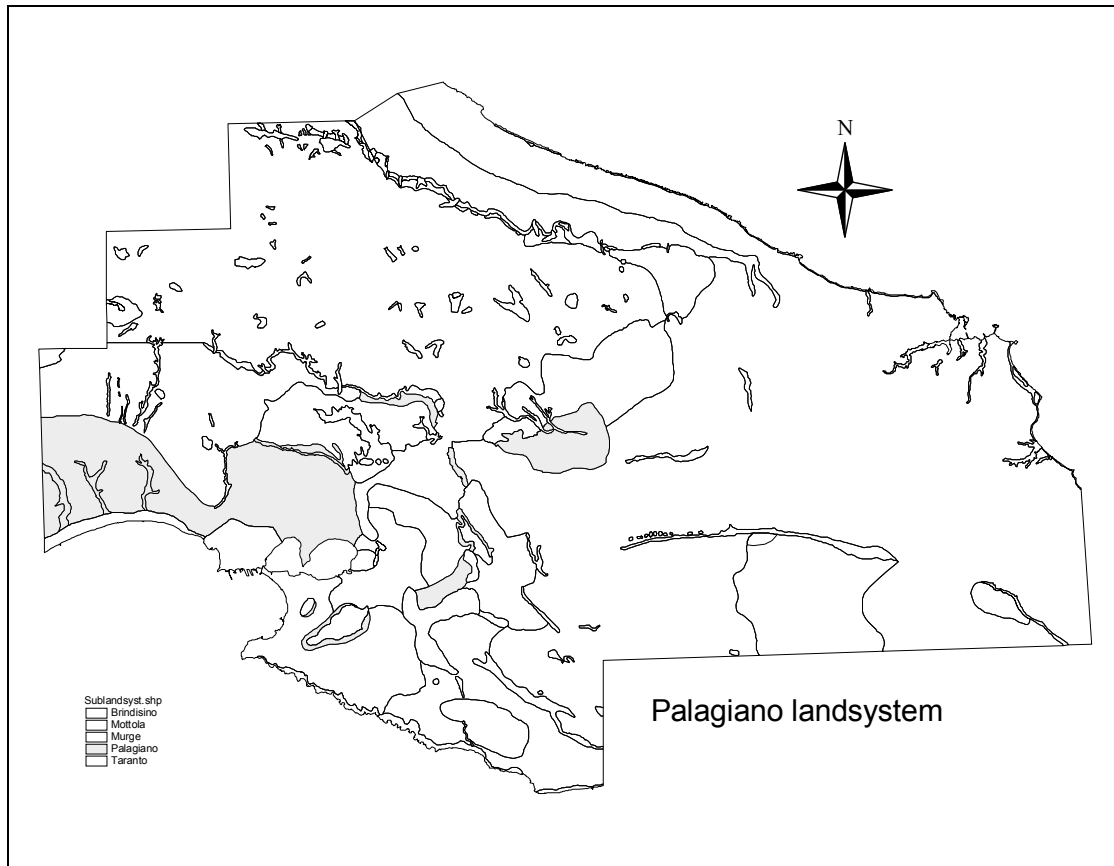


Figure 3.12 Map showing the location of the Palagiano sloping land system (scale: see figure 3.4)

Geology: The south-western land system, and the area between Lizzano and Maruggio, is lithologically composed of Pleistocene calcarenite, calcrudite and Cretaceous limestone. Pleistocene coastal deposits occur in the straight gently sloping land between the hill of Monteperano and Mont Scianna and Pleistocene clays have been deposited around the lagoons.

Geomorphology: the area gently slopes towards the Gulf of Taranto, intersected by three major valleys with floodplains. Terrace edges are included when they are too small to be classified as singular slope (SS) or singular steep slope (SSS).

Land use: Cereals, olives, grapes and watermelons are cultivated. All soils in the valley floors are ploughed for the cultivation of grapes, cereals, citrus, fig, and olive. Olive trees are also planted on the river terraces.

Description of the Palagiano sloping land system

Straight gently sloping land (SgSL)

The SgSL can be divided into areas having no or very shallow soils (less than 30 cm) and areas having thicker soils (more than 30 cm).

Areas having no or very shallow soils (less than 30 cm): these areas are located north and north-east of Taranto (figure 3.13). The SgSL is part of a cuesta landscape,⁴ situated south of the Murge. No human interference is found.

Unit	Extent in km ²	Landform	Soil	Vegetation and land use
SgSL	245	Straight gently sloping land shows minor or no relief, but slopes at a gradient of 2 and 8 %. It is subdivided into areas having shallow soils and areas having deeper soils.	Lithic Leptosols have been developed in the thin soils, Luvisols occur in the deeper soils.	Maquis, cactus hedges and rough grazing land
RV	8	A (dried-up) river valley of which the maximum width between the incised walls measures at least 100 m, with slopes of more than 20 m in height possibly terraces. It is subdivided into river valley floor, river valley wall and terrace floor.	In the valley floors, Eutric or Calcic Vertisols or Calcic Fluvisols have been developed. These last soils were also found on the terrace floors.	Maquis, rough grazing land
SSS	2	Singular steep (or very steep) slope connecting two areas of different elevations. Minimum height is 50 m, at the coast 20 m.	Exceedingly stony and extremely rocky thin Leptosols.	Maquis and deciduous forest

Table 3.5 Summary of the characteristics of the Palagiano land system

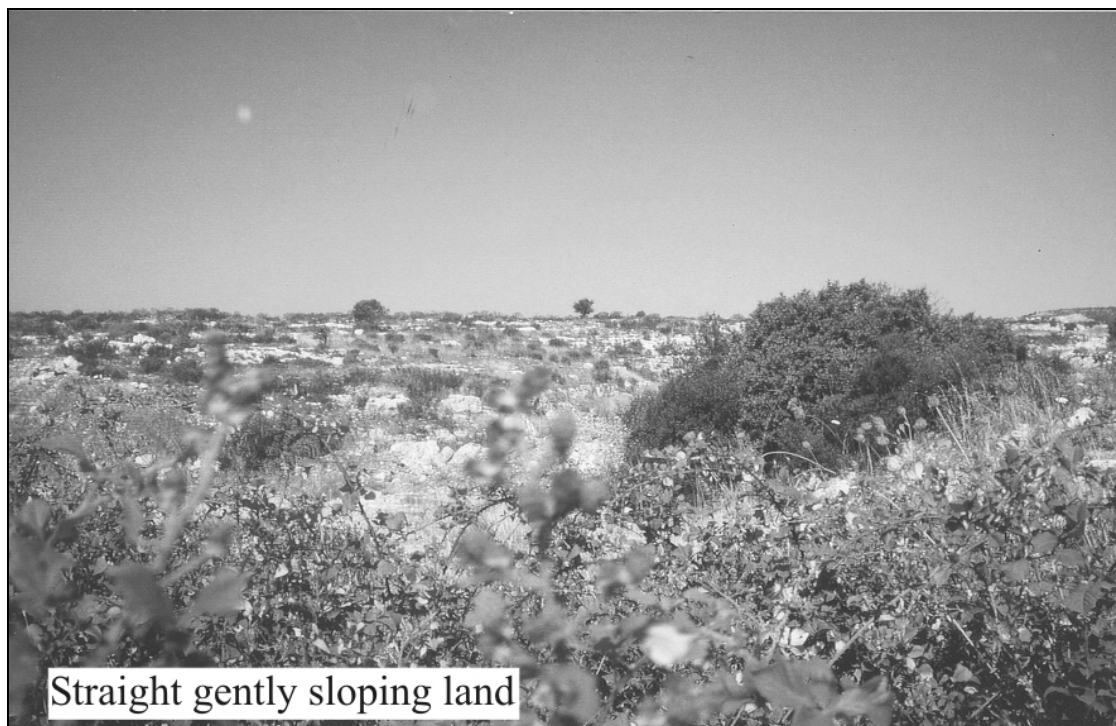


Figure 3.13 Straight gently sloping land east of Statte

Areas having deeper soils (more than 30 cm): thickness of the soil and stoniness mostly depend on the genesis of the area and the type of parent material. Especially in the SgSL, this is relevant. The

⁴ A cuesta landscape forms where sedimentary rocks are tilted and a succession of relatively weak and relative resistant lithologies are exposed. River channel incision will tend to be more active on the less resistant lithology (Summerfield 1991). This can lead to the formation of, for example, modestly dipping asymmetric ridges: a cuesta.

area near Palagiano forms part of a deltaic system (see also the geological map: marine and terrestrial sediments, figure 3.14). Fluvial material has been deposited here. So lithologically this region shows silt and sand, mixed with well-rounded pebbles of limestone, quartzite and quartzite sandstone. Colours vary from yellowish brown at the surface to reddish brown for the non-calcareous layers underneath. The ploughed SgSL is very stony. Unfortunately, the soil type could not be determined here.

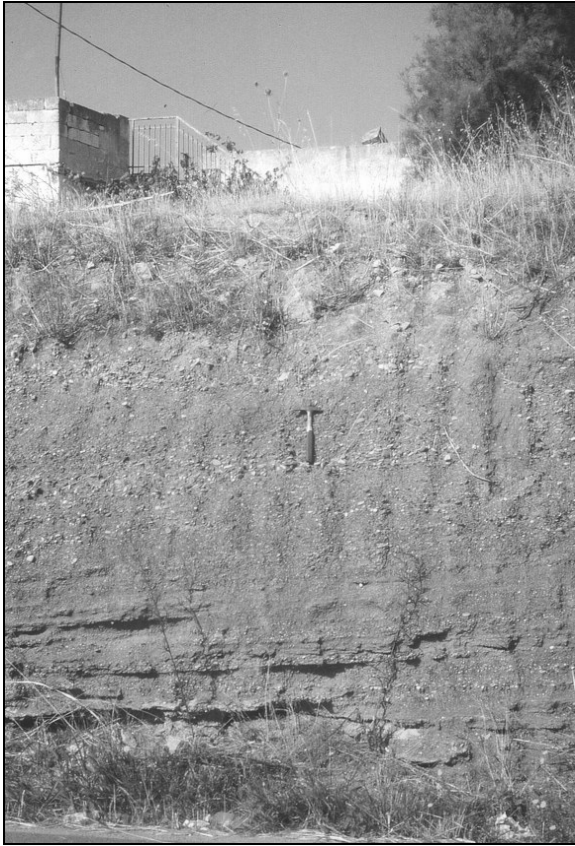


Figure 3.14 Delta deposits in road section near Palagiano

In this same system, further north to Palagiano, lithology changes to dark reddish brown, non-calcareous, sandy clay containing rounded pebbles. Here the soil is very stony and becomes firmer downwards. Remarkable is the large-scale addition of soil, visible as raised fields. North of this, at the boundary between UgSL and SgSL, loose, brown, light sandy loam, containing pebbles of calcite and conglomerate occur. The soils are very calcareous.

To conclude, the SgSL landform is divided into: areas with soils less than 30 cm thick, which are very stony and extremely rocky and areas with soils more than 30 cm thick, which are very to extremely stony. All fields in this SgSL have been ploughed and at times, rocks have been removed to build partition-walls.

River valley (RV)

River valleys are *Canale dei Cupi* (west of Torricella), *Fiume Patemisco*, *Lama d'Uva*, *Lama di Vite*, *Lama di Lenne* and a few nameless valleys about 3 and 10 km north of Mare Piccolo.

They are divided into three physical geographical units: a river valley floor, incised steep walls and possible terrace floors. The latter do not always occur.

Flat or almost flat river valley floor: lithologically, the soils consist of very sandy clay or sandy clay. Soil colors are divers: brown (10YR4/6), dark brown (10YR3/4), brownish black (2.5Y3/2), and olive black (5Y3/2). Thickness of the soil also varies: from about 50 cm to more than 170 cm. Some parts have been smoothed, and/or lime (-stone pebbles) is added. Stoniness in the soil varies between

no stones to stony. All profiles are very calcareous.

Steeply incised river valley walls: rock outcrop varies between extremely rocky to complete exposure of bedrock.

Flat or almost flat river terraces: an outcrop of the lowest river terrace of Lama d'Uva reveals a stratigraphy of about 360 cm. The upper 160 cm lithologically shows yellowish brown (2.5Y6/6), very calcareous, fairly stony, sandy loam with Fe(hydr)oxyde spots. This layer is followed by one meter of light gray (5Y7/2), very calcareous, fine sand. The lower 100 cm (from 260 to 360 cm) consist of light yellow (5Y7/4), very calcareous clay. Along a road cut near Lama di Vite a 150 cm profile could be seen, its stratigraphy showing 40 cm silt, followed by 110 cm of alternating gravel and sand lying on a sandy gravel layer. But these profiles appear to be exceptional: most terraces are covered with a layer of grayish brown to brown very calcareous sandy loam, without stones.

The river valley landform can be described as having river valley floors with a stony surface and no rock outcrop. Even nowadays, these river valley floors may be (partly) inundated during winter.

Singular steep slope

Lithologically, the landform is composed of Pleistocene calcarenite and calcrudite. It stretches over a distance of at least eleven kilometres north of Crispiano in western and eastern direction, having a width of 500 m to 750 m. Only 1 % of the area has flat parts on which cereal cultivation is possible.

3.4 Land systems in Agro Pontino (Central Italy)

3.4.1 Introduction

3.4.1.1 General

As discussed before (2.2.2), the Pontine region is remapped from physiographic units into land systems and landforms.

Generally, the area can be divided into two main units: the Lepini mountains and the adjacent coastal plain (chapter 1): a horst and graben system as a result of tectonic processes. In the graben (situated at the foot slopes of the mountain range), three sub-landforms are distinguished: former Pontine Marshes, Sezze alluvial sheet and Amaseno fluvio-colluvial deposits. The horst with faultlines (running parallel to the sea) consists of four marine terraces: a Holocene beach ridge system with lagoons, and three older terraces with beach ridges and/or lagoonal areas. In the eastern part of this marine terrace environment, aeolian deposits cover the beach ridges (chapter 1).

3.4.1.2 Case studies

Research has shown that in some parts the Pontine region is a (highly) dynamic landscape that has been subject to environmental changes (such as erosion of the hinterland and burial of marshy areas) since at least 4000 years. This pertains to the mountainous border-zones and adjacent foot slopes as well as to the lagoonal areas in the south. More specifically, three case studies were executed to investigate the possible causes, the effects and the archaeological and agricultural consequences of these changes. The locations of these case studies were (figure 3.15):

- the Lago di Fogliano coastal area in the south,
- the Sezze area in the north, and
- the Amaseno river area in the east.

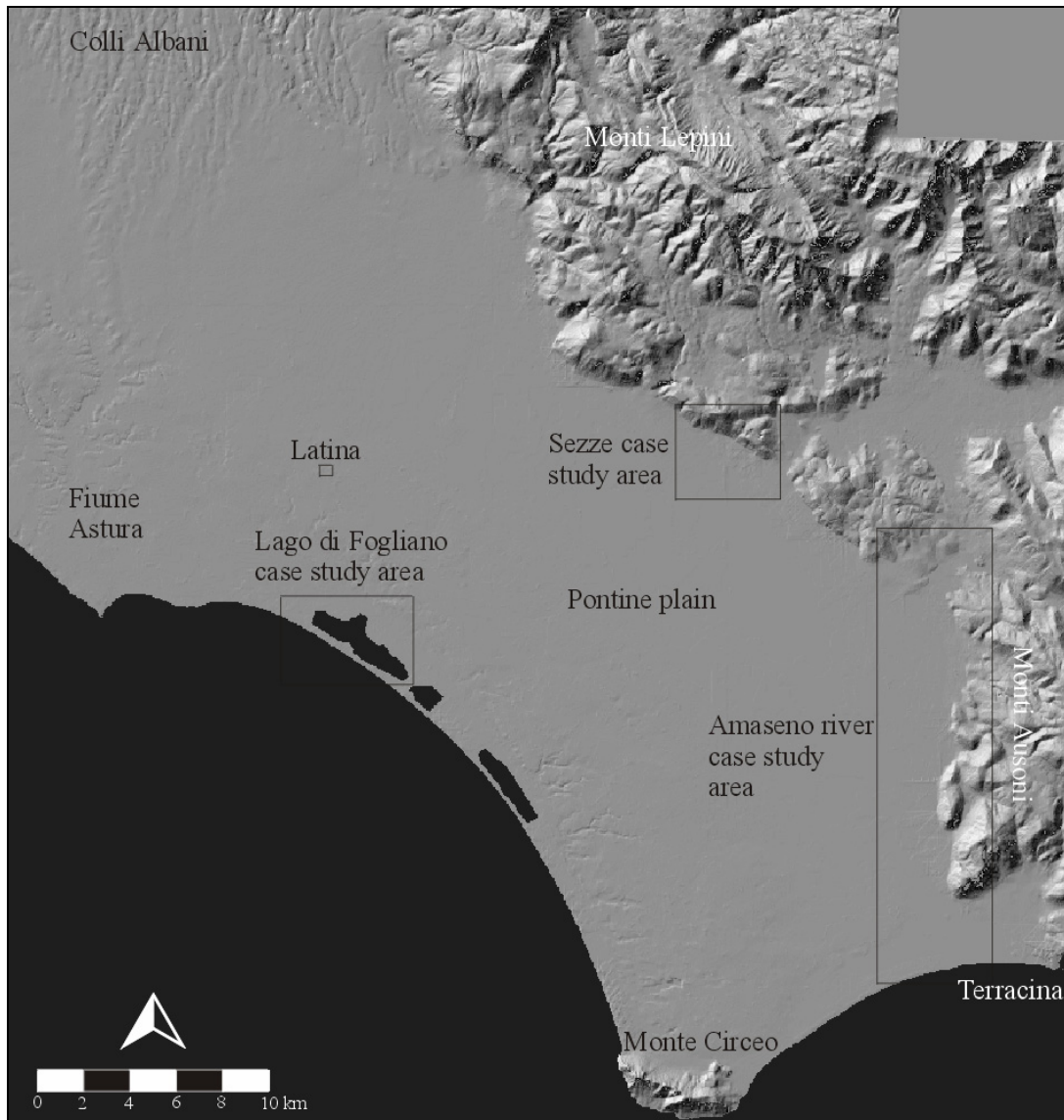


Figure 3.15 Map showing location of the case study areas in the Pontine Region: Lago di Fogliano area, Sezze area and Amaseno river area

The first study area parallels the Tyrrhenian Sea: the Fogliano beach ridge area. Attema, Van Joolen and Van Leusen (2002) have executed archaeological and physiographic research in order to determine, among other aims, the environmental changes in the area.

