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Agricultural Terracing and Landscape History at Monte Pallano, Abruzzo, Italy

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Abstract:

This study examines the role of agricultural terracing in the archaeological landscape of Monte Pallano, in the Sangro river valley of Abruzzo, Italy. This area is the research focus of the Sangro Valley Project, an ongoing archaeological project whose mission is to investigate and characterize long-term dynamics of human settlement and land use in this region. The project's 2010 and 2011 field seasons incorporated a program of mapping and reconnaissance survey and experimental excavation of abandoned agricultural terraces on the upper slopes of Monte Pallano. The survey was designed to assess the spatial distribution of agricultural terraces in the study area and to describe major patterns of form, construction style, and degradation. Test excavations of selected terraces sought to characterize the sedimentary profile of the terrace fill and gather botanical and sediment samples that might date the period of the terrace's construction and use.

The survey found important stylistic and typological variations in terrace form across the study area, and identified distinct systems of terracing on the eastern, western, and southern flanks of Monte Pallano. Excavations within a small area on the west flank clarified aspects of terrace construction, though an effective program of sampling requires further development. Comparative studies from elsewhere in the Mediterranean, and the limited evidence from the terraces themselves, suggest that the majority of the extant terraces on Pallano are the product of early modern (18^{th}-19^{th} century) agricultural intensification. Terrace systems particularly the southern flank may be ancient constructions based on stylistic distinctions and their close association with archaeological sites. Excavations in the Sangro Valley and elsewhere have indicated that terracing was a technology used to a certain extent in antiquity. The findings of previous survey, excavation, and palaeoethnobotanical investigations in the region point to phases of population and settlement growth in antiquity and the exploitation of a mountain economy similar to that of later time periods. A continued investigation of early modern land use is therefore essential for modeling long-term settlement dynamics, land use, and human-environment interactions in the Sangro Valley.

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Chapter 1: Approaches to Landscape History in the Sangro Valley

1. Introduction

Abandoned agricultural terraces are among the more conspicuous traces of past human activity on Monte Pallano in the Sangro Valley of Abruzzo, Italy, but ones that have never before been systematically studied. The Sangro Valley Project (SVP) began an investigation of agricultural terracing during the 2010 and 2011 field seasons, as part of its overarching research aims to investigate the long-term dynamics of human interaction with the natural environment in the context of a Mediterranean river valley. Since its inception in the mid-1990s, the SVP has combined extensive and intensive archaeological survey with focused excavation to gather data on ancient land use, economy, and rural settlement patterns. Its research has centered on Monte Pallano, a focal point of human occupation in the Middle Valley from the Iron Age through the Roman and early medieval periods, with settlement continuing into the modern era. An archaeological investigation of agricultural terracing offers a new approach to the project's long-standing questions on the history of land use and patterns of human-environment interactions in this region.