Van Leusen and Feiken (2001) provide a further check on the anthropogenic impacts on the landscape. Their main aim was to interpret field survey results in the light of historic relief change during the last decennium of the past century. By comparing two elevation maps, one produced in 1927/8 and one more recently, it was demonstrated that considerable erosion and elevation took place during this relatively short timespan.

Attema, Delvigne and Haagsma (1990) and Attema and Delvigne (2000) have extensively demonstrated the dynamic history of the alluvial sheet near Sezze and an alluvial fan near Sermoneta. They discovered various ages and causes of the development of these depositional features, being natural and human-induced.

The third and final case-study area lies in the eastern part of the region and was investigated by Bas Bijl and me. It focused on the erosional and depositional activities of the river Amaseno, between

1500 years BC till 500 AD. Both natural and anthropogenic factors triggered the Amaseno to deposit its fluvio-colluvial sediments over a lagoonal area.

3.4.1.3 Structure of this section

After a landscape reconstruction of the entire Pontine region is given (from 3.4.2 to 3.4.5), a description of the four land systems follows (3.4.6, figure 3.16):

- *Fogliano coastal land system,*
- *Borgo Grappa beach ridge land system,*
- *Latina-plain land system, and*
- *Monti Lepini land system.*

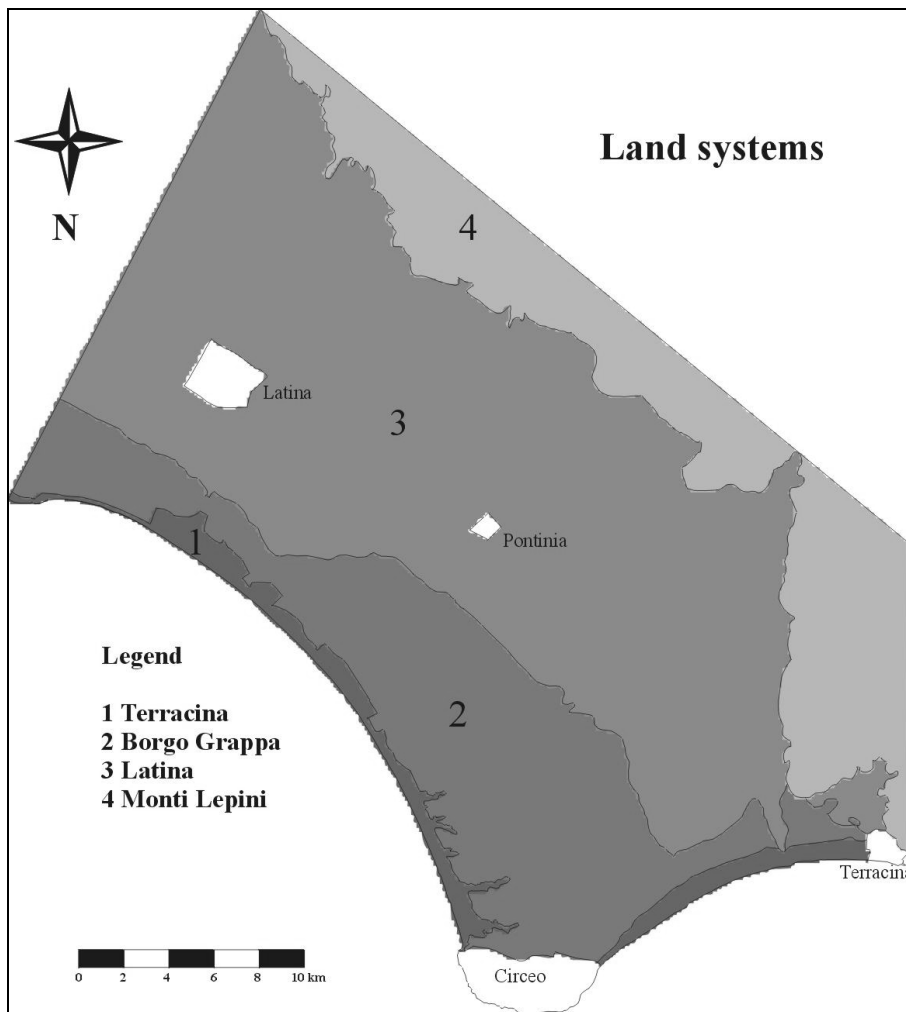


Figure 3.16 Location of the four land systems in the Pontine region research area

3.4.2 Landscape reconstruction of the southern part of the Pontine region: Fogliano coastal area

3.4.2.1 General

This research is concerned with the horst system along the sea coast, consisting of four sandy clayey marine terraces with a local aeolian cover, developed as a consequence of the relative (Quaternary) sea level fall (chapter 1). The four terraces are called (from the oldest to the youngest): Middle-Pleistocene

Latina level, Minturno level, Borgo Ermada level and Terracina level (Sevink et al. 1984).

The Minturno level has been dated by fission track, K/Ar and amino acid racemization to about 125.000 years BP. During the early Würm (about 90.000 years BP), the Borgo Ermada level was formed (Kamermans et al. 1991). Only in the Holocene the beach ridges of the Terracina level developed, with fluvial incisions. Soon after, these valleys were filled up with fluvial and marine sediments (Bouman and Rot 1983). Aeolian sands have locally covered all units during dry phases from the Würm to the early Holocene. Because of the combat against the malarial mosquito, Lago di Fogliano was partly deepened and salted and partly filled in with sediment (J. Sevink, personal communication). Surplus sediment was dumped around the lake and further inland; the area was classified by Kamermans et al. and Bouman and Rot as anthropogenic.

3.4.2.2 Fogliano coastal area in the Agro Pontino

In 1998 and 1999, an archaeological and physical-geographical fieldwork took place in the area between Borgo Sabotino and Borgo Grappa, the coast forming the southern limit, the beach ridges of the Minturno-level the boundary to the north (Attema, Van Joolen and Van Leusen 2002; figure 3.17).

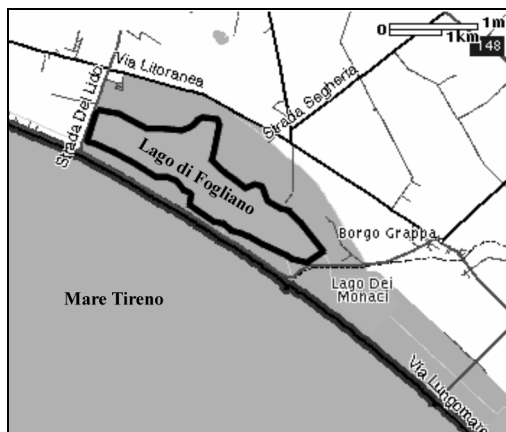


Figure 3.17 Detailed map showing the Lago di Fogliano case study area

Main aim of the archaeological research was to investigate a ‘marginal’ landscape, that is a landscape, which was not especially favoured for settlement during proto-and historical periods. First aim of the geographical research was to compare the detailed soil maps (1:25.000) of this region made by Kamermans et al. (1979) and Bouman and Rot (1983) and compile these into one map. The reason for this was that in the area concerned archaeological surveys took place and a soil map with uniformity in legend units was needed. Secondly for the soil units constituting the map a description according to the guidelines of the Food and Agriculture Organisation (1976) was required for land evaluation. A final aim was to reconstruct the Fogliano coastal landscape by examining the units, and especially the recent anthropogenic influences, which changed this landscape drastically.

Kamermans et al. studied the area between Borgo Sabotino and the western part of Lago di Fogliano in great detail. Bouman and Rot created a map of the northern area of Lago di Fogliano.

3.4.2.3 Comparing the maps

Beach ridge unit

The beach ridges of the Minturno-level (M1) and those of the Borgo Ermada level (B1 to B6) can be classified into the same unit for the land evaluation, despite the fact that age (respectively 125.000 BP and 90.000 BP) and elevation levels can differ significantly (respectively 13 m and 6 m above sea level). Texture (sandy clay/sandy loam to loam), soils and drainage class (well-drained) were more or less the same.

However, the older beach ridges had a longer period for soil development, were more clayey textured and had more Chromic properties than the younger ones.

The anthropogenic unit B13 of Kamermans et al. (1979) is also classified as part of the beach ridge system (probably Minturno-level), because of its distinct hilly appearance in the landscape, its corresponding soils and its elevation of 11 m above sea level.

Nowadays, the aeolian unit (B6) of Bouman en Rot (1983), lying in the western part of the research area near *Strada Litoranea Foce Verde*, is difficult to recognise. We classified it as a part of the beach ridge system.

Lagoonal unit between beach ridges

These narrow valleys consist of fluvial and/or lagoonal sediments. The width of the unit is relatively small (less than 150 m).

North of the *Strada Litoranea Foce Verde*, the units B7 and B9 (deposits between and alongside the beach ridges) of Kamermans et al. (1979) and the units B4 (valley-units) of Bouman and Rot (1983) coincide. Two south-east to north-west running valleys between the beach ridges are clearly visible. South of the Minturno beach ridge M1 the unit B9 (Kamermans et al. 1979) coincides with M4 of Bouman and Rot (1983).

South of the *Strada Litoranea Foce Verde*, the units B7 and B9 of Kamermans et al. (1979) coincide with unit B6 and T4 (Bouman and Rot 1983). The aeolian unit B6 could not be differentiated from the beach ridge deposit B1, it is lying in the same position of the B7 and B9 deposits and has the same texture.

Unit T4, just west of the village of Fogliano, could not be differentiated from the beach ridge unit B1, so it was classified alike.

Level lagoonal unit

Despite the fact that Bouman and Rot (1983) classify T7 as anthropogenic, it seems justified to consider T7 the same as T2, taking into account that it has the same position in the landscape and (probably) the same (lagoonal) genesis.

Aeolian unit

North of the western side of Lago di Fogliano, the aeolian units (B6) of Bouman and Rot (1983) are classified as lagoonal between beach ridge deposits, because the texture (clayey loam) resembled that of the lagoonal deposits. North of the *Strada Litoranea Foce Verde*, the aeolian deposits are classified as beach ridge unit.

Anthropogenic unit

All anthropogenic units of Bouman and Rot (1983) are classified as level lagoonal unit, except for the one north of *Canale Allacciante* at the western site of Lago di Fogliano (T7). The anthropogenic unit B13 of Kamermans et al. (1979) is considered to be a beach ridge unit, because (as said before) it forms a well-drained elongated ridge in the landscape at an elevation level of 11 m above sea level. On the map the other anthropogenic units, from which the genesis could be reconstructed, are shaded purple.

The results have been described schematically in table 3.6

Examined units		Compared units
Units of Kamermands et al. (1979)	Units of Bouman and Rot (1983)	
B1 to B6; B13; M1	B1; B6; M1	<i>Beach ridge unit</i>
T4; B7; B9	T4; B4; M4	<i>Lagoonal unit between beach ridges</i>
B8; B10 to B12	T2; T7; B2	<i>Level lagoonal unit</i>
	B6	<i>Aeolian unit</i>
	T7	<i>Anthropogenic unit</i>

Table 3.6 Construction of new legend units on basis of the mappings by Kamermands et al. (1979) and Bouman and Rot (1983)

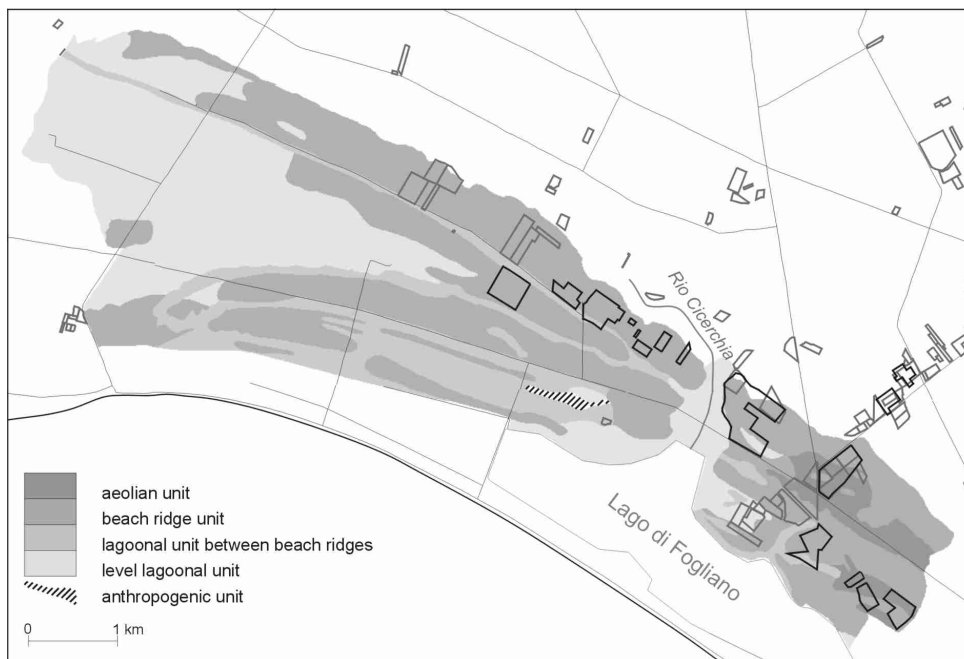


Figure 3.18 Adjusted map from Kamermands et al. (1979) and Bouman and Rot (1983) with new geomorphological units

3.4.2.4 Historic relief change in the Fogliano beach ridge area

Using a GIS procedure, Van Leusen and Feiken (2001) subtracted two elevation maps in order to produce a map, which showed areas of environmental relief change. They used a 1927/8 map, produced by the Italian Topographic Institute (IGM), which was made before the large-scale land reclamation works (*Bonificá*), and a commercially available map produced in the 1940s and 1950s.

After 'cleaning' the maps from biases and differences (scale, resolution, mapping errors, interpolation and datum shift; for a detailed discussion concerning these issues, I refer to Van Leusen and Feiken (2001) and Van Leusen (forthcoming)), the real differences between the maps *might be the result of either natural or human causes, or to a combination of both*. Van Leusen and Feiken discovered zones, which have become more than 7 meters lower, and zones, which lie up to six meters higher since 1927. They explain the differences by the works carried-out during the *Bonificá* (such as intentional dumping of material into marshy places), by plough-induced erosion and levelling, subsoil compaction and soil removal (for example aeolian sands) for building activities. These causes can be subjects for debate, and more research is desirable. The example clearly emphasises the importance of landscape reconstruction in archaeological land evaluation.

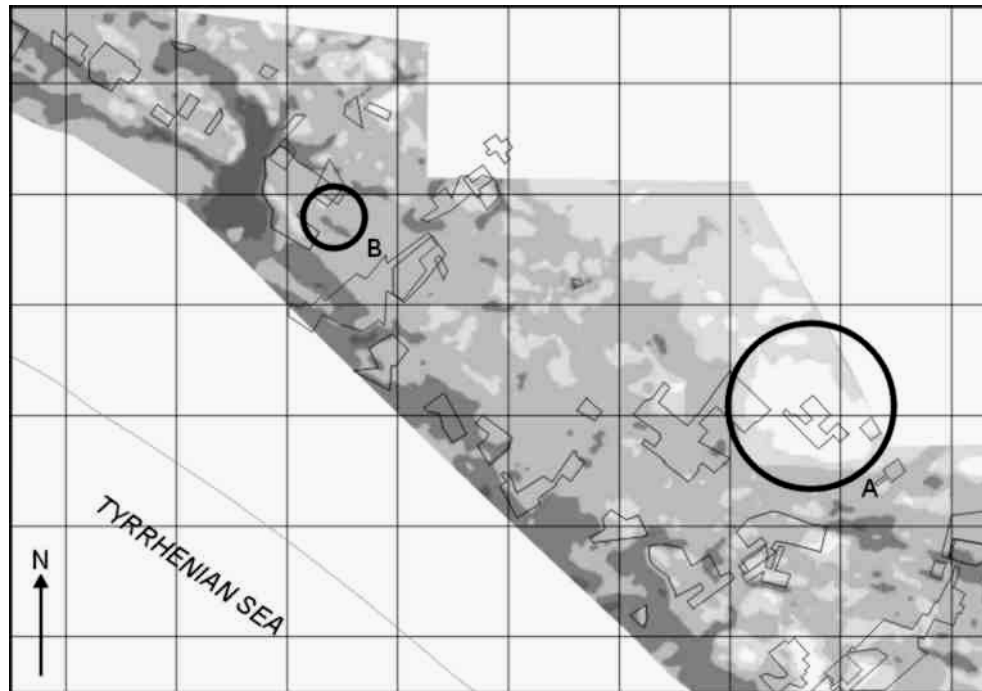


Figure 3.19 Eroded and elevated areas (Van Leusen and Feiken 2001) Simplified corrected differences between the two DEMs, with the RPC (continuous lines) and APP fieldwork areas (dashed lines) overlaid. A: area where large-scale sand removal may have taken place; B: area where farmer has levelled his field.