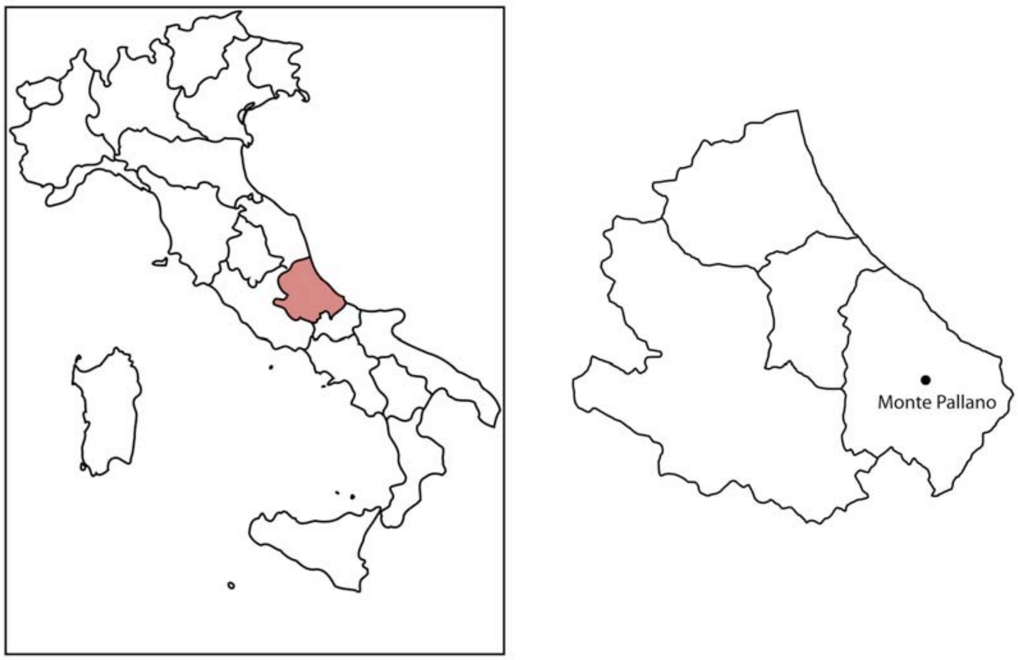
2. Geography of the Sangro Valley

The Sangro is one of a series of rivers flowing roughly northeastward from the central Italian Apennines to the Adriatic Sea. The valley is divided into the Upper, Middle, and Lower valleys, with distinctive topographic, climatic, and settlement changes as one moves from the mountains to the coast. The terrain of the Upper Valley is steep and mountainous; small settlements cluster along the river, and transhumant pastoralism is the mainstay of the traditional economy. The Middle Valley is characterized by a complex and variegated landscape of riverine terraces and isolated limestone ridges along the watershed. The climate here becomes warmer and drier from the comparatively cool and wet upper valley. Most of the high ridges today are forested, while cleared land at lower elevations is used for growing vines, olives, and cereals, with some small-scale stock-raising. The Lower Valley levels out into a broad flood plain and rolling hills, with extensive olive and cereal cultivation (Lloyd, Christie, and Lock 1997, 3-4).

The landscape of the Middle Valley is dominated by the limestone ridge of Monte Pallano (Fig. 1), which rises to 1020 meters at its highest peak. Pallano is centrally located at the edge of the Apennine range, where the mountains transition to the coastal plains. The western flank descends steeply to the Sangro River, which here runs roughly north-south at approximately 200 meters. Along the southern and eastern flanks there is a significant break in slope between 600 and 700 meters, at the interface between the limestone ridge and a series of small upland plains composed of Miocene/Pliocene marine clays. Along this junction is a spring line, and modern villages encircle Pallano at this 600-700 m contour. A small seasonal lake known as Lago Nero lies on a flat ridge ca. 750 meters on the eastern side of Pallano. The areas downslope of the villages are used for agriculture, predominantly cereals on the plains to the south and east, and predominantly vines, olives, and fruit trees on the steep slopes to the west. Above about 700 meters Pallano is mostly covered in forest and scrub (Fig. 2). Much of this vegetation is relatively young, however, and the derelict cultivation terraces indicate that the upper slopes, too, were once heavily used for agriculture. The mountain and its hinterlands are rich in archaeological materials from prehistory through the Middle Ages, pointing to several thousand years of human habitation in this area.

Fig. 1: The study area

(A) Location of Abruzzo in Italy



(B) Monte Pallano within the Sangro Middle Valley

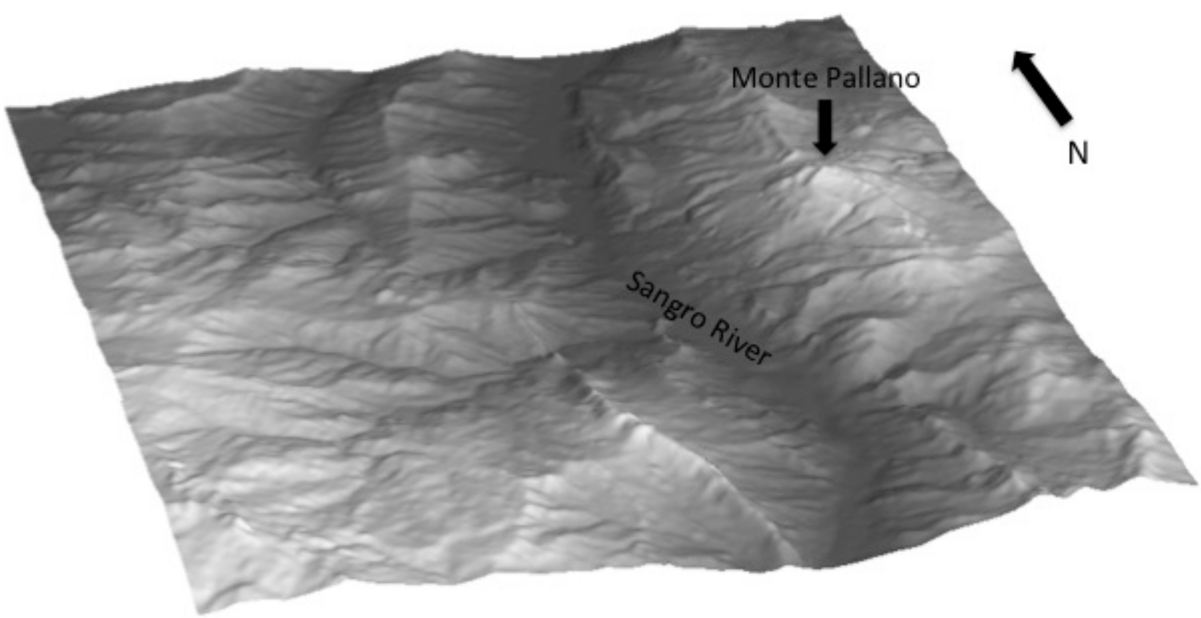
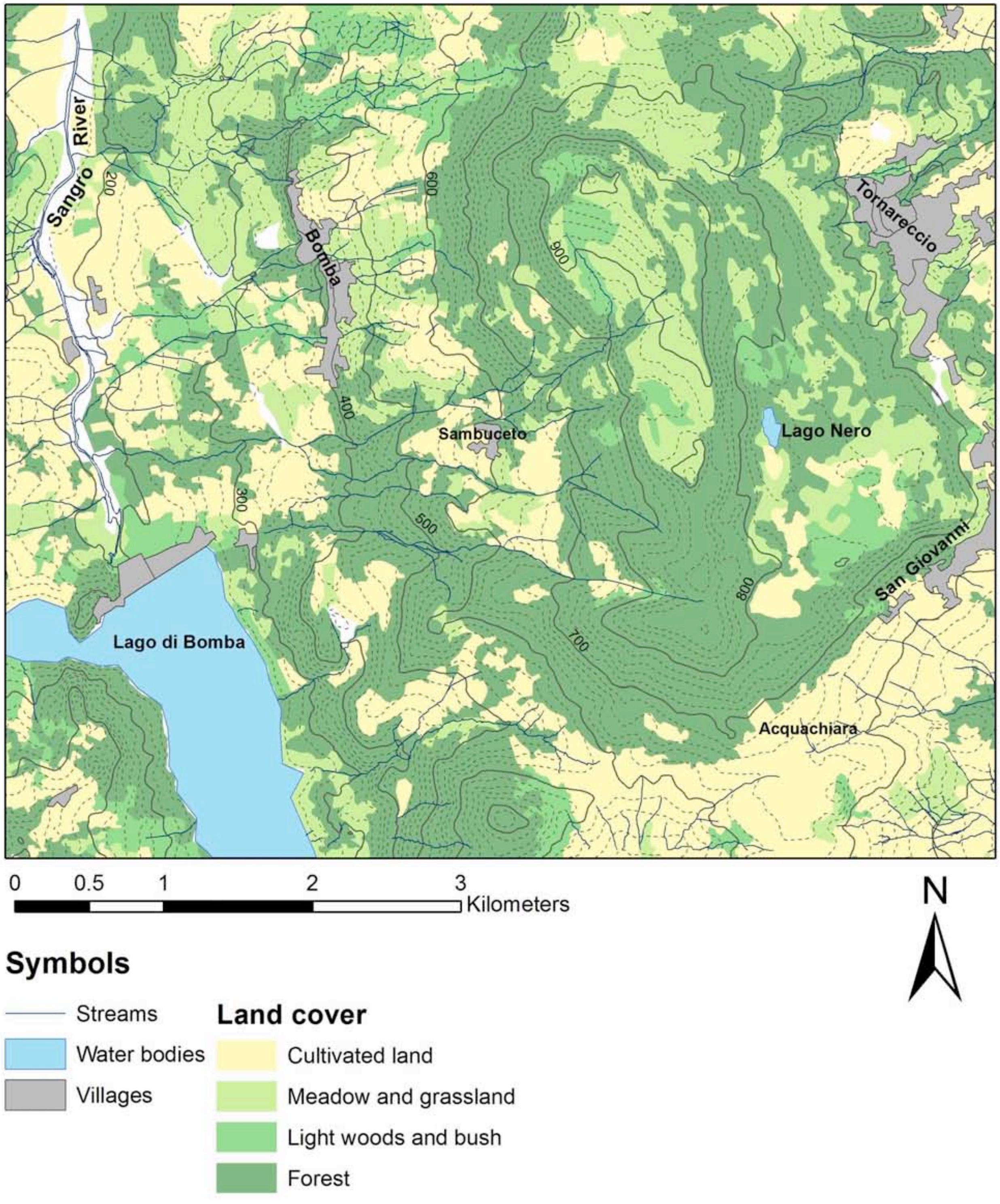


Fig. 2: Modern settlement and land use around Monte Pallano



Topographic contour interval 20 meters

3. History and exploration of the Sangro Valley

The Middle Sangro Valley lies in the northernmost extents of the territory of the ancient Samnites, an Italic tribe that was the dominant culture of central Italy from the 5th century BCE until their final subjugation by the Roman Republic in the Social War of 91-87 BCE (Bispham 2008, Salmon 1967). Monte Pallano was situated at the boundary between the territories of three major tribal groups – the Samnite Carricini and Pentri, and the Frentani along the Adriatic coast (Faustoferri and Lloyd 1997, 6). The Samnites are most known for stubbornly resisting the advance of Roman hegemony in Italy and waging a series of bitter wars with Rome from the mid 4th century through early 3rd century BCE. The central Apennines and its peoples have long been perceived, in both ancient and modern times, as rustic pastoralists, culturally unsophisticated and isolated from many of the historical developments of the rest of the Italian peninsula (Dench 1995).