3.4.2.5 To conclude

For archaeological land evaluation, the beach ridge area includes elongated beach ridges, here and there covered by aeolian sands and separated by relatively narrow valleys, filled with both lagoonal and fluvial sediments. But the present-day relief does not fully reflect the ancient landscape (as became clear from van Leusen and Feiken 2001) in that certain valleys have been widened and other areas were levelled since 1927.

3.4.3 Northern-northwestern alluvial area

3.4.3.1 Landscape reconstruction of the fluvio-colluvial or alluvial area near Sezze

The north-western fluvio-colluvial basin fills (Sevink et al. 1984) or alluvial sheet south of Sezze have been intensively studied by Attema (1993), Attema, Haagsma and Delvigne (1996-1997), Attema and Delvigne (1998, 2000; figure 3.20).

They investigated the sediment changes in the area and also radiocarbon dated the transition zone between the lagoonal sediments and the covering alluvium. They interpreted environmental changes as follows.

Even before, but with certainty from around 4000 BP onwards, rivers from the north-west and from the north, such as *Fosso della Valle* and *Fosso Briolco*, from the Monti Lepini, built up alluvial fans in the marshy Pontine plain. These fans merged to form an alluvial sheet with alluvial fine-textured 'fingers' pointing in south-easterly direction. The 14C dates showed that since about 3000 BP, one to more than four meters of alluvium was deposited.

River channels must have been associated with the alluvial sheet, as became clear from hand augerings under the temple of Juno (5 km northwest of Sezze). At a depth of 1.50 m, a late Bronze Age/early Iron Age site (3340 BP) was found by local archaeologists (Zaccheo 1986, 1992), situated

on a layer of coarse and loamy sand. This layer was interpreted as a stream fill, and probably its levees served as the settlement location.

Since the Roman Republican, only little sediment was added (40 cm) indicating a decrease in sediment supply or an increase in soil erosion (Attema et al. 1996-1997).

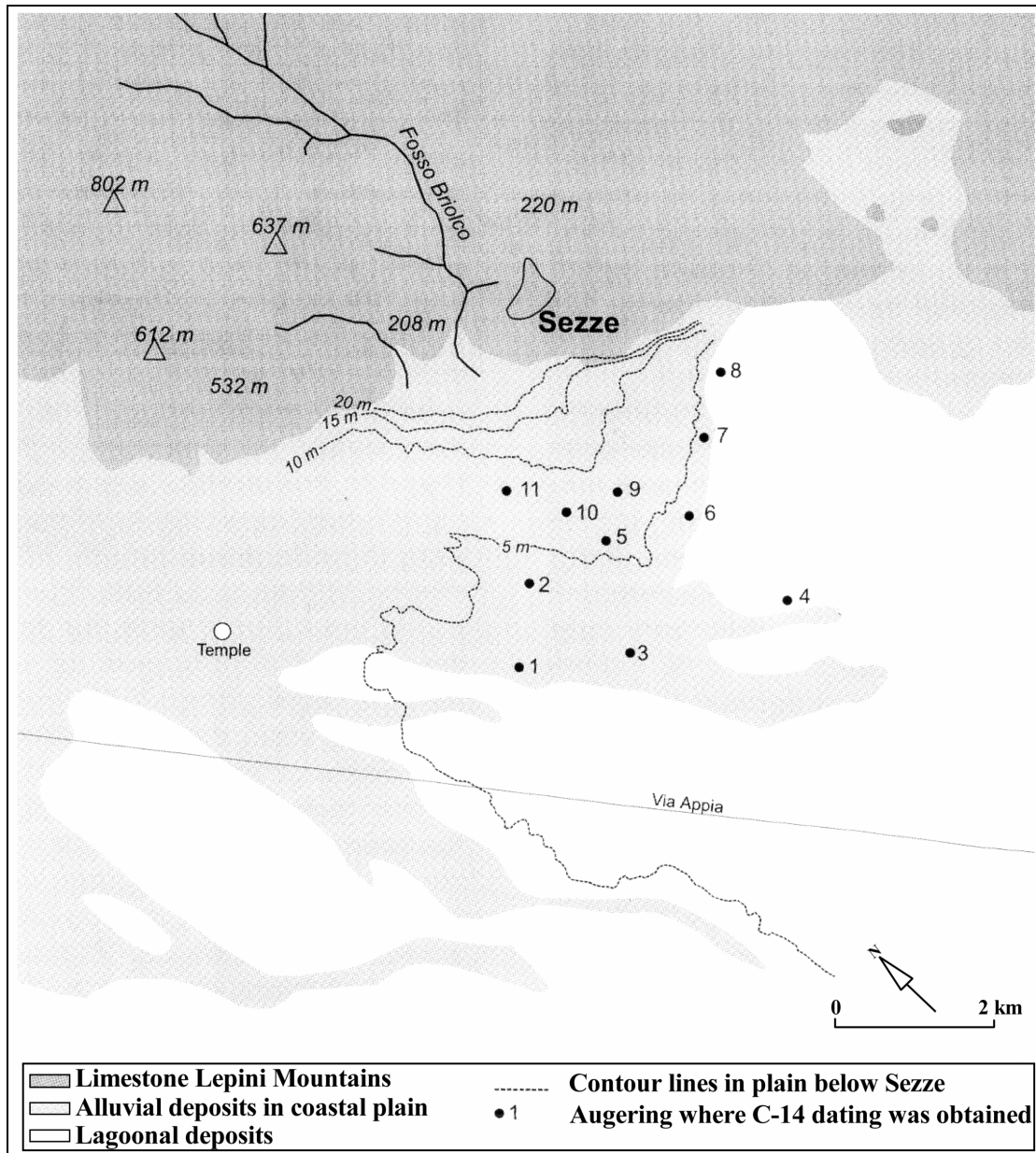


Figure 3.20 Map showing the location of the alluvial area near Sezze (Attema and Delvigne 2000)

The authors argue that fan and sheet building was not originally triggered by human disturbance of the hinterland, because *all dates of the fan and the sheet are too old to match the observed settlement expansion in the Sezze area* (Attema and Delvigne 1998). Human impact, as they claim, is expected only from especially the 6th century BC, when overgrazing and deforestation added a growing pressure on the natural vegetation. The Roman colony of *Setia* (Sezze) was founded in 382 BC, and as they claim, the alluvial sheet was already allocated for farming.

However, the Monticchio pollendiagram (Haagsma 1993) showed a decrease in arboreal pollen from the 4th century BC and an increase of cultivated species, with may have lead to unprotected unstable soils and locally to the occurrence of mudflows.

3.4.3.2 Landscape reconstruction of an alluvial fan area near Sermoneta

Near Contrada Trentossa (north of Latina Scalo, south west of Sermoneta, figure 3.20), a detailed sedimentological study took place in a trench, which was dug for a building-project in one of the ‘fingers’ of the alluvial sheet (Attema et al.1990, Attema 1993). This ‘finger’ or alluvial spur rises 4 m above the surrounded landscape and measures 1 km in length and 300 in width. Lithologically, at the bottom of the sequence lay a layer of undifferentiated red-brown colluvial clay, which was covered by loose gravel imbedded in a matrix of clay, deposited by mudflows (as the authors explain), originating from the valley of *Vado la Mola*. To the side of the spur, the gravel disappeared. On at least one location, the colluvium was incised by a river, which was subsequently filled with stratified sand and gravel.

At a depth of 40 to 60 cm below the surface, a dark coloured humic band was visible, probably indicating a stable phase in landscape development, in which the layer lay at the surface and was subject to soil forming processes. With reasonable precaution, human ploughing activities could be seen in the uniform distribution of gravel and sherds, and presence of undulations at the bottom of this zone. These undulations can be interpreted as filled (plough-) furrows. The upper 40 cm represented the recent stable phase accompanied by soil tillage and cultivation.

Archaeological remains in the sediment gave absolute dates for the energetic and stable periods in landscape development. The channel fill was completed at the end of the Archaic period (6th century), because the sediment only contained well-rounded *impasto rosso* and Archaic red *impasto*. During the Roman and Republican Age, mudflow sediments were deposited, containing well-rounded and angular sherds from both periods transported from the hinterland. In a period after the Republican, a stable phase enabled vegetation to grow and soils to form. Unfortunately, no radiocarbon date is available.

When we turn to agricultural suitability of the landscape, in the Roman and Republican period, the sediments grew to a dry ridge in the unstable humid colluvial environment of this part of the Pontine plain. This ridge can be considered potential farming land.

3.4.4 Genesis of the river Amaseno area in the eastern part of the Agro Pontino

3.4.4.1 Introduction

Sevink et al. (1984) mapped two areas of fluvio-colluvial basin fills, with layers of peat and/or lagoonal clay lying underneath, in the Agro Pontino (Lazio, Italy). But, as they also indicated, it has never been investigated *when* these fluvio-colluvial sediments were deposited and *what* triggered the process. Research in the eastern part (river Amaseno area) took place in August 1998 and in April 1999, and was executed by B. Bijl and myself (figure 3.21).

From the sedimentological information, obtained during the fieldwork, and ten radiocarbon dates, we could reconstruct at least two phases of fluvio-colluvial or colluvial deposition in this area, probably due to human activities in the foothills of Monti Lepini and Monti Ausoni. The ten dates contribute to a more thorough understanding of the period, when marshes and lagoons were covered with these fluvio-colluvial sediments. This burial with clayey sediments increased the potential suitability of the region for ancient (and present-day) agriculture.

Fieldwork was focused upon the eastern part of the plain (figure 3.15). The area stretches from Fossanuova in the north to Porto Badino in the south, covering an area of about 50 km². The region is surrounded by the limestone mountains of the Monti Ausoni (characterised by its irregular karst relief, Sevink et al. 1984; figure 3.22) in the north and east, by the lagoonal deposits of the Terracina level and the Borgo Ermada level in the south and south-west, and the (former) Pontine Marshes of the Terracina level in the west. The relief slopes in southern and western direction.

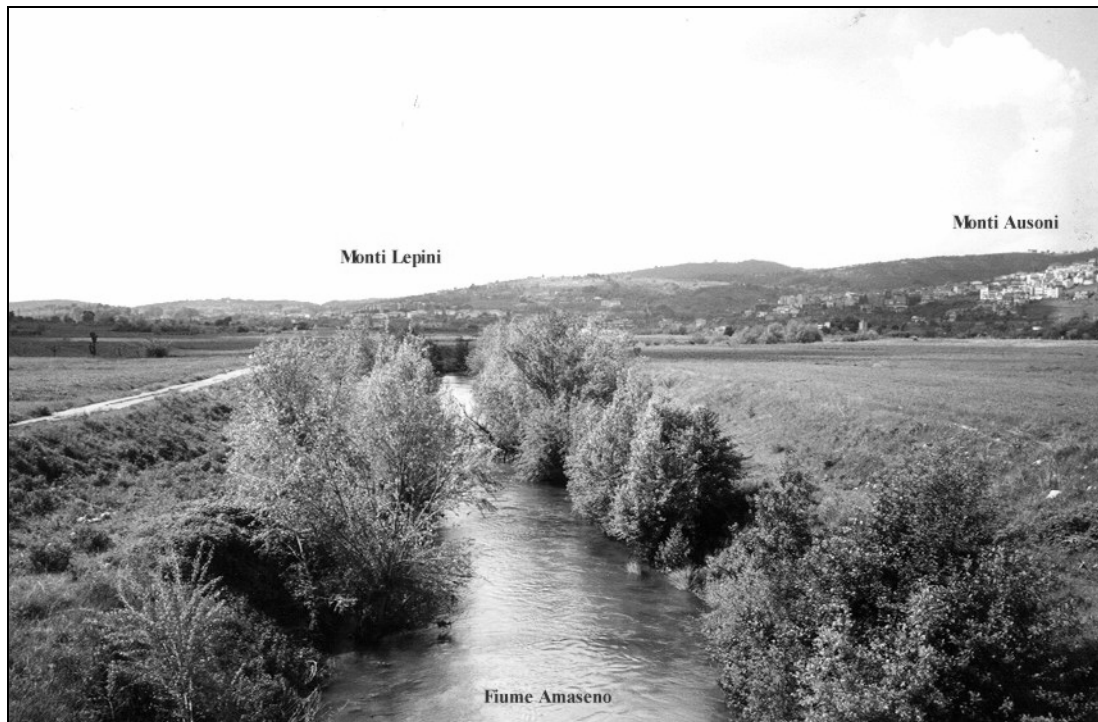


Figure 3.21 Present-day course of the Amaseno river with the Monti Lepini in the background

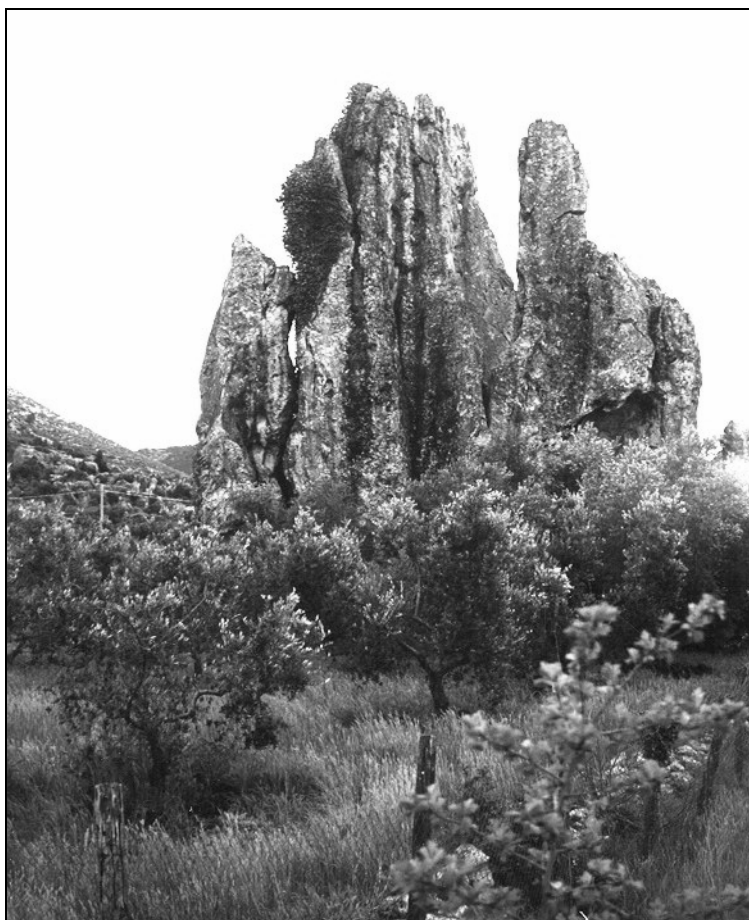


Figure 3.22 Example of a karst phenomenon in the Monti Ausoni

According to the soil map of Southern Lazio and adjacent Campania (Sevink et al. 1984), the area lithologically consists of a complex of irrigation deposits and fluvio-colluvial basin fills. Sevink et al. define the irrigation deposits as *sediments from irrigation and drainage waters, running through man-made channels, consisting of very fine textured, non-stratified deposits, and medium to coarse textured sediments in and along former channels*.

Later Sevink (1985) suggested that the sediments are '*colmatage deposits*', defined as *sediments resulting from the deliberate silting up of the lower, swampy areas of the Agro Pontino*. Large amounts of sediments have been forced through man-made canals that do not follow the original relief. Such forced transport and sedimentation of gravel, sand, reddish brown clay and silty clay could have contributed to the reclamation of the marshy areas. There is, however, no historical evidence for this.

The main river that runs through the research area is the *Fiume Amaseno*, partly canalised now. The river emanates from the Monti Ausoni, and flows via the *Fiume Portatore* into the sea at Porto Badino. The discharge of the river is unknown. Crops that are cultivated here are maize, tomatoes, luzerne, and barley. The fields have often been left fallow or are used as grassland.

Aim of the research

In the Late-Holocene, two areas in the Pontine Region have been considerably changed. These include the area under investigation south of Fossanuova (figure 3.23), covered by fluvio-colluvial sediments (Sevink et al. 1984) and another area described before near Sezze.

The extension and possible phasing of the fluvio-colluvial sediments were to be determined; the natural processes viewed in relation to the history of human occupation and land use. Changes in land use (forest clearance in order to create arable land, abandonment of terraces, cultivation shift from cereals to olives) can have had a severe influence on the stability of the soils and their erodibility. Sediment discharge in the hinterland may have increased, and these sediments could have been deposited in the low-lying marshy environment of the Pontine plain.

Research method

Landscape reconstruction started with the examination of the present-day sediments (for example texture, structure and overall thickness), as well as the underlying peat in the research area. Radiocarbon dates of the peat reveal the maximum age of burial by fluvial and/or colluvial sediments. So we know at least when deposition could have started and increased in this area. Part of the peat can have been eroded, ageing the peat at the boundary with the upper-lying sediments. The kind of boundary (sharp, clear or gradual) was examined too, indicating the possible presence of erosional phases.

We drew a grid at one-km intervals over the area; a core was taken at each intersection in the grid. A total of 48 drillings were carried out, of which ten samples are C14-dated.

Definitions

In the Amaseno research area, various sediments occur, such as colluvial, alluvial and fluvio-colluvial sediments. These deposits, their internal and field characteristics and the accompanying sedimentation processes are extensively described below.