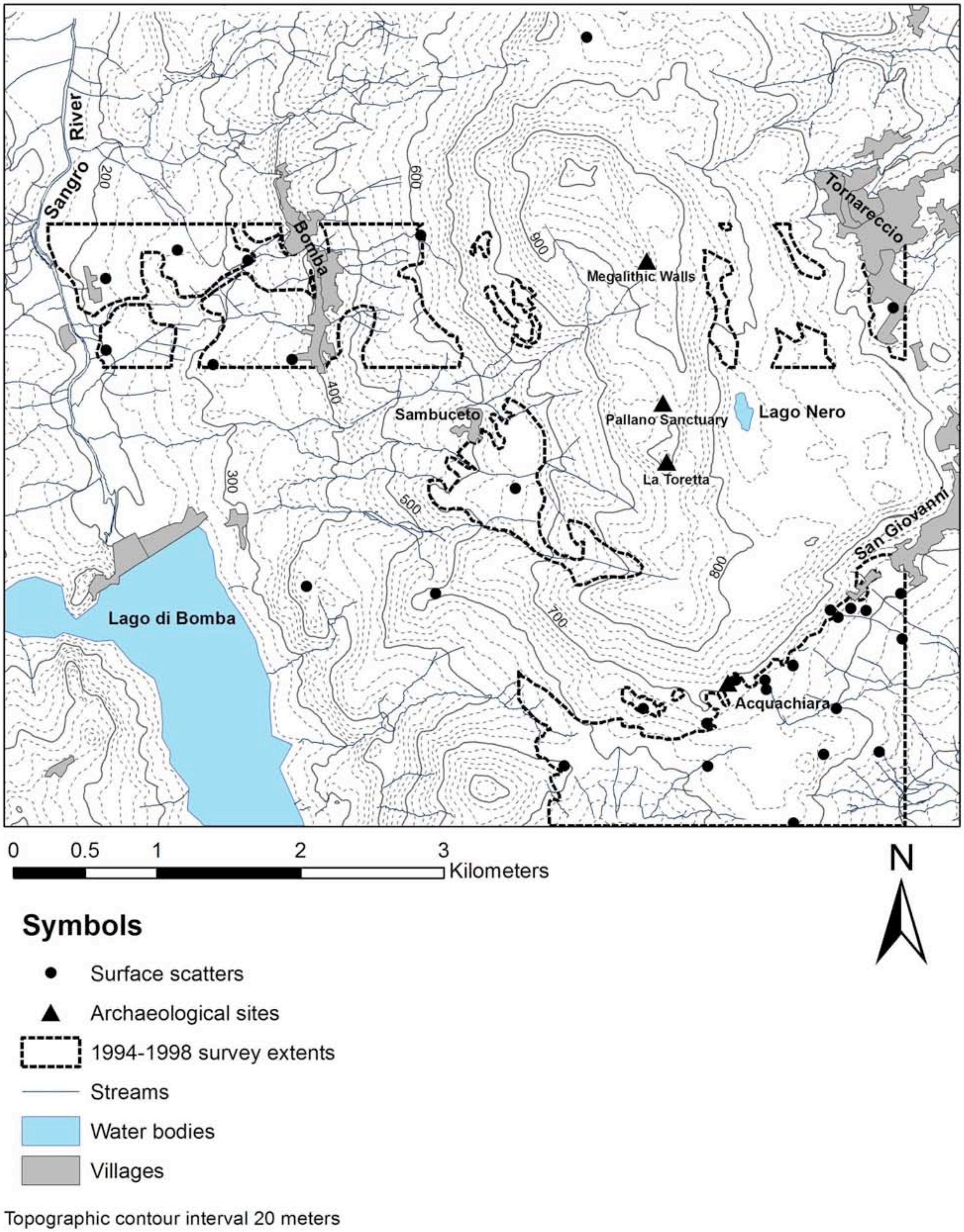
Archaeological work of recent decades has gone far to illustrate that the cultural history of central Italy was far more dynamic and complex than has long been supposed. Graeme Barker's landmark study of the Biferno Valley in the Molise region combined archaeological survey, excavation, botanical, geomorphological, and historical data to create a narrative of long-term settlement in the valley from the Neolithic to the present day (Barker 1995). The Biferno Valley survey served as a model for the Sangro Valley Project, whose findings from surface survey and excavation of sites in the hinterlands of Monte Pallano have added further information on the history of rural settlement and economy in central Apennine Italy from antiquity to the early Middle Ages.