Colluvial deposits

In the Amaseno-area, colluvium consists of reddish brown, heterogeneous materials of any particle size and often contains soil aggregates, which were transported by water, without falling apart in its original constituting particles. Colluvial sediments are fine- to coarse-textured and often mixed with angular limestone fragments. The sediment accumulates at the foot slopes of mountains.

Transport of material occurs as a result of detachment of particles from aggregates by raindrops and of loosely bound aggregates, which subsequently are transported by surface runoff. Surface runoff will occur during rain storms on slopes; the period and magnitude of surface runoff being determined by factors such as the rainfall intensity, rainfall duration and soil infiltration. Given a certain combination

of these, water will start to flow and detached particles and aggregates will start to be transported. The requirement for surface transport is that the carrying capacity or kinetic energy of the surface runoff is sufficient, implying that a clear relation exists between the velocity and maximum size of the grains and aggregates.

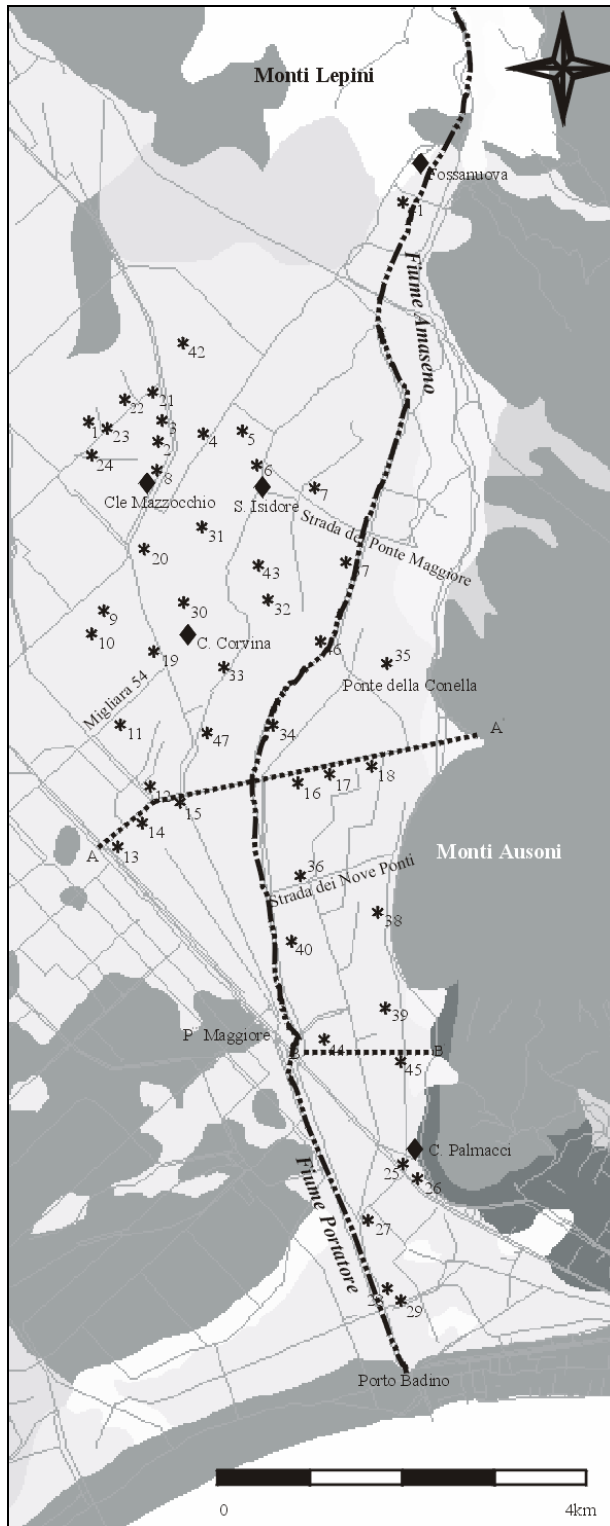


Figure 3.23 Map showing the Amaseno research area with location of the cores and two cross-sections A-A' and B-B'

During the transport, the aggregates may become fragmented (mainly by mutual collisions but also by dispersion). The increasing amount of smaller sized suspended particles increases the sediment transport capacity of the runoff. Thus, lower down the slope, increasingly larger aggregates and particles may be transported. To what extent this fragmentation and dispersion occurs, depends on the aggregate stability and kinetic energy available. Fast running runoff is capable of destroying more aggregates than a slow and thin layer of runoff.

If aggregates are very stable, soils tend to be permeable and unlikely to generate runoff upon minor rainstorms. Therefore, high rainfall intensities, as well as absence of vegetation, are needed in order to produce runoff loaded with sediment. Down slope, where slope angles decline and thus runoff velocity declines, aggregates accumulate as a result of the combination of a declining stream velocity and increased infiltration of the runoff. This produces steep colluvial slopes with colluvial deposits, marked by abundant aggregates of which the sedimentary origin may be hard to establish.

Fluvio-colluvial sediments

In case that aggregates are less stable, slope transport is more prominent or rainfall intensities are high, even relatively stable aggregates may disintegrate to produce fine primary particles. Settlement of these particles will occur at lower stream velocities and thus on less steep slopes, for example on very gentle lower slopes (a few degrees). The sediment will consist of a fine matrix with embedded aggregates and primary rock fragments, which may be considerable in size as a result of the higher carrying capacity of the sediment loaded water. This produces inclined fan-shaped deposits or fluvio-colluvial slopes with some stratification and matrix-supported deposits, typical for mountain foot zones in the Mediterranean.

In the Amaseno area, fluvio-colluvial deposits usually consist of very firm clay, sandy loam or loamy sand, containing both (moderately) sorted material and soil aggregates. The deposits are yellowish red, dark greyish brown, dark brown to brown and reddish brown. If colour changes from brown to grey: dark olive grey, very dark grey to grey, the reduction zone has been reached. The sediment usually is sandier near and along river channels and can contain pebbles and/or volcanic material.

Alluvial deposits

If sediment fully disintegrates, the runoff will produce well-stratified and well-sorted deposits being low in aggregates and having the normal characteristics of fluvial sediments. This may occur in fully fluvial environments or in areas where aggregation is weak, for instance due to the scarceness of free iron to cement the primary particles as in Planosols. In the Amaseno area, alluvium is fine-textured, greyish coloured and well sorted. Such sediments are scarce, since most soils in the Agro Pontino and its surrounding slopes are well-aggregated red soils in which iron cements the primary particles.

The distinction between fluvial and colluvial sediments is gradual and in the field often difficult to determine. On the plains, the alluvial and fluvio-colluvial processes may succeed in time, with fluvial deposits being formed during winter periods with high runoff and saturated soils, while during incidental autumn rainstorms flash floods may occur with sediment loaded with aggregates. These mud-flow type sediments fill the large pores in the coarse gravelly more truly fluvial deposits to produce matrix-supported gravels, which are so characteristic for the fans of the border zone.

In Italy, samples from the B-horizons were taken to the University of Amsterdam. Here, thin slides were prepared from the sediments described above, to examine the differences with the naked eye and under a polarisation microscope (personal communication Sevink and Bolt).

Colluvial sediment near Frasso (sample I. 718)

The sample shows a rounded aggregate of circa 1 cm surrounded by plasma (figure 3.24), composed of many small particles of circa 1 mm, and some angular Ferric nodules, which have clearly been transported. Bioturbation is expressed in the appearance of the abundance of voids and the channels. Reduction and oxidation (redox) spots are visible.

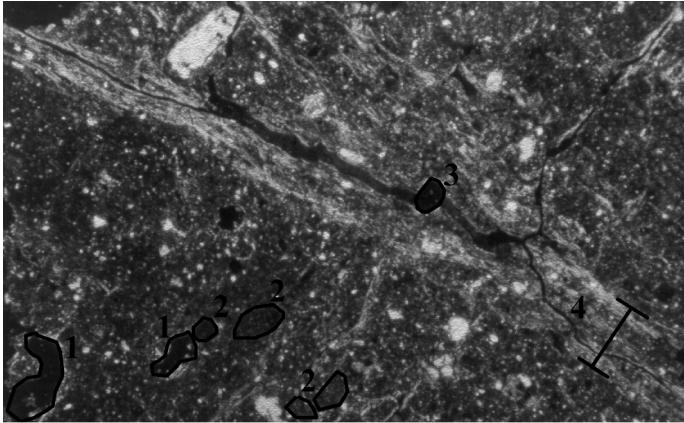


Figure 3.24 Colluvium: aggregates and plasma, crossed nicols, magnitude 25x. Dark brownish colour, rounding and the variety in shape and size characterise the aggregates; 1 = channel, 2 = aggregate, 3 = redox, 4 = vosepic clay (aligned clay minerals, which are striated along voids).

Fluvio-colluvial sediment

The next sample (I.716) was taken in the northern part of the Amaseno area (figure 3.25 and 3.26). We can clearly distinguish a rather large (3.5 x 2.5 cm), rounded, dark brown aggregate together with abundant smaller, also rounded, aggregates of a few millimetres, rounded Ferric nodules and pieces of charcoal. All together these elements indicate, that the sample was transported, and stratification and the well-sorted skeleton grains evidence sedimentary sorting. This sample is an example of fluvio-colluvial sediment. Presence of channels, faecal pellets, and disturbed sedimentary stratification indicates bioturbation after deposition. The presence of coarse material (sand) suggests a relative high energetic sedimentary environment, in which coarse material (such as aggregates) was being transported.

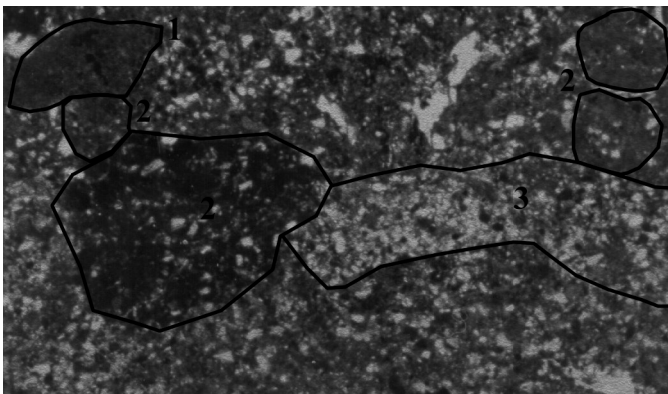


Figure 3.25 Fluvio-colluvial sediment: sedimentary sorting evidenced by stratification and well-sorted skeleton grains. Abundant transported aggregates (rounded) with dark brown colour and common small papules (brown clay) with similar size as skeleton grains. Bioturbation is evident with channels and other voids, as well as disturbed sedimentary stratification. Magnitude: 25x. (Sevink and Bolt, personal communication). 1 = papule, 2 = aggregate, 3 = sorted sediment

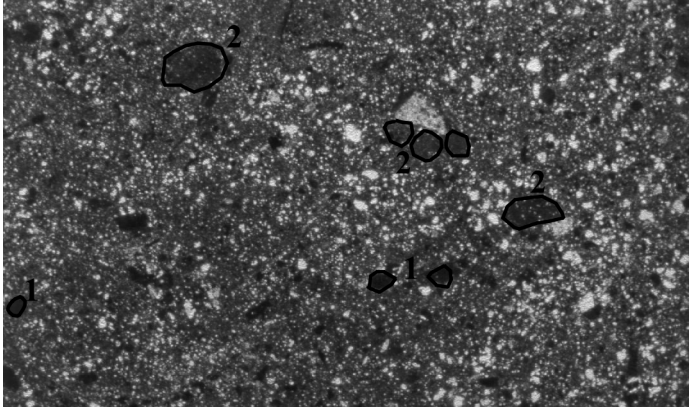


Figure 3.26 Fluvio-colluvial sediment: overall picture. showing textural differentiation in skeleton grains, disturbed by bioturbation. Magnitude 7.9x (Sevink and Bolt, personal communication); 1 = channel, 2 = aggregate.

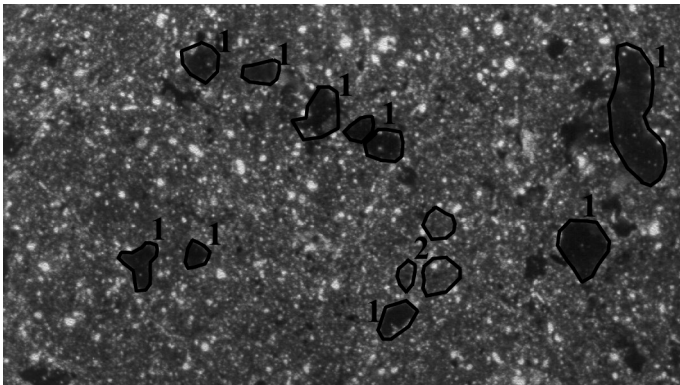


Figure 3.27 Alluvium: finer matrix, illustrating higher plasma content and good sorting with some aggregates. Magnitude 31x (Sevink and Bolt, Personal communication); 1 =channel, 2 = aggregate.

Figure 3.26 Mainly fluvial sediment: Amaseno deposits

The fourth sample (I. 717; figure 3.27) also shows large rounded aggregates of a few cm and less. But the sediment is especially composed of plasma instead of grains (sand and silt). This sample represents sediment, which was deposited in a low-energetic environment (further inland from the 'channel'). Some large rounded ferric nodules indicate the fluvial genesis.

Lagoonal deposits usually consist of calcareous clays and are less firm than the alluvial deposits. Shells and shell fragments often occur, together with fragments of vegetation (for example roots, leaves, and branches). The sediment can be very organic and sometimes layers of peat occur. The colour does not differ from the alluvial clay in the reduction zone.

Peat is a dark brown to black relatively coarse organic material. It contains fragments of (probably) alder, reed, roots, and/or leafs. Relatively small snails and shell fragments occur frequently. At some places dark grey peaty clay or clayey peat was found.

Calcareous gyttja is a fine-crystalline lime deposit, sedimented in lakes or lagoons, nourished by calcareous ground water, in a low-energetic environment. It contains almost completely decayed fragments of vegetation. The colour usually is pale olive, shells and shell fragments frequently occur.

3.4.4.2 Description and interpretation of the cores

A total of 48 cores were taken in this area (figure 3.23). Appendix A-II shows the soil profile descriptions.

Cores 1 to 12 were taken in 1998, cores 12 to 29 by staff members of the University of Amsterdam in 1974 and 1975, and the rest (cores 30 to 48) in 1999. We took samples from cores 2, 3, 12, 36, 38, 39, 40, 44, 45, and 47 for C-14 dating. Table 1 shows the dates for all ten cores in years before present and the calibrated ones.

Core number	Material	14 C date BP	Calibrated date (confidence level 95,4 %)	Surface level (m asl)	Sample depth (m)	Net altitude (m asl)
2: GrN-24418	Peaty clay	2660 ± 70	988 BC – 546 BC	2	1.8	0
3: GrN-24419	Peat	2840 ± 70	1204 BC – 830 BC	3	2.1	1
12: GrN-24420	Peat	2100 ± 90	368 BC – 74 AD	3	2.8	0
36: GrN-24858	Peat	1740 ± 60	142 AD – 424 AD	1	1.7	-1
38: GrN-24859	Clayey peat	1530 ± 50	430 AD – 630 AD	4	1.7	2
39: GrN-24860	Peat	1380 ± 50	600 AD – 772 AD	4	1.2	3
40: GrN-24861	Peat	3240 ± 50	1618 BC – 1410 BC	3	3.2	0
44: GrN-24862	Peat	2620 ± 70	914 BC – 522 BC	1	2.5	-2.5
45: GrN-24863	Peaty clay	1380 ± 60	554 AD – 778 AD	2	1.3	1
47: GrN-24864	Peat	2750 ± 70	1046 BC – 796 BC	3	2.6	0

Table 3.7 Radiocarbon dates of organic material directly lying under fluvial-colluvial sediments

Since the staff members of the University of Amsterdam had a different research aim (to map the deposits at the surface), they only drilled the top layer to about 200 cm. Unfortunately, therefore, the underlying sediments are not known in some cases (in cores 15, 16, 20, 21, 22, 24, 25, and 27). In one case (core 9) all sediment was totally disturbed, and subsequently interpreted as anthropogenic.

Almost all cores have a top layer of fluvio-colluvial deposits. This sediment decreases in thickness from circa 4 m in the north to where it disappears in the uttermost south. In the northern part of the area, the fluvio-colluvial deposits are composed of clay, sandy clay or loamy sand, whereas in the southern part sand does not occur in this unit (except for cores 28 and 29, but they lie in the vicinity of the beach ridges of the Terracina level, so the sand has been deposited here by quite different processes). Twelve cores completely consist of fluvio-colluvial deposits: cores 42, 22, 21, 5, 6, 7, 43, 32, 46, 30, 20, and 27 (in core 46 minimal thickness is 660 cm), but it cannot be excluded of course that other deposits occur at greater depths.

Clay and sandy clay with angular limestone fragments, at the foot slopes of the mountains, can be interpreted as colluvium. This sediment covers peat in core 26 and 39 and fluvio-colluvial sediments in core 35 and 37. Fluvio-colluvial deposits have covered the colluvial sediments in cores 35 and 37 again. On the soil map of southern Lazio and adjacent Campania (Sevink et al. 1984) this area is mapped as a fine textured, large alluvial fan unit.

In core 36, peat, lagoonal clay, calcareous gyttja and lagoonal clay occur successively to a minimum depth of 1300 cm (figure 3.28).

Peat and/or lagoonal clay were also formed or deposited in the north (cores 24, 3, 2, 31, 33 and 34); in the middle and in the south these sediments can be seen in cores 12, 13, 14, 47, 16, 17, 18, 40, 38, 44, 45, 25 and 26. In cores 24, 16, 17, 18, 25 and 26, lagoonal clay surfaces, in the other cores clayey fluvio-colluvial deposits cover the deposits.

Coarse sand on top of loamy sand is found in core 19, which can be interpreted as bedload sediment. The sand in core 1 (under the fluvio-colluvial sediments) contains shells. In core 13, peat and fluvio-colluvial deposits cover very dark grey, fine sand with shells.

Lagoonal clay was not reached in the central eastern area, in the vicinity of cores 47, 12, 13, 14 and 15, possibly on account of the moderate depth of the staff members augerings. But, as can be seen in core 13 (sand under peat), lagoonal clay simply does not occur, because the circumstances for deposition were not suitable (see landscape reconstruction).

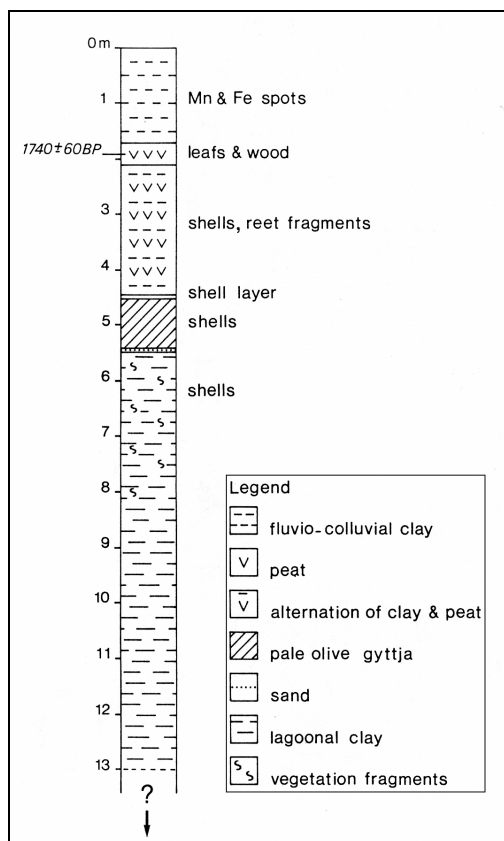


Figure 3.28 Lithostratigraphy of core 36 (for location see figure 3.23)

3.4.4.3 Landscape reconstruction of the Amaseno area

Now we have described the sediments and attained ten radiocarbon dates, we may reconstruct at least three (probably four) phases of landscape development.

The first phase deals with the Amaseno, meandering to the south in a dried up lagoonal environment. Vegetation grew at the border of the lagoon and between the tributaries in the north of the river itself. During phase two (about 1000 years BC to 300 AD), the river Amaseno built up a large alluvial fan, stretching to the area around core 36. From around 500 AD (phase three), colluvium was deposited at the foot slopes of the Monti Ausoni. At the same time (or during the fourth phase) fluvio-colluvial sediments covered the (rest of the) whole region. Below, a detailed discussion shows the various depositional phases in the Amaseno area in the recent past.

Phase one

The thick layer of lagoonal deposits in core 36 (figure 3.28) proves the existence of a deep lagoon. The beach ridges in the south dammed up water running from the mountains into the basin. Until now, we have not been able to determine if the water in the lagoon was fresh or brackish, but analysis of the many snails we found may give an answer. According to a local farmer, at a depth of 800 cm, saltwater molluscs were found after drilling for a well.

The lagoonal clay, the peaty clay, the calcareous gyttja and the peat in core 36 are continuously deposited in a low-energy environment. So, because of the thickness of the sediment, we may conclude that the genesis of the lagoon goes far back in time, belonging to the Borgo Ermada complex. Sevink et al. (1984) drew two profiles just north and south of core 36 (figure 3.29 and 3.30). Especially figure 3.30 shows relatively thick layers of peat, peaty clay, and calcareous muds.

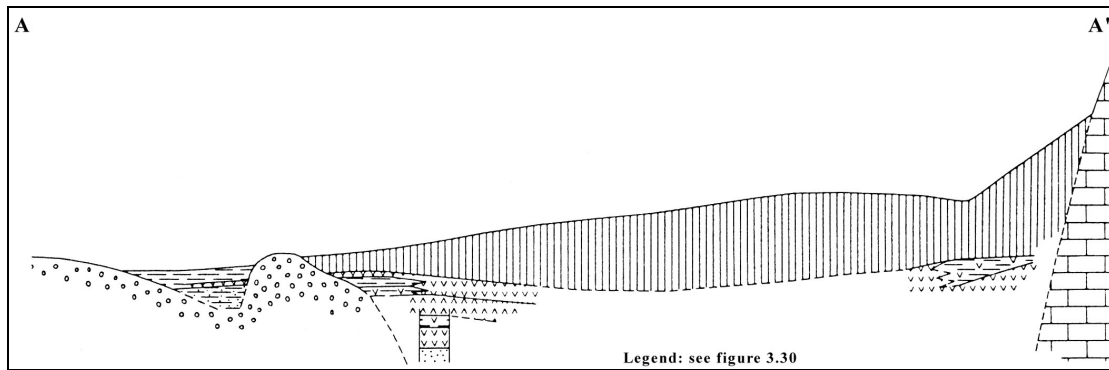


Figure 3.29 Schematic section of the Amaseno lithology A-A' (for location see figure 3.23), adjusted from Sevink et al. 1984 (scale unknown)

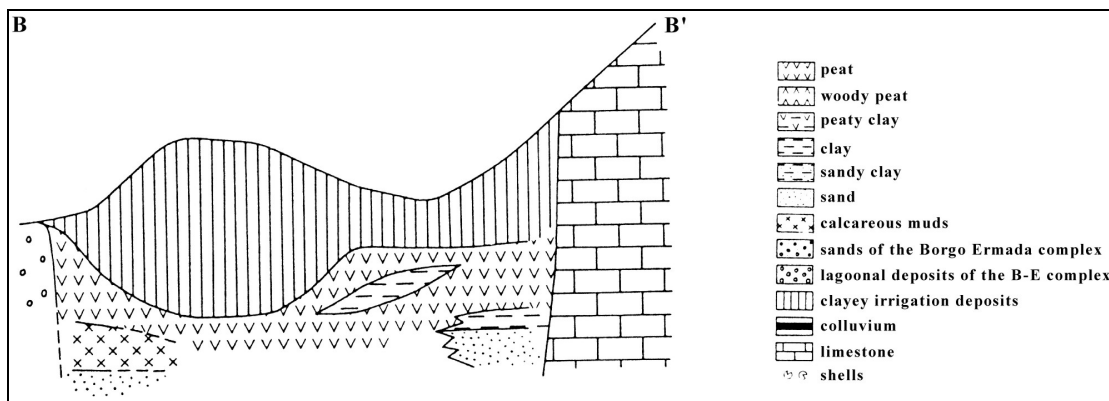


Figure 3.30 Schematic section of the Amaseno lithology B-B' (for location see figure 3.23), adjusted from Sevink et al. 1984 (scale unknown)

The Monti Ausoni probably bordered the lagoon in the east, as proved by the lagoonal sediments that occur in core 18. The area in the west was filled in with peat, which indicates a lower water level than in the east. To the west, the lagoonal Borgo Ermada deposits occur at the surface or dip under the (former) Pontine Marshes of the Terracina system. In the north, the mountains probably bordered the lagoon.

Later, the river Amaseno incised the dry filled-up lagoon, having various shifting tributaries, in southern and south-western direction. Marshes were present between the channels (cores 24, 2, 3, 8, and 31). This may have been the result of increased rainfall. Such a humid period, between 5,000 BP and 3,000 BP (Subboreal), can be deduced from the change in the pollen signal (Hunt and Eisner 1991), in which local mixed oak forest alters to an alder carr with some willow.

Phase two (ca. 1000 BC to ca. 500 AD)

The top of the peat (lying underneath the fluvio-colluvial sediments) at cores 3 and 2 was dated at respectively ca. 2840 BP (1204-839 BC) and ca. 2660 BP (998-546 BC; table 3.7). So from the end of the first millennium BC, the north-eastern area had been covered by an alluvial fan, built up by the river Amaseno, gradually extending to core 36 (relatively thick layers of fluvio-colluvial sediments occur in cores 5, 6, 30, 43 and 32: circa 350 cm, and core 46 with a minimum thickness of 660 cm). The peat in core 36 was dated at ca. 1740 BP (142-424 AD).

McGowen and Groat (1971) show in a schematic diagram the lithofacies in an alluvial fan deposit (figure 3.31).

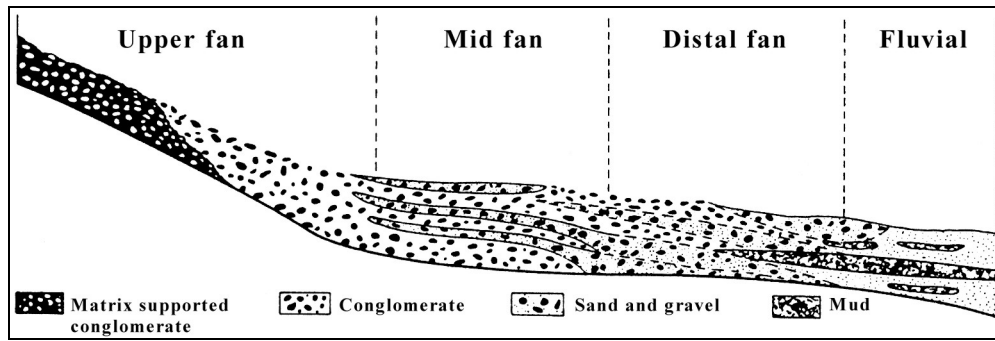


Figure 3.31 Schematic diagram showing distribution of lithofacies in an alluvial fan (after McGowen and Groat 1971).

In this research area hardly any gravel has been found, so probably the distal fan interfingers with a fluvial (floodplain) environment. The fluvio-colluvial sediments show no signs of buried soils (indicators of periods of landscape stability between phases of deposition). Probably, no such periods occurred at all, have been eroded or were not visible in the field.

Remains the radiocarbon date of core 47: 2750 ± 70 (1046 BC-796 BC). The time difference with core 12 is remarkable; it does not follow the logical sequence of dates, which rejuvenate in southern direction. Lithologically, the upper layers of core 47 consist of alluvium on top of peat, separated by a sharp boundary. So an explanation is that the upper peat layer has been eroded. Consequently, therefore, the peat that was dated much older than one may suspect.

Phase three (from ca. 500 AD onwards)

The age resemblance of the (clayey) peat or peaty clay at cores 38, 39, and 45 is remarkable (table 3.7), ranging from 430 AD to 778 AD. The peat was able to develop here, because of an abundance of springs (Sevink et al. 1984), providing a constant fresh water flow for the local vegetation. The upper lying sediments (probably colluvium) were almost simultaneously deposited from the western hill slopes of the Monti Ausoni.

The relatively old ages of the peat in cores 40 and 44 (table 3.7) can be explained by erosional forces of the downstream course of the Amaseno river, confined in the funnel-shaped form of the landscape or peat formation may have stopped, when discharge increased. Sediments on top of the black peat are composed of firm, (dark) grey clay and can be interpreted as pure alluvial sediments.

Phase four?

If a fourth phase of fluvio-colluvial deposition happened is unclear. Maybe the sediments were deposited simultaneously with the colluvial sediments. But we can be sure that somewhere after 500 AD all lagoonal deposits were covered in this area.

Natural or human-induced erosion?

Phase 2: alluvial fan building

From the landscape reconstruction it is clear, that the eastern part of the Pontine region, now covered by fluvio-colluvial sediments, was uninhabitable before the first millennium BC. But from around 1000 BC, the Amaseno started to deposit its sediment over the lagoonal and peaty environment. Compared to the Sezze area, where it was concluded that the alluvial sheet was deposited before the archaeologically attested period of intensive Roman inhabitation (before the Roman Age, the mountains and the plain were inhabited also, but, deduced from the low site-density, there is no proof of intensive occupation; see also 4.3.3), the building up of the Amaseno alluvial fan may have been triggered by anthropogenic activities, because the radiocarbon dates were considerable younger.

Because of a decline in the arboreal pollen signal (especially *Alnus*) from the Mezzaluna core, Eisner et al. (1986) and Hunt and Eisner (1991) conclude that the Subatlantic since 3000 BP may have started by a major dry phase around 1100 BC. But, as they admit, the decline can also be caused by

human activity such as deforestation, thereby increasing soil instability and consequently erosion. Unfortunately, the upper part of the Mezzaluna core does not provide information about the vegetation history after 1100 BC. That is why a core was taken in one of the lakes of Vescovo, just in the vicinity of Mezzaluna.

The Laghi di Vescovo-core seems to fill up the gap in the Mezzaluna-core, the first overlapping biozone 9 (*Alnus-Quercus*) of the latter. The full descriptions of the results are given in chapter 7 (pollen analysis). One of the conclusions from the Laghi di Vescovo-core is that between 366 BC and 10 AD, the environment around the lake was disturbed. During this period, considering the corrosion of the pollen, the lakes probably dried-up occasionally. Most common vegetation is *Quercus*, *Cladium* (galingale) and *Pistacia*. *Dryopteris-type* reaches its largest extent, indicating a shallower waterbody. Altogether this period indicates disturbance of the environment, maybe by deforestation of the hinterland.

Biozone 3 (around 450 cal BC) shows a maquis vegetation with *Castanea* and *Trapa* (water nut). *Quercus*, *Alnus*, *Olea* and *Cladium* also occur or increase. At a depth of 230 cm, some *Triticum* was found. Human influence clearly is visible in the increase of *Castanea*, *Triticum* and *Olea* especially.

Between ca. 700 and 400 BC (late Iron to Archaic Age), an increase of the rural landscape was seen along the slopes of the Lepine mountains. But from the Roman period onwards (400 to 100 BC), the number of settlements increased rapidly and probably with that, the influence on the landscape. So-called platform villae associated with olive culture, clearly present by the increase of *Olea* in the pollen diagram of Monticchio (Haagsma 1993), appeared at the foothills of the mountains.

The data given before prove that anthropogenic environmental influence can be the cause of the increased sediment supply by the river Amaseno.

Phase 3: colluvial sedimentation

Next to the indications of human activity from the Monticchio pollen core, traces of an early centuriation system have been found in the Terracina valley, which have been dated to 329 BC (Dilke 1971, 116). At that time, Rome (that probably could not provide enough agricultural land) sent 300 colonists to Terracina, to acquire more farming land. According to Eijgelaar (1998, thesis), early villas (4th century BC) were situated at the steeper slopes of the Monti Ausoni. Self-subsistence farming (cultivating cereals, olives and vine) with small plots and a few people can be assumed. In the third and second century BC, Terracina faces the introduction of platform villae, which specialised in olive cultivation. Then, with later villas (first century BC, *latifundi*), large-scale olive and cereal cultivation was common, and the whole valley was used. However, during late antiquity and after, *the colonies were contracted and the region became exploited extensively* (Attema 1996). So after an intensive use of the footslopes of the Monti Ausoni for olive cultivation especially during Roman Republican times and the (early) Imperial period, the area was abandoned (Attema, personal communication).

Can this abandonment be the reason for the rapid colluvial sedimentation dated between roughly 400 to 800 AD? This question formed one of the issues of the RPC conference, held in April 2000 (for more details I refer to the conference volume: Attema et al. 2003).

- According to Verhagen, abandoned agriculture on terraces can cause serious erosion of the terrace systems and the change from agriculture to husbandry can lead and has clearly led to bare landscapes very prone to erosion. But, at the contrary, vegetation cover can regenerate very quickly under favourable circumstances, actually reducing the vulnerability of a field for erosion. For example, olive groves usually had undergrowth, decreasing the erosion rate.
- To make the issue more complex, Farshad claimed that a field could degrade when no one takes care for it after abandonment, increasing its vulnerability to erosion. Furthermore, erosion also depends on soil type, and position in the landscape. But in terms of real erosion (wa-

ter erosion), abandoned fields do not experience severe erosion, because of a regeneration of the vegetation.

- Veenman introduces a very interesting aspect from her recent research on the degradation of vegetation in the Mediterranean (Veenman 2002). She concludes that present-day agricultural fields are never fully abandoned. Animals (goats, cows) always have their effect on the vegetation cover.

Additional information is given by the work of the MEDALUS (Mediterranean desertification and land use. The researchers aim to understand, predict and mitigate the desertification in the Mediterranean countries) groups and others (Clark 1996):

- *Vegetation improves the size and strength of structural units thereby increasing infiltration rates and hence the proportion of rainfall reaching the soil surface that enters the soil.*
- *Cultivation by destroying and creating pans reduce water input, increases runoff and hence increases desertification.*
- *The harmful effects of cultivation persist after abandonment due to the slow recovery of structure and hence the continued low permeability and consequential adverse soil water regime.*
- *The liability to erosion, ..., depends on a number of factors (after Clark 1996):*
 - *amount of precipitation and intensity*
 - *steepness of slope*
 - *nature of the vegetation cover*
 - *soil permeability (which depends on texture and structure, degree of soil development and the hydraulic conductivities of the horizons)*

Abandonment, overgrazing, and degradation versus regeneration of the vegetation turns out to be a complex subject. A lot of additional information is needed to decide upon the causes of the colluvial sedimentation. Pollen diagrams can prove the existence of olive cultivation, regeneration of the vegetation and overgrazing. Unfortunately, by lack of time, we were not able to analyse the pollen from the peat, which was radiocarbon dated. More research is recommended for the origin of the colluvial sediments, and perhaps some hinterland investigations into old terraces and agricultural practices.