Archaeological evidence from Monte Pallano indicates that this area has been a full participant in the major cultural phases of central Italy from antiquity onwards. The northeastern ridge of Monte Pallano is guarded by a stretch of fortification walls that are among the finest surviving examples of megalithic polygonal masonry in central Italy, and the area has been generally presumed to be a Samnite hill-fort (Oakley 1995). A Hellenistic and Roman settlement on the saddle between the two peaks of the ridge may correspond with the ancient town of Pallanum, which is attested from epigraphic evidence and recorded on the Peutinger Table. Chance finds from the hinterland, including fragments of early Iron Age sculpture, Hellenistic bronze figurines, a handful of Roman funerary inscriptions, and Iron Age tombs, further attest to the importance of Monte Pallano in antiquity (Lloyd, Christie and Lock 1997, 4, 39-44; Faustoferri and Lloyd 1998, 6-7, 13-17).

An intensive surface survey in the hinterlands around Monte Pallano from 1994-1998, termed "Phase 1" of the Sangro Valley Project, revealed a rural settlement pattern consisting of aggregated villages and isolated farmsteads, occupied remarkably consistently from the Iron Age through the mid-Roman Empire (Fig. 3). Overall, sites around Monte Pallano appear small and self-sufficient, especially in the earlier periods, though a small amount of material such as metals, lava quern stones, and imported pottery suggest a modest level of surplus and exchange. Settlement in the countryside appears densest from the late Iron Age to the early Roman Imperial period, ca. 500 BCE – 200 CE, with a dramatic decline in the rural population during the late Empire, in the 3rd-5th centuries CE (Lloyd et al. 1997, 44-45).

Excavations at the Hellenistic-Roman settlement on the summit of Monte Pallano between 1999 and 2005 uncovered the outer precinct walls and architectural fragments of a nearby Italic temple constructed in several phases between the early 2nd century BCE and 1st century CE. Domestic occupation of the site seemed to continue into the late antique/early medieval periods (SVP 1999-2004 season reports). From 2004 to 2007, the SVP excavated an Iron Age agricultural site on the southern flank of Pallano near the Acquachiara spring, designated ACQ 8000 (Fig. 4a). These excavations uncovered a terraced outdoor working area, with a series of gravel and beaten clay floor surfaces built up between the 7th and 5th centuries BCE (SVP 2005-2007 season reports). Evidence of burning, seeds, and quern stone fragments

Fig. 3: Previous SVP archaeological survey in the Pallano hinterlands



recovered by flotation, suggests that the activities at this site included the cooking and processing of emmer wheat and large quantities of bitter vetch; the latter was apparently cultivated for human consumption, a surprising botanical discovery that is unparalleled in Samnium (Shelton 2009). A Roman site (ACQ 10000), located to the southwest of ACQ 8000 on the same artificial terrace, was excavated in 2002 and 2006-2009. This site consisted of a rectangular outbuilding of a Roman farm complex, occupied in the 1st through 2nd centuries CE, and used for processing a variety of agricultural products, probably including wool, fruit-drying, and hide working (SVP 2006, 2007 and 2009 season reports).

Upland settlement in the area persisted through the Medieval and modern periods. The need for defense against raids and invasions drove the medieval Italian rural population to settle in hilltop towns, adopting settlement patterns similar to those predominant amongst pre-Roman Italic peoples (Sereni 1967, 62). Most modern habitations in the Sangro Valley are medieval foundations, products of the 10th-12th century process of *incastellamento.* Medieval remains on the southern peak of Pallano (La Toretta) appear to correspond with the *Castellum di Pallano* documented from the 11th century (Lloyd *et al.* 1997, 46). Transhumance played a central role in the medieval economy of the Sangro Valley, especially in the Upper Valley, and Medieval castles were strategically placed to oversee drove roads (Christie 2008).

Major desertion of hill settlements in the Apennines occurred between the 13th and 15th centuries due to depopulating factors such as the Bubonic Plague. A huge increase in population between the 17th and 18th centuries resulted in the expansion of existing settlements into "agrotowns" that were centers of population for farmers cultivating the surrounding lands (Barker 1995, 286). Cultivation favored higher slopes, while the valley bottoms were used mainly for pasture (*ibid.* 292). The rural population reached a height in the 19th century, leading to ever greater pressure on agricultural resources. Taxation on transhumance by the Bourbon state beginning in 1806, as well as the acquisition of most of the better land by wealthy landlords, forced poorer individuals to clear more of the forested upper slopes and build hillside terraces for cultivation (Lloyd *et al.* 1997, 39; similar trends documented for central Sicily: Pluciennik *et al.* 2004). Upland agriculture in the Sangro Valley declined sharply over the course of the 20th century, along with other traditional subsistence practices such as transhumance. Factors causing this decline have been numerous: the introduction of tractors caused many small plots on steep slopes, which could only be plowed by hand or with animals, to be given up in favor of flatter lowland fields; as cheap grain became available from France and other European countries this drastically reduced the profitability of agriculture in the mountains; low wages and unemployment spurred emigration abroad, and the growth of towns and the development of schools prompted more people to seek employment in urban areas (Lloyd *et al.* 1997, 36-37).

The early modern history and ethnography of the region has been studied by a handful of local scholars. Donato Silveri and Aurelio Manzi's research is focused on the botanical heritage of the Abruzzo and the preservation of traditional horticultural practices (Silveri and Manzi 2009). Ethnographic study of traditional animal husbandry in the Upper Valley was conducted during the early years of the Sangro Valley Project (Lloyd *et al.* 1997, 23-24, 37-39), but a comprehensive ethnohistorical study of the region, on the order of Sarti's (1985) history of the village of Montefagetassi in the Tuscan Apennines, or Forbes' ethnography of agricultural communities on the peninsula of Methana, Greece (1982, 2008), has yet to be realized.

4. Research questions, trees, and terraces

Archaeological investigations in this region have observed signs of growing social complexity through the Iron Age and Hellenistic periods, with drastic changes to the rural economy and society under the Roman Empire. Scholars assert that the density of rural settlement, the presence of a wealthy elite signaled by the evidence from cemeteries, sanctuaries, and fortified hilltop centers, and the success of Samnite military ventures during the Classical period, is indicative of a stable and significant agricultural surplus, one that extended far beyond the simple animal pastoralism long assumed to be the mainstay of the economy (Shelton 2009: 4-5, 108-116; Bispham 2007: 185; Dench 1995: 113-125). Flotation samples from excavations indicate an agricultural regime centered on cereals barley and emmer wheat, and legumes including peas, beans, lentils, and bitter vetch. Viticulture is evidenced by ceramic fine wares (drinking cups) and grape pips have been recovered by flotation from Acquachiara, at Monte Pallano. Adriatic pollen cores also indicate olive growth for this period (Bispham 2008: 185-186). The production and management of this diverse agricultural base was undoubtedly a critical component of population growth and social complexity in Samnium at the end of the Iron Age. Shelton (2009) has argued that the botanical assemblage from Acquachiara points to a diverse agricultural economy, where the exploitation of subsistence crops uniquely adapted to the mountain environment is closely tied to formations of Samnite cultural identity.

Yet the mechanics of these production systems and the dynamics of Samnite social complexity remain unclear. In its ongoing research, the SVP seeks to use a variety of interdisciplinary and non-traditional approaches to “move beyond socio-political categorization and instead consider the interactions and exchanges that constitute the social order from the bottom up, paying especial attention to the relationships between people and their land as each was shaped by the opportunities and limitations of a uniquely challenging environment.” (2011 Field Manual)