3.4.5 Landscape reconstruction of the Pontine region from 4000 BP onwards

As has been said before in this dissertation, landscape reconstruction forms a vital part of land evaluation in Archaeology. Therefore, a detailed reconstruction of the landscape since 4000 BP is given below (see also figure 3.32).

Situation just before 4000 BP (before 2000 BC)

From the results of the various researches described before, it can be concluded that the Pontine plain looked rather different from today. The northern part (graben) consisted of a marshy area (Pontine Marshes), with a lagoonal area in the east. The foot slopes of the Alban volcanoes bordered the western side of the region. To the south, four marine terraces formed the step-like relief of the present-day landscape.

Climate induced alluviation between 4000 and 3000 BP (between 2000 and 1000 BC)

Gradually, alluvial sediments covered the marshy area south of Sezze, forming an alluvial sheet extending in south-eastern direction (Attema and Delvigne 1998). As argued above, the sheet building was triggered by climatic factors. The lagoon still existed in the east.

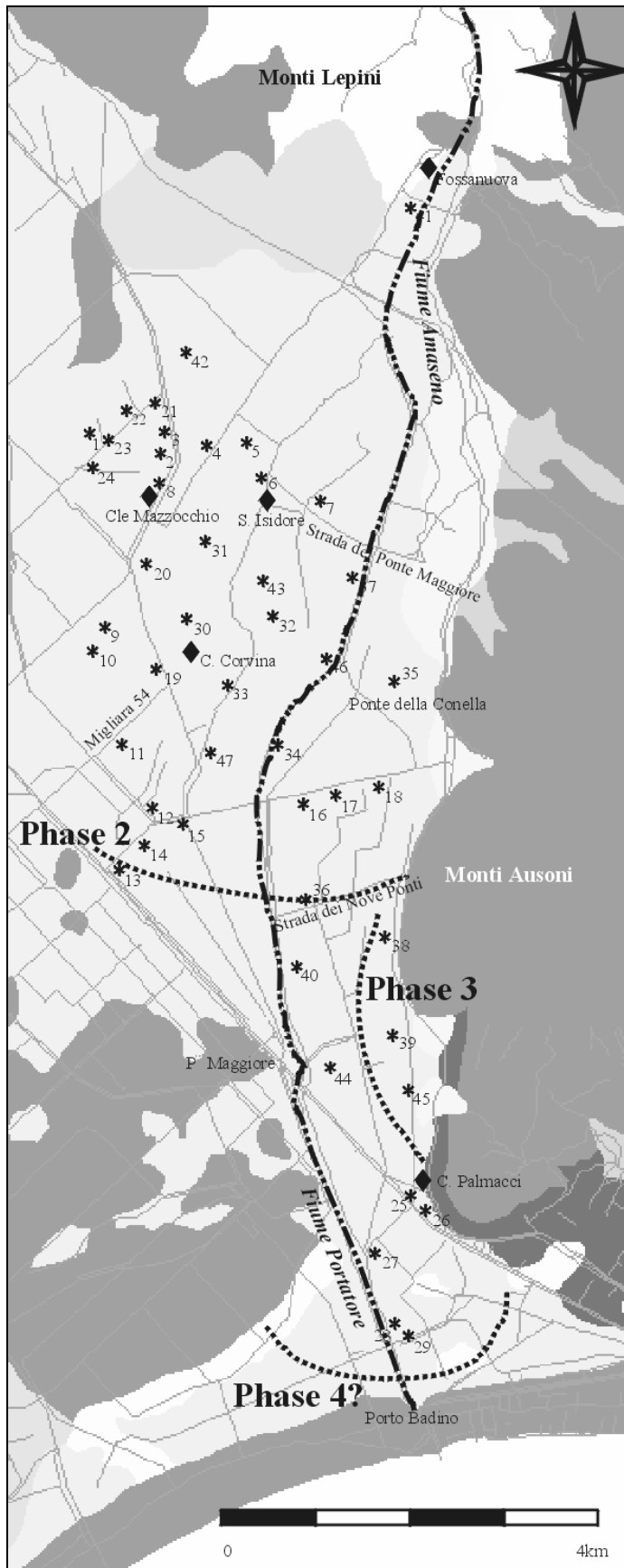


Figure 3.32 Map showing the Pontine region with the reconstructed phases in the development of the landscape

Human-induced alluviation between 1000 BC and 400 AD

As a consequence of environmental anthropogenic disturbance by deforestation, erosion took place in the hinterland of Priverno. Possibly the residents of Privernum (the Volscian city which was conquered by the Romans in 329 BC) were (partly) responsible (Armstrong 1911). Agricultural and pastoral activities took place in the upper Amaseno valley, in which the river played probably an important role. Hence, the Amaseno river started to deposit the eroded sediments in the plain, forming various alluvial fans in the previous lagoonal area, which was gradually covered in southern direction by fluvio-colluvial and alluvial sediments. Meanwhile, new alluvial fans were built on top of the alluvial sheet near Sermoneta (and probably alongside the entire Lepini foothills) as a consequence of human influence on the natural vegetation during the Iron and Archaic Age.

From the research it is clear that the Sezze alluvial sheet was built as a consequence of climatic changes before human interference with the landscape, whereas the Amaseno alluvial fan building was triggered by anthropogenic environmental disturbance. This age difference between the Sezze alluvial sheet and the Amaseno alluvial fans can be explained by the very different sediment sources, from which the alluvial sheet and fans were formed:

- The hinterland of Sezze consists of both calcareous mountains and especially tuff from the Alban volcanoes. The soils in these tuff areas are very suitable for agricultural activities because they are very fertile and easy to work. On the contrary, the mountainous hinterland of Priverno is less suitable for farming, because of slope steepness and shallow soils. Therefore, the area north and west of Sezze were in use much earlier than the Priverno hinterland (as proved by Attema 1996).
- The vulnerability of the tuff area to erosion is relatively high compared to the calcareous mountains. Agricultural activities can easily lead to erosion of the soil and deposition in the plain.

The Pontine landscape during and after the Roman Age

During the Roman Age, the contours of the alluvial sheet were more or less formed, and little sediment was added since. However, in the Roman period and ever in the Republican, the alluvial fans at the foot slopes continued to grow, alternated by periods of environmental stabilisation phases during which peat could develop.

The lagoonal area was entirely covered by fluvio-colluvial and alluvial sediments. A new phase of colluviation between 400 and 800 AD was probably caused by the abandonment of terraces. Consequently, coarse material was deposited in the plain covering the older alluvium.

In the south, the beach ridge area was influenced by drainage activities, digging and levelling. But these activities are difficult to date. But it is proved that the area underwent a lot of changes, at least in the 20th century, but probably also earlier.

3.4.6 Description of the Pontine land systems

For the geological description of the Pontine region, two maps were used: Foglio 150 (Roma) and Foglio 158 (Latina).

We distinguished four land systems in the Pontine region (figure 3.16):

- A. *Fogliano coastal land system,*
- B. *Borgo Grappa beach ridge land system,*
- C. *Latina-plain land system,* and
- D. *Monti Lepini land system.*

A. Fogliano coastal land system

An area with beaches and dunes and large lagoons

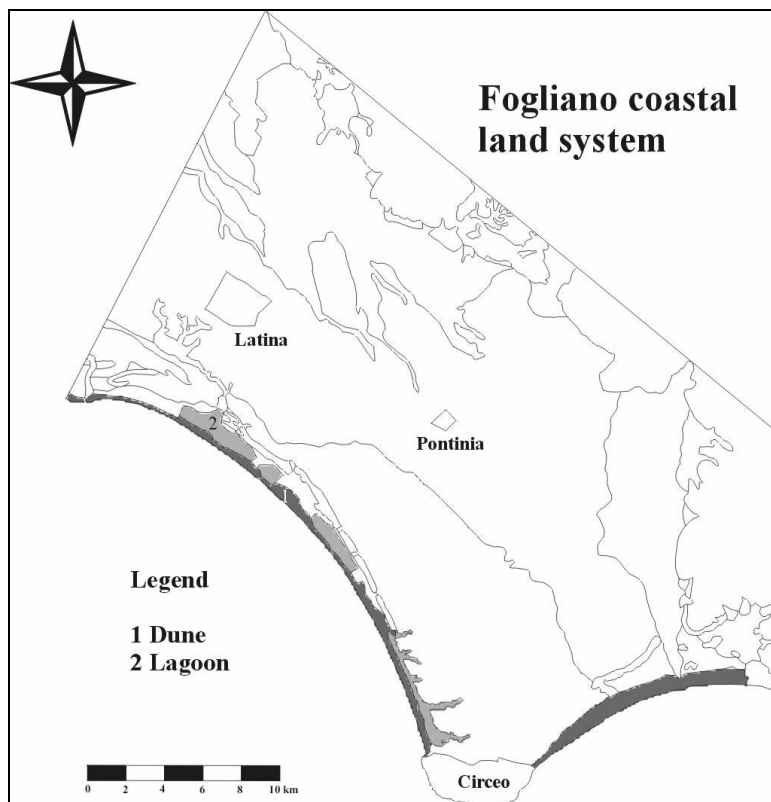


Figure 3.33 Geomorphic map showing the location of the Fogliano coastal land system

Extent and location: along the entire Tyrrhenian Sea coast in the southern part of the region.

Geology: according to the geological map, in the area Holocene mobile dunes and beach sands occur, in front of lagoons with marshy areas (peat, black earth and muds).

Geomorphology: an irregular pattern of positive forms (dunes) with maximum elevation of 15 m above sea level, which slopes varying between zero and 10 %. Flat parts in between the sandy dunes occur. The lagoonal unit is flat.

Land use: the area is unsuitable for any kind of agricultural land use.

Unit	Landform	Soil	Vegetation and land use
DN	Dune: form of positive relief (less than 20 m) together with relatively flat parts, having an irregular pattern and beaches. The valleys measure 3 m maximum in width and slope percentage is 10% maximum.	Arenosols.	Rough grazing land
LG	Lagoon: a bay inshore lying parallel to the coast (Skinner and Porter 1987). The bay is filled with water.	No soils were determined.	Rough grazing land

Table 3.8 Summary of the characteristics of the Fogliano coastal land system

Description of the Fogliano coastal land system

Dune (DN)

Present-day the most remarkable vegetation element in the dunes is the Hottentot fig (*Carpobrotus edulis*), growing between wild grasses and other coastal vegetation.

More or less the same soil properties were found as in the Salento area: in the medium fine to fine sand Arenosols were developed. The (very) loose, well-drained soils were very calcareous. Shell fragments and lime concretions may occur.

Lagoon (LG)

Separated by dunes lie four lagoons: Lago di Fogliano, Lago dei Monaci, Lago di Caprolace and Lago di Sabaudia. The original forms of these water bodies have been altered in the previous century, primarily to banish mosquitoes. In prehistory, they were probably used for fishing and gathering of shellfish.

B. Borgo Grappa beach ridge land system

A cultivated landscape of beach ridges separated by narrow valleys and vast plains

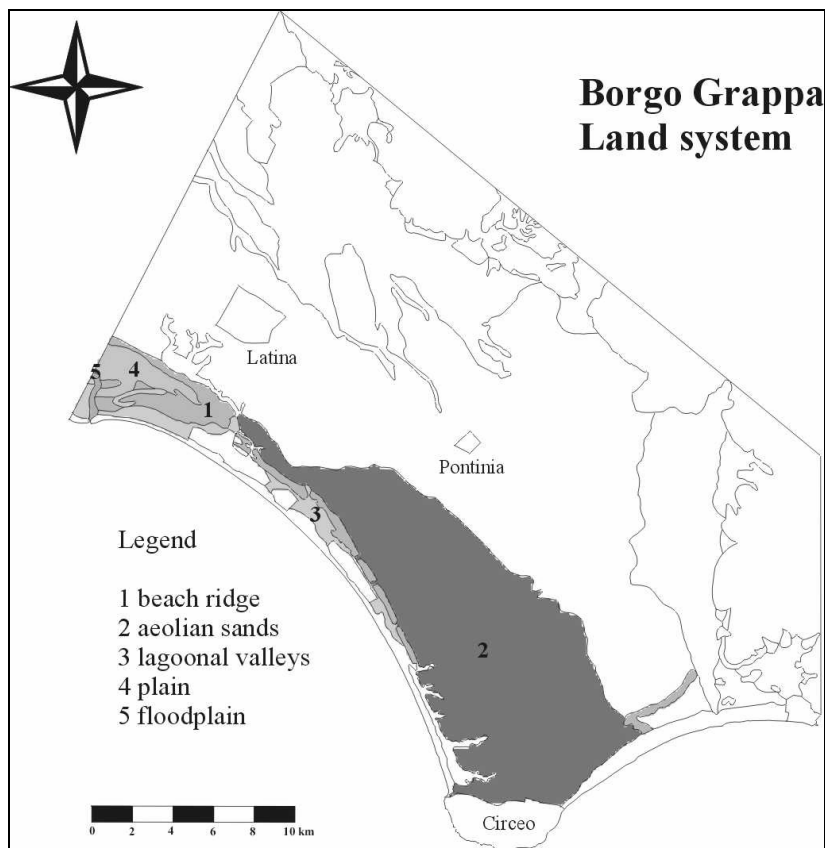


Figure 3.34 Geomorphic map showing the location of the Borgo Grappa beach ridge land system

Extent and location: ...km²; a south-west to south-east running strip of land parallel to the Tyrrhenian Sea.

Geology: according to the geological map, the upper-Pleistocene beach ridges described as “old dunes” are composed of reddish aeolian sands, occasionally mixed with clay and silicate (quartz)

gravel. Also, calcareous deposits occur. A variety of sediments appear in the Holocene floodplain areas such as marshy and alluvial deposits (especially peat).

Geomorphology: the level to rolling beach ridges rise between 2 and 13 m above sea level and are separated by narrow valleys, occasionally opening to substantial plains.

According to Sevink et al. (1984), a level to hilly aeolian unit was deposited on former beach ridges in the south-eastern part of the research area.

Land use: on the beach ridges, maize, melon and olives are cultivated, together with tall grass for haymaking (Bouman en Rot 1983) The valleys between the beach ridges are too small for large-scale agriculture and are mainly used for grazing.

According to Bouman en Rot (1983) and our own observation, the plain is unsuitable for agriculture (for reasons explained below) and is also left abandoned or in use for grazing.

Unit	Landform	Soil	Vegetation and land use
UL	Undulating land is a flat area, comprising relatively small hills and valleys.	Beach ridge: Chromic, Orthic, Albic, Gleyic, Ferric Luvisols without any stones or rocks. Lagoonal between Orthic en Gleyic Luvisol en Chromic Vertisol without any stones or rocks	The landscape is entirely cultivated, except for the Solodic Planosols.
PL	A plain is defined as an area with relative minor or no relief, which can be vaguely terraced and slopes at a gradient of 0 and 2%. It is subdivided into areas having shallow soils and areas having deeper soils.	In the lagoonal plain area, the most common soil type were Solodic Planosols, but also Albic and Gleyic Luvisols, Pellic Vertisols and Calcaric or Eutric Fluvisols occurred. No stones, no rocks. Calcaric Cambisols and Gleyic, Chromic and Orthic Luvisols developed in the aeolian unit. No stones, no rocks	
FP	Floodplain : an area of subdued relief formed by deposits laid down by flooding rivers (Summerfield 1991). Minimum width is 100 m.		

Table 3.9 Summary of the characteristics of theBorgo Grappa land system

Description of the Borgo Grappa beach ridge land system

Undulating land (UL)

Beach ridges

Kamermans et al. (1979) describe the well-drained beach ridge deposits (Borgo-Ermada-terraces (B1 to B6), which consist of sandy clay loam or sandy loam and with clay content increasing with depth. Occasionally, gravel (< Ø 3 cm) was found 30 cm below surface. Colour of the sediment of the relatively low beach ridges varies between brown (7,5 YR 4/4), strong brown (7,5 YR 5/6) and smooth brown (10 YR 4/4); whereas a bright reddish colour (5YR4/6) is more common in the relative higher beach ridges of the Minturno terrace (M1).

In general, the beach ridge deposit is friable, porous and permeable, lacking any structure. Human intervention is expressed in ploughing and levelling practices.

Aeolian sands on former beach ridges

Lithologically, the aeolian unit consisted of fine, well-sorted sands of 50 cm minimum depth (Bouman en Rot 1983), showing manganese pebbles. These calcareous sands were deposited on a (10 YR) paleosol. Sevink et al. (1984) describe this unit as follows: G5g = medium textured, well-drained aeolian

and other sand cover. Colour changed from 10 YR 4/4 and 10 YR 4/6 to 7.5YR5/3 at a depth of 100 cm below surface. Permeability and porosity are rather high. Irrigation is a common practise, as in ploughing of the topsoil.

Lagoonal valleys between beach ridges

Flat or almost flat, relatively narrow valley (maximum width is 50 m), consisting of imperfectly drained sandy loam or lagoonal clay. The clay acts as an impermeable layer, but in the dry season a weak to moderate structure (mudcracks) permits water to flow along cracks downwards; porosity is relatively low. In the fluvial sediment on top of lagoonal clay, layers of gravel may occur.

Plain (PL)

Relatively large area consisting of poorly drained, lagoonal sandy clay or clay covered by a sandy or sandy loam of 45 cm maximum (Kamermans et al. 1979). According to Bouman and Rot (1983), the fine clayey material has been deposited in a low-energetic environment behind the beach ridges.