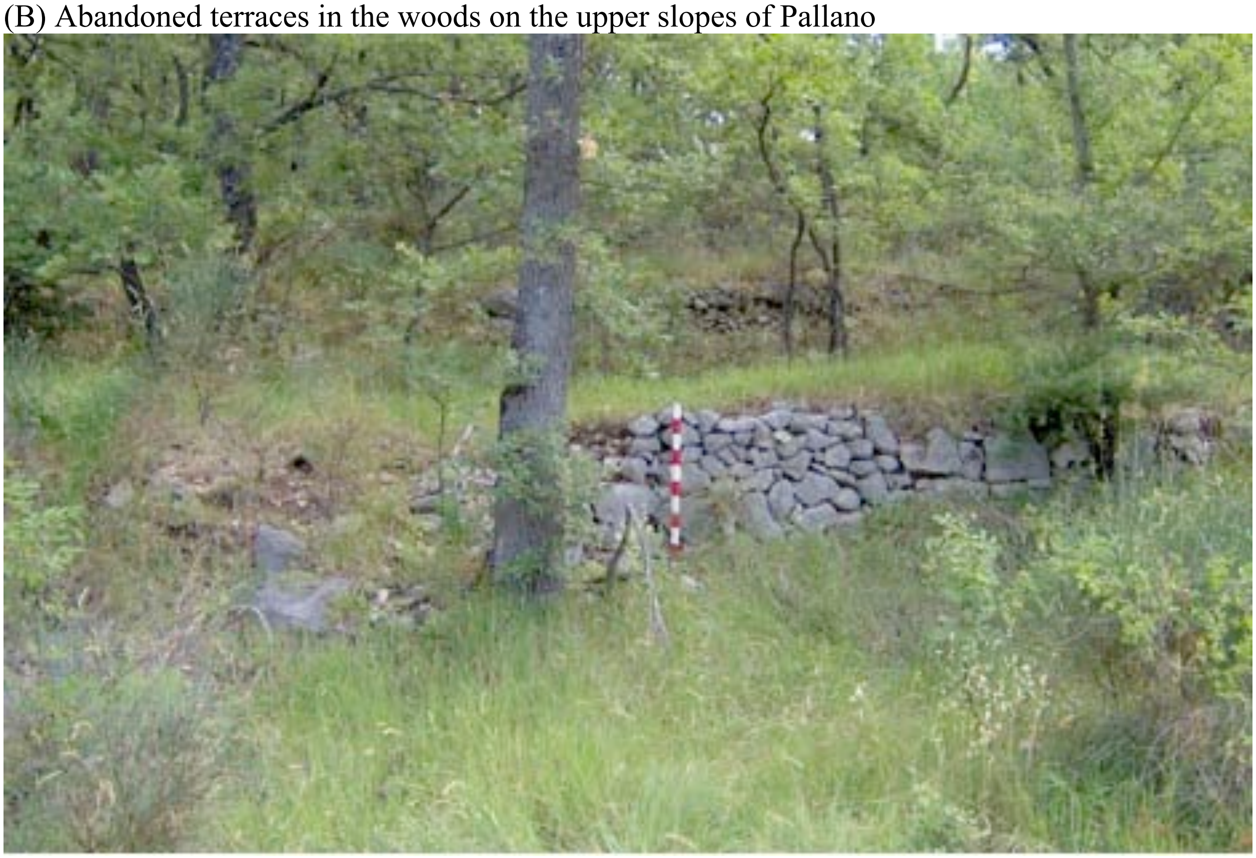
As the SVP began to restructure and clarify its research agenda after a decade of excavation, it became clear that forested areas had been a major understudied element of the cultural landscape of Monte Pallano. Because traditional fieldwalking gathers information from artifacts that are visible on the ground surface, this technique is effective only in areas with low amounts of vegetation cover (Banning 2002). In non-arid environments, such as central Italy, freshly plowed or recently fallow fields typically yield the best results for fieldwalking. This biases such surveys towards collecting data only in areas of minimal vegetation, which may be few and far between. In the case of Monte Pallano, much of the landscape is currently uncultivated and covered in young, thick forest. Surface surveys have largely been confined to plowed farm fields at lower elevations. Most of forested upper slopes of Pallano were not surveyed during Phase 1, save for a few small open patches. The SVP's 2005 and 2006 seasons included a program of experimental shovel testing in the woods on the southern flank of Pallano above Acquachiara, and east of Lago Nero. Results of these tests were limited, but suggested that currently-forested areas do contain archaeological material, and that further investigation of the forests was essential for a holistic reconstruction of past settlement and land-use trends (Sekadat 2005 and 2006). Although the upper slopes of Monte Pallano are today covered in dense forest, much of these areas were open and under cultivation as recently as 60 years ago, based on evidence from historical aerial photographs and the frequent occurrence of relict agricultural terraces and field boundary walls in now-forested areas (Fig. 4b). It is likely that the borders of forested and cultivated zones have fluctuated considerably over the course of Pallano's long history of human occupation.

An additional difficulty complicating the interpretation of survey data in the Sangro Valley is the geomorphic instability of the area. The Apennine region is very seismically active, subject to regular earthquakes and landslides. Seasonal downslope movement of soil (hillslope creep) is also a significant process affecting this mountainous landscape. The result is that few surface scatters of artifacts are *in situ*; most have washed down from sites further upslope. Plowing causes additional disturbance to artifacts and sites. Surface scatters, therefore, when plotted on a map, cannot be taken to reflect the exact distribution of ancient sites in their original locations; they are at best proxy indicators of ancient activity (Bispham 2007: 183; Bispham, Swift, and Wolff 2008).

Fig. 4: Terracing on Monte Pallano

(A) Acquachiara Trench 8000 (photo source: Susan Kane)

(B) Abandoned terraces in the woods on the upper slopes of Pallano



The difficulties of applying a comprehensive program of fieldwalking to this steep and forested terrain leave a variety of unanswered questions regarding the long-term dynamics of human settlement in the area. We do not know to what extent ancient settlement and agricultural activity occurred in areas that are now under tree cover, nor do we understand the relationship between the ritual and civic sites on the summit of Pallano and the agricultural processing sites at lower elevations on its flanks. Archaeological work in the area ultimately hopes to elucidate how spatial relationships between settlement and cultivation, and the human uses of the landscape change over time, especially in correlation to cultural changes such as Roman colonization, the decline of the Roman state and the transition to medieval settlement patterns, the collapse of the medieval feudal system, and modernization.

The author became involved in the SVP at a time when many of the project's long-term research aims were being reconsidered and redefined. A survey of abandoned agricultural terraces offered a fruitful approach to filling in blank areas of the archaeological map and addressing diachronic questions of land use in a new way, complementary to the evidence gathered from traditional survey and excavation. Frequent stone terrace walls, along with boundary walls, stone piles from field-clearing, and collapsed field huts, all attest to a period of intensive agricultural activity on the now-forested upper slopes of Pallano. Previous SVP surveys had noted incidentally the presence of artificial terracing in the landscape (e.g. Faustoferri and Lloyd 1998, 12), but these features had never been studied systematically.