The impermeable soils cause water to stagnate during winter times, but during drier periods, the soils experience mudcrack formation (personal communication Sevink) and precipitation can percolate downwards. Human interference is limited to ploughing.

C. Latina-plain land system

A vast, flat area between the Monti Lepini to the north and the beach ridges to the south, experiencing a wide variety of soil types and sediments

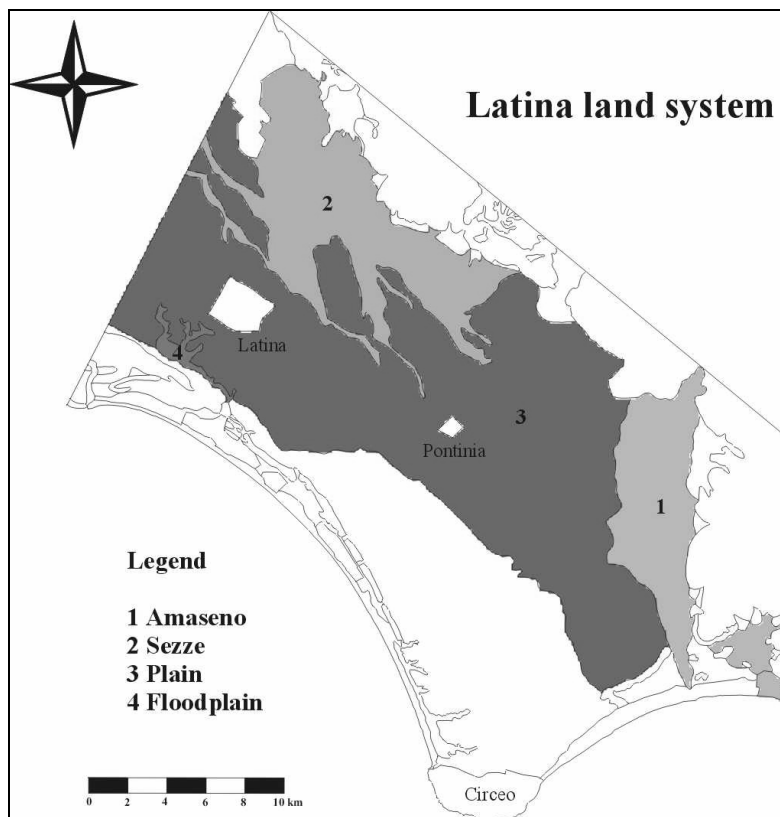


Figure 3.35 Geomorphic map showing the location of the Latina-plain land system

Extent and location: km²; the plain is situated in the centre of the research area

Geomorphology: a large flat area split up by a north-west to south-east running faultline, causing an uplifted area (horst) near the Thyrrean Sea in the south and a depressed area (graben) south of the Monti Lepini.

Land use: Grain is cultivated on the colluvial ridges, the colluvial plains are lying fallow.

Unit	Landform	Soil	Vegetation and land use
PL	This circum-lagoonal plain is defined as an area with relative minor or no relief, partly covered by alluvial sediments.	Non-calcareous Eutric Histosols, Mollic, Calcaric and Eutric Gleysols (Voorrips et al. 1991). No stones, no rocks.	Rough grazing land or abandoned fields.
	Sezze alluvial sheet with ridges	Very stony, Vertic Gleyic Cambisols (Voorrips et al. 1991), no rocks.	
	Amaseno fluvio-colluvial plain	Chromic Luvisols (Voorrips et al., 1991), no rocks.	
FP	Floodplain: an area of subdued relief formed by deposits laid down by flooding rivers (Summerfield 1991). Minimum width is 100 m.		

Table 3.10 Summary of the characteristics of the Latina-plain land system

Description of the Latina-plain land system

Plain (PL)

Former Pontine marshes: the historical and present situation

As was described in the first chapter, the former wooded Pontine Marshes were drained in several phases in history, but especially during the 1930s.

The area comprises poorly drained lagoonal deposits of the Terracina level (Sevink et al. 1984) and lies about 1 m above sea level in the central part of the research area. Two lithological sequences occur: a black, humified peat of 80 cm on top of a brown peat of at least 240 cm with pieces of elm wood and dark brown, calcareous silty loam of 220 cm on top of non-calcareous black peat. With increasing depth, the poorly drained loam changes from faint red (2,5YR5/3) and dusty red (2,5YR 3/3) to very dark grey brown (10YR3/2) and dull brown (10YR6/3). The topsoil is ploughed sporadically.

Sezze alluvial sheet and ridges

To a depth of at least 240 cm, the well drained to somewhat excessively drained (class 4-5: Voorrips et al. 1991) ridges consisted of dark brown (10YR3/3), non-calcareous loam and sandy loam (lower 50 cm). Stones were found in the upper layer only (upper 35 cm), whereas Fe and Mn spots were shattered over the whole profile.

Amaseno fluvio-colluvial plain

In this chapter, a detailed description of the Amaseno river genesis was given earlier. At least three phases in landscape development were distinguished, resulting in specific physical environments.

* Lagoonal area (before 1000 BC)

Whether the area was still wet and the lagoon filled with water at the end of the first millennium BC is difficult to reconstruct, but the many peaty areas found in cores indicate at least moist conditions.

* Alluvial fans (between 1000 BC and 400 AD)

Generally, the fluvial sediment comprises very sticky or firm dark brown to brown clay without struc-

tural features. Stoniness and rockiness both were zero at and just below the surface. According to the soil map (Sevink et al. 1984, 1991), the fine textured soils were well-drained. An association of soil types occurred: Chromic Vertic Luvisols and Chromic Vertic Cambisols.

*** Colluvial areas (after 400 AD)**

The gently sloping colluvial sediments generally were composed of very firm, stony sandy clay. According to the soil map (Sevink et al. 1984, 1991), in the colluvium, a complex of Chromic Luvisols and Lithosols has developed.

For the sake of completeness, two additional deposits are briefly described below, but because of their position this plain (outside the study area), they will be excluded from the research.

Tuff area

Duivenvoorden (1985) thoroughly examined the physiography in the area north-west of Latina. In the moderately well to well-drained middle-Pleistocene lithoid tuff Orthic to Chromic Luvisols and Eutric Nitosols were developed.

Travertine area

Compact lithoid travertine of pre-Holocene age appear in the south-west of the Monti Lepini, in which Chromic, Vertic Luvisols and rarely Calcaric Lithosols have been developed (Duivenvoorden 1985).

Floodplain (FP)

Unfortunately, the floodplain area was not examined.

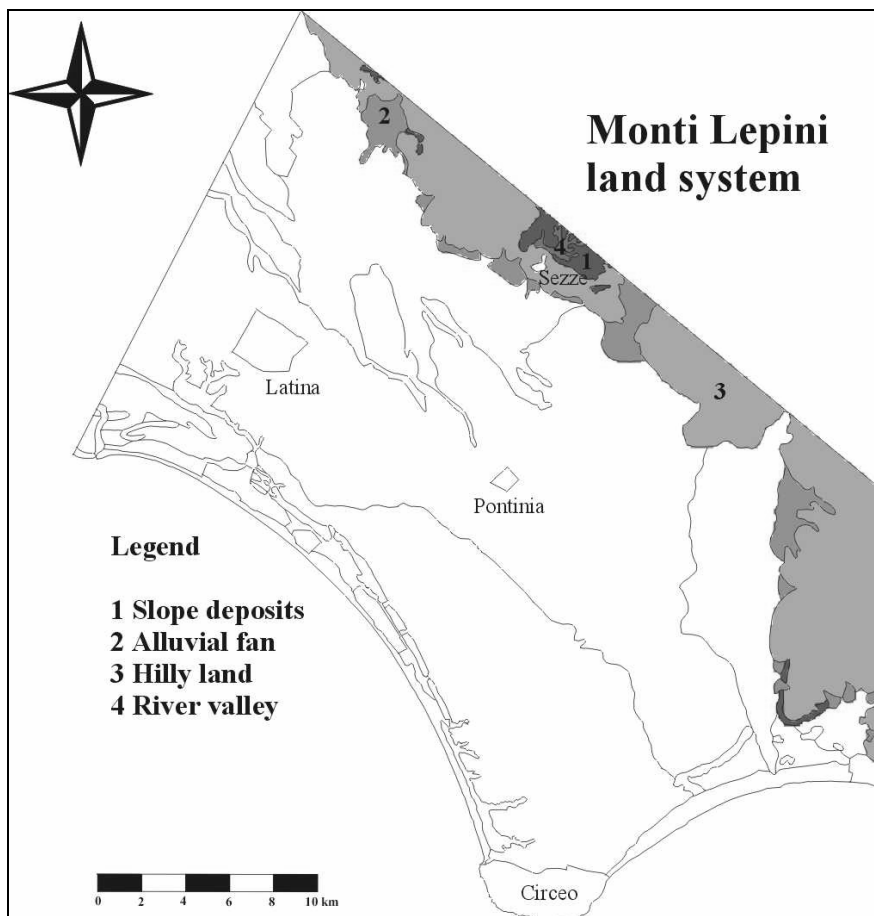


Figure 3.36 Geomorphic map showing the Monti Lepini land system

D. Monti Lepini land system

A steep mountainous area, dissected by a few north-west south-east running valleys and karst phenomena, especially in the east

Extent and location: ...km² ???, the Monti Lepini are located in the north, the Monti Ausoni in the east.

Geology: the Cretaceous *Formazione dei Lepini* is predominantly composed of limestone and whitish dolomite, flanked by Holocene slope deposits.

Geomorphology: steep to very steep mountains with gently sloping foothills arise from the plain, dissected by valleys and floodplains. The relatively soft limestone is subject to weathering processes, forming karst phenomena like dolines and poljes. Alluvial fans and slope deposits border the mountains.

Land use: abandoned olive yards, vine and horticulture are found on the slope deposits. The alluvial fans lie fallow or were covered with grass. No kind of agriculture is possible on the steeper slopes of the mountains.

Unit	Landform	Soil	Vegetation and land use
UgSL	Undulating slopes comprises sediment bodies composed of unconsolidated material (slope deposits).	Stony to exceedingly stony, Fairly rocky to rocky Lithosols, Chromic Vertic Cambisols & Chromic Luvisols	Rough grazing land
UgSL	Undulating gently sloping alluvial fan is a sediment body whose surface form approximates a segment of a cone which radiates downwards from a point on a mountain front (Summerfield 1991)	Association of Luvic Phaeozems or Chromic Luvisols (Voorrips et al. 1991). Exceedingly stony soils without rocks.	Entirely cultivated
MT	Mountains with steep to very steep peaks surrounded by sloping to moderately steep areas.	Very stony and exceedingly rocky Lithosols with occasionally rock outcrop)	Rough grazing land
RV	A (dried-up) river valley of which the maximum width between the incised walls measures at least 100 m, with slopes of more than 20 m height difference.	Chromic Vertic Luvisols (Voorrips et al.1991), no stones, no rocks.	Rough grazing land

Table 3.11 Summary of the characteristics of the Monti Lepini land system

Description of the Monti Lepini land system

Undulating gently sloping land (UgSL)

The foot slopes of Monti Lepini and Monti Ausoni comprise the following geomorphological units:

- Undulating slopes and
- alluvial fans.

Undulating slopes

Soil thickness within these undulating slopes varies considerably: from 5 cm to more than 150 cm. The gently sloping to moderately steep slope deposits having limestone banks exposed to the surface were well drained to excessively drained (Voorrips et al. 1991). Thickness of the calcareous, dark

brown (10 YR 3/3) to very dark grey brown soils varies between 5 and 30 cm. Pebbles of limestone up to 2 cm lie interbedded in the loamy texture.

The thin soils only offer potential for extensive grazing, whereas cattle intensively graze the deeper soils, cultivated with olive trees. The deeper soils show signs of gully erosion, whereas the thin soils probably suffer sheet erosion.

At the lower concave parts of the slope deposits, deeper non-calcareous soils of more than 150 cm were present. These dark brown (7,5YR3/3) loams or slightly sandy loams showed Fe and Mn spots and concretions.

These deeper soils were ploughed.

Alluvial fans

Alluvial fans can be subdivided into areas with high percentage of stones in the soil and areas with scarcely any stones in the soil. Slightly sandy, exceedingly stony loams occur in these gently sloping to sloping areas. The non-calcareous dark brown (10YR3/3) soils are well drained to somewhat excessively drained.

The second type alluvial fans without stones have been described in this chapter before (4.4.3).

Mountains (MT)

Sloping to moderately steep mountains

The thin soils developed into these limestone slopes were excessively drained. They show a dark brown (7,5YR3/4), very calcareous, sandy texture.

Steep to very steep limestone mountains

Thin, excessively drained humic black (10YR2/2) loams were found on the very steep slopes of the Monti Lepini.

River valley (RV)

The fluvio-colluvial valley fills (Sevink et al. 1984) were loamy textured and measured at least 120 cm. Colour varied from dark brown to brown (7,5YR3/3 and 7,5YR4/4). The non-calcareous soils were moderately well drained to well drained. Mn mottles and charcoal were found from 25 cm downwards.

3.5 Land systems in Sibaritide

3.5.1 Introduction

In the first introducing chapter (1.4.4), a general description of the Sibaritide (including the plain, the foothills and the Pollino and Sila Mountains) was given. Compared to the other two regions (Salento Isthmus and Pontine Region), the Sibaritide research area is relatively small. The area is situated around and south of the village of Francavilla Marittima (figure 3.37), at the margins of the plain of Sybaris and the footslopes of the mountains behind. The main aim was to examine the archaeological suitability of the land surrounding the *Timpone del Motta*, which hilltop was inhabited between the Bronze Age and the 6th/5th century BC. Although comparatively small, the research area covers all geomorphological units in the vicinity of the site of *Timpone del Motta* and is assumed to be representative of the agricultural areal of the site.

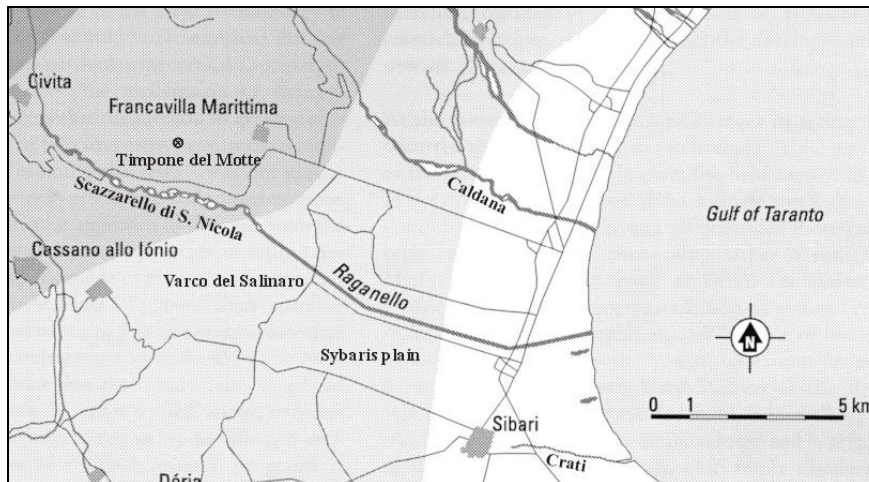


Figure 3.37 The Sibaritide research area

3.5.2 Landscape reconstruction

Both alluvial fan and floodplain deposits cover the plain of Sybari (chapter 1). Hofman (2002) examined the area between the Crati river and the Satanesso/Caldana rivers aiming for a more detailed reconstruction of the sedimentation history of the plain, focused especially at a landscape reconstruction during the first millennium BC. A close examination of the sediments revealed that these rivers, and the Raganello river, were responsible for the plain's stratigraphy. At several locations, at depths ranging from 0.8 m to 7.90 m, peat was collected for radiocarbon dating. Three km east of Doria, the oldest peat (from a depth of 7.85 to 7.90 m) was dated at 2120 ± 35 BP. It is obvious therefore, that the ancient landscape, familiar to and used by Bronze Age people, is hidden beneath a sediment layer of at least 8 m thick.

For that reason, the present-day plain cannot be used as a representative landscape present during the research periods. However, since the original Bronze Age surface is not discovered yet, it is assumed that it may have resembled the present-day surface, bearing in mind that more research is necessary.

In the plain of Sybaris, a thick layer of alluvial sediments covers the ancient city of Sybaris. It was founded by Archaeans (who came from the city of Helice) in 720 BC and destroyed in 510 by Greek neighbours from the city of Croton, 120 km to the west (Bullitt 1969). The fertile plain, abundantly watered by streams with the forested mountains in the hinterland, formed an ideal place to settle. Later, Sybaris was succeeded by settlements such as Thurii and Copia.

3.5.3 Description of the land systems

For the geological description of the Sibaritide, one map (1:100.000) is used: *carta geologica della Calabria* (sheet Castrovillari).

Below, three land systems are described (figure 3.38):

- A. Sybaris-plain land system, roughly in the eastern part of the area,
- B. Lauropoli undulating sloping land system in the west and the south, and
- C. Cerchiara di Calabria hilly land system in the north.

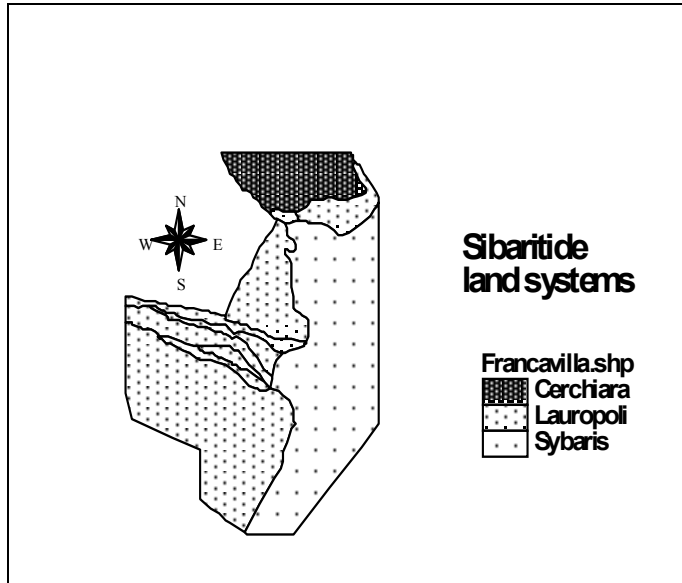


Figure 3.38 Map showing the three land systems in the Sibaritide research area (the river shown is the Raganello-river, for other locations and scale see figure 3.37)

A. Sybaris-plain land system

A flat or almost flat landscape, surrounded by mountains, built up by alluvium and marine sediments and entirely cultivated

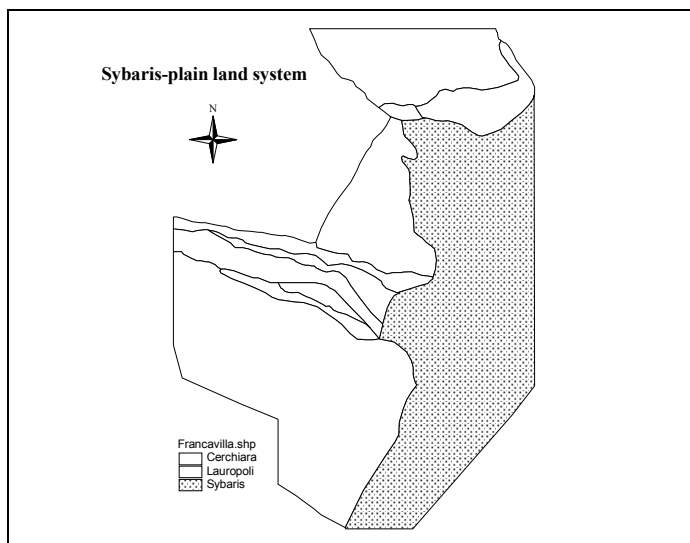


Figure 3.39 Geomorphic map showing the location of the Sybaris-plain land system (the river shown is the Raganello-river, for other locations and scale see figure 3.37)

Extent and location: 10 km², the plain covers the eastern side of the research area.

Geology: according to the *carta geologica della Calabria* (Castrovillari), the main geological unit in the plain is the Holocene terrestrial formation of Sibari: recent alluvium is composed of gravels and stones in a matrix of clayey silt and locally sand.

Geomorphology: a flat or almost flat very stony landscape, in which a distinctive river and many relatively small rivers flow

Land use: growing of wild cereals and other grasses, probably intended for haymaking, citrus and olive yards, with and without undergrowth of cereals.

Unit	Extent	Landform	Soil	Vegetation and land use
PL	10 km ²	A plain is defined as an area with relative minor or no relief, which can be vaguely terraced and slopes at a gradient of 0 and 2%	Stony Calcaric Regosols and Anthrosols. Stoniness at the surface varies between stony and exceedingly stony. No or only a few rocks in the field.	Entirely cultivated

Table 3.12 Summary of the characteristics of the land system

Description of the Sybaris-plain land system

In the very gravelly plain, only one location was suitable for taking a core of approximately 65 cm. No clear soil was formed into the very calcareous yellowish brown (2.5Y5/3) clayey silt and no mottles were found. Surface observations were taken at all other locations in the plain. The very calcareous dark greyish (2.5Y5/2) and yellowish brown (2.5Y5/3) silt, very calcareous grayish olive (5Y6/2) clayey silt and calcareous brown (7.5YR4/4) silty clay contained well-rounded pebbles; their diameter measuring up to 15 cm.

Elevation varies between about 85 m and 50 m above sea level. Stoniness at the surface decreases in easterly direction; near the footslopes and in the vicinity of the Raganello the agricultural fields were stone-spangled. Human influence was expressed in ploughing and irrigation of the fields and crops. No signs of natural erosion were found.

The down-stream part of the Raganello is embanked. Because its width measures just 100 m, and steep walls of 20 m in height are lacking, this part of the Raganello (including its river terrace) is not incorporated into the research, because it does not fit in the definition.

B. Lauropoli undulating sloping land system

A sloping landscape showing relatively small hills and valleys, occasionally dissected by river valleys and many relatively small streams

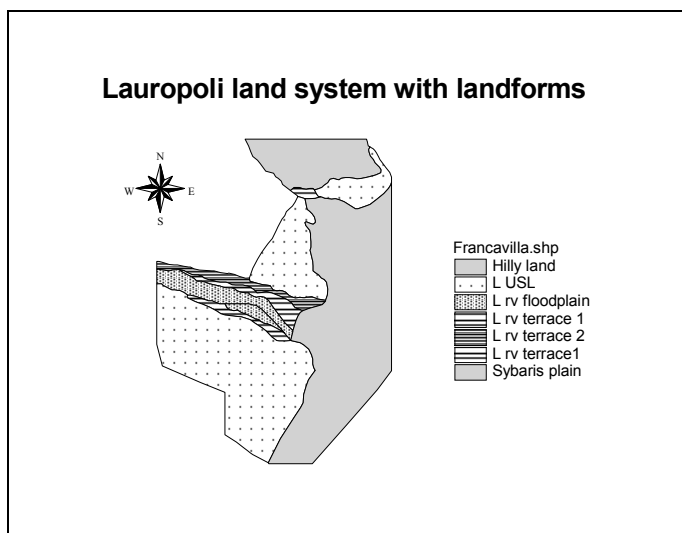


Figure 3.40 Geomorphologic map showing the location of the Lauropoli sloping land system (the river shown is the Raganello-river, for other locations and scale see figure 3.37)
L USL = Lauropoli undulating sloping land, L rv = Lauropoli river valley

Extent and location: 14 km²; the land system covers the south-western, the central and the north-eastern part of the research area.

Geology: Upper and Middle Pleistocene marine/fluviol terraces (see also section 1.4.4), which are lithologically composed of alluvial gravels and stones in a matrix of sand and clay, underlain by the Middle Pleistocene marine formation of Lauropoli: weakly cemented conglomerates and gravelly sand (especially quartz, grey-yellow, incorporated in layers of sand and clay).

Geomorphology: a stony landscape, undulating sloping in eastern direction, incised by many small rivers, creating relatively narrow valleys with rather steep walls. The Raganello river channel with floodplains, terraces, and steep walls intersects the undulation landscape. Alluvial fans were formed on top of the northern terraces, but at a scale of 1:50.000, they are too small to be mapped.

Land use: Cereals and olives grow on the sloping parts of the land system, the terraces are used for olive, citrus, and occasionally cereal cultivation; mandarins grow on the floodplains.

Unit	Extent	Landform	Soil	Vegetation and land use
USL	11 km ²	Undulating sloping land: landscape dipping at a gradient of 8 to 13%, with relatively small hills and valleys	Very to exceedingly stony (up to 75 %) Regosols were found.	Here and there, some shrubs grow on the terraces; at steeply eroded locations (especially in the western part of the research area), only natural vegetation can survive, such as maquis (pine).
RV	3 km ²	A river valley of which the maximum width between the incised walls measures at least 100 m, with slopes of more than 20 m in height, and with terraces. The river valley is divided into river channel, alluvial floodplain, and terraces.	A Regosol was found on the first terrace	

Table 3.13 Summary of the characteristics of the Lauropoli land system

Description of the Lauropoli undulating sloping land system

Undulating sloping land (USL)

Taking cores in the undulating sloping land turned out to be very difficult, due to the high percentage of stones in the soils and at the surface. Even with a corer, specially adapted for very stony sediment, it usually was impossible to work.

In the northern part of the USL, a core was taken to a depth of 80 cm. The grey-brown or brown (7.5YR4/6) silty clay contained both rounded and angular gravel of 3 cm maximum. The surface around the core location was exceedingly stony, probably because of ploughing. Large boulders (25 – 30 cm) were put aside. In a vertical section (close to the core) up to 130 cm, an A/C profile showed 20 cm reddish brown clayey silt lying on top of light reddish brown silt.

In the southern part of the area, another vertical section in the slope of Scazzarello di Nicola showed a similar stratigraphy: an alternation of very calcareous silt and gravel was covered by a 50 cm layer of exceedingly stony, brown (7.5YR4/6), non-calcareous silt up to the surface. The stony and fairly rocky slope showed some gully erosion.

A large, former pit or quarry (at the margins of the undulating sloping land and the Sybaris plain) revealed a vertical section of at least 10 m. The first 4 m were composed of unsorted rounded gravel, showing a fining upwards sequence. A clear boundary separates this gravel from the layer beneath: very calcareous olive brown (2.5Y4/4) silt.

South-west of Varco del Salinario (at the margin of the USL), we cored along a transect from the bottom of a small valley to the top of a small hill (figure 3.41). The main aim was to investigate the dif-

ference in stoniness in the valley, on the slope and at the top. The results (shown below) may be an explanation for the presence or absence of sherds at a specific location, due to erosive and depositional processes. Average distance between the cores was 500 m; the elevation was increased with 10 m.

The topsoil texture in the valley was composed of dull yellow orange (10YR6/4) loose, very calcareous silt. Stoniness in the core was 2 % (stony). Below (40 – 75 cm), loose dull brown (7.5YR5/4) clayey silt was found, which also was very calcareous and stony. At the bottom (75 – 100 cm), dull yellowish brown (10YR5/4) clayey, very stony silt with an abundance of gravel was found. No stones were met at the surface.

On the slope, the first 50 cm were composed of very stony, dull yellowish orange (10YR6/4) clayey silt. This clayey silt was deposited on a dull yellowish brown (10 YR5/4) stony silty clay of 25 cm thick. The bottom layer was composed of grey (5Y45/1) sticky clay, in which stones were lacking. All layers were very calcareous. Stoniness class 1 was found at the surface.

To a depth of 40 cm, the top layer of the small hill was composed of very stony, very calcareous, dull yellowish brown (10 YR5/4) loose silty clay. At the surface, stoniness percentages could rise to 30 % (exceedingly stony).

From the lithological descriptions of the cores, it is obvious that easily detached and transported material has moved down slope, leaving a very stony surface at the top and the slope of the hill. In the valley, the sediment is deposited, covering stones and eventually, archaeological sherds. By surveying valleys such as investigated here, or even slopes, requires adjustments.

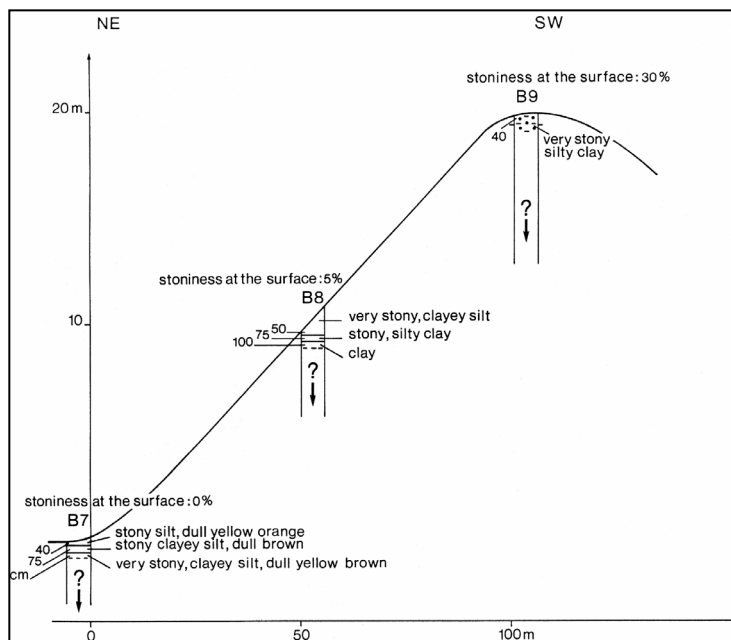


Figure 3.41 Hill section south-west of Varco del Salinario

Raganello river valley (RV)

A river, accompanied by alluvial floodplains and recent and older terraces, ringed in by steep walls of ancient coarse fluvial material and angular slope deposits.

The coarse textured river *channel* is unsuitable for any kind of agriculture, partly due to annular floods, partly because of the presence of gravel and even boulders and the absence of finer material.

The sediment in the *alluvial floodplain* at the inside bend of the river shows grey (5Y6/1), very calcareous sandy clay with no stones or rocks. The flat area was ploughed manually. We were not allowed to take a core.

In a vertical section of the lowest Raganello *river terrace*, the following profile was described: starting at a depth of 130 cm, a layer of gravel and boulders of minimal 52 cm thick was overlain by a grey

silty clayey layer (78 – 72 cm). On top of this clayey layer was a layer of poorly rounded gravel of sandstone and limestone (72 – 65 cm). Finally, very calcareous grey silty clay appeared at the surface. No signs of soil development were found.

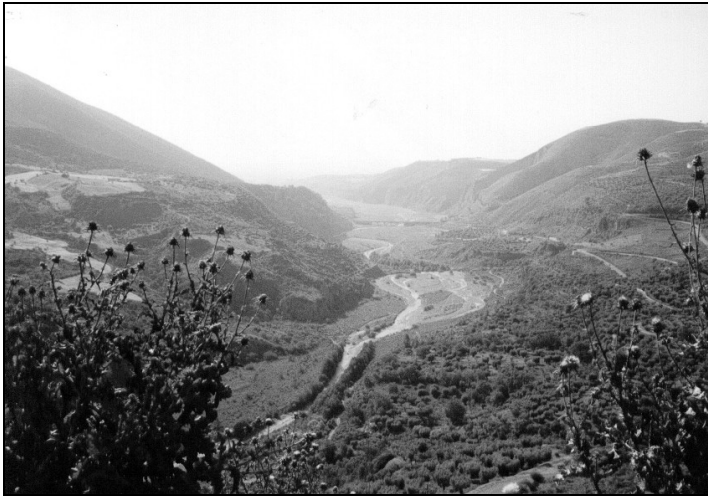


Figure 3.42 Overview of the upstream area of the river Raganello



Figure 3.43 Raganello river with the cultivated floodplain

C. Cerchiara di Calabria hilly land system

A rolling to hilly landscape, cultivated to some extent, with moderately steep and almost Vertical slopes

Extent and location: 3 km²; in the northern part of the research area

Geology: north of Francavilla Marittima, the *Timpone del Mante* is composed of marine heterogeneous sediments and rocks: black and multi-coloured clays, grey-white limestone, calcarenite, and breccias. In northerly direction, the marine formation of the black limestone rises in the landscape, comprising also black silty clays.

Geomorphology: only one landform could be distinguished: moderately steep to almost vertical limestone mountain with gently sloping slopes at the base. Relatively flat parts also occur ($\pm 20\%$).

Land use: olives and cereals are cultivated on the slope deposits

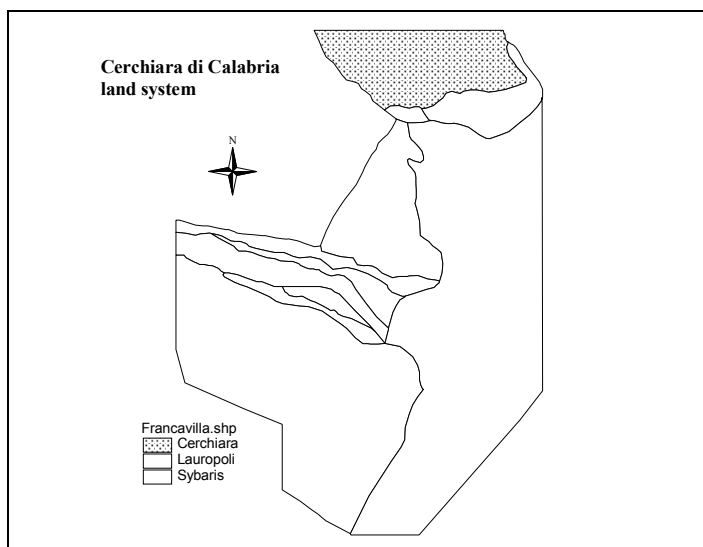


Figure 3.44 Geomorphic map showing the location of the Cerchiara di Calabria land system (the river shown is the Raganello-river, for other locations and scale see figure 3.37)

Unit	Extent	Landform	Soil	Vegetation and land use
HL	3 km ²	Hilly land: alternating hills with moderately steep to steep slopes and narrow valleys .	Soils in the slope deposit were exceedingly stony soils (40-80%); few rocks. Entire rock outcrop at the steep slopes of the hill, at the base, few rocks occur.	On the very steep limestone slopes, rough grazing land or low trees and shrubs.

Table 3.13 Summary of the characteristics of the Cerchiara di Calabria hilly land system

Description of the Cerchiara di Calabria hilly land system

Hilly land (HL)

Only a fraction of the total Cerchiara di Calabria mountain was examined in the research area. At the surface of the gently sloping slopes, angular stones of 20 cm maximum laid in a poorly sorted matrix of sand, silt and clay. Gully erosion was visible in the relatively young deposits. The soils were both ploughed and irrigated. The very steep slopes of the hill showed signs of weathering by dissolution.



Figure 3.45 Very steep slope at the foothills of the Cerchiara mountains