5. Agricultural terracing: background and previous study

Agricultural terracing is a land management strategy common to arid and mountainous regions throughout the world. Terrace walls create cultivatable land on steep slopes by preventing soil erosion, improving soil depth and root penetration for crops, collecting runoff from rain water, and making use of field stones that would otherwise interfere with cultivation

(Grove and Rackham 2001: 111; Treacy and Denevan 1994: 93-96; Sandor, Gersper, and Hawley 1990: 74). Terraces have been studied extensively in Central and South America and the southwestern United States, where they are recognized as an important component of the archaeological record and essential to reconstructing patterns of pre-Columbian agricultural intensification, population growth, and environmental change (Denevan 2001, 170-205; Inbar and Llerena 2000; Beach et al. 2002; Treacy and Denevan 1994; Dunning and Beach 1994; Sandor, Gersper, and Hawley 1990; Nickel 1982; Donkin 1979). Terracing technology in the Americas is of considerable antiquity, but terrace agriculture in the New World declined considerably after the European conquest and the accompanying reduction of native populations. Geographic and ethnographic studies of terrace agriculture also exist for regions of Africa, Asia, and the Pacific (Sutton 1984, Netting 1968, Spencer and Hale 1961). Mediterranean terracing has only recently become an object of serious study by landscape archaeologists, with a growing number of case studies in Greece and the Aegean (Krahtopoulou and Frederick 2008; Forbes 2007; Price and Nixon 2005; Bevan *et al.* 2003; Bevan and Conolly 2002; Bull, Betancourt, and Evershed 2001; Frederick and Krahtopoulou 2000; French and Whitelaw 1999).

Terraces represent major human efforts to modify the mountain landscape in order to be more suitable for agricultural production. Terracing is usually considered to be indicative of heightened populations and pressure on limited agricultural resources (e.g. Beach et al 2002; Sereni 1961). Ethnographic studies such as those of Netting (1968; Kofyar, Nigeria) and Forbes (2007; Methana, Greece) suggest that patterns of land management are also closely tied to systems of social organization and cultural identity.

Terraces are typically associated with small, independent, peasant farming practices (Grove and Rackham 2001: 116; Forbes 1982 and 2008; Netting 1993: 28-41; Netting 1968), though this is not always the case: Inca terracing in the Andes was constructed with great skill as part of a state-sponsored policy of land improvement. As Donkin states, "much Inca terracing appears to overstep the bounds of mere utility and to take on symbolic significance.” (1979: 33) Terraces, as geometric constructions that made the steep and irregular terrain of the Andes agriculturally productive, became a potent symbol of human order imposed upon the natural landscape, the stepped form appearing in language, ritual, and art (Nickel 1982). Sutton suggests that extensive terracing in the Inyanga district of eastern Zimbabwe indicates a long-lasting cultural and economic adaptation to the hills, prompted first by historical circumstances but eventually becoming a cultural preference (1984: 32, 36).

Hamish Forbes’ research on modern agricultural communities on the peninsula of Methana, Greece, offers one of the best-documented case studies of terrace agriculture in the Mediterranean, and a valuable ethnographic model for understanding the cultural ecology of Mediterranean terracing. Small villages and hamlets on Methana cluster around a central mountain feature whose slopes are intensively terraced. At the time of Forbes’ fieldwork during the 1980s, the communities of Methana still practiced a mostly non-mechanized form of agriculture, similar to the techniques and practices that would be available to most rural Mediterranean communities prior to the 20th century. The peninsula’s volcanic soils are fertile, but thin, and remains of terracing indicate that close to the maximum possible limit of cultivable land was exploited in the recent past (Forbes 2008: 53). According to informants, terraces were constructed primarily to remove rocks from the fields, with the additional benefits of improving soil moisture and minimizing the risk of erosion (Forbes 1987: 204; 2008: 54). Small field houses and treading floors were built on terraces far above villages, to be used during periods of intense cultivation and harvesting (*ibid*. 1987: 241; 2008: 236-237).

The mountain landscape of Methana creates tremendous environmental diversity, with different temperatures, moisture, and growing rates at various altitudinal zones (*ibid*. 1987: 201-203; 2008: 190). Specific crops were grown at specific elevations: the thick, fertile soils and warmer temperatures on the coastal plains were used for olive, fruit and nut trees; areas of thicker soil were set aside for vines and vegetable plots; vetch was especially well suited to the thinner, poorer soils on the highest slopes. Cultivation generally followed a two-year rotation cycle of wheat and legumes; vetch was predominant amongst the latter, serving as animal fodder and helping to maintain soil fertility. Most households owned some animals, and poorer-quality land (i.e. the highest terraces) was left fallow for longer periods and used for animal pasturing (*ibid*. 1987: 222-224; 2008: 195-197).

The Methanite economy was geared towards self-sufficiency and subsistence farming, which required large inputs of labor throughout the year. Most families were devoted entirely to producing their own essentials, with a small amount of involvement in cash-cropping or wage-earning, non-agricultural employment. Each household within a farming village grew a variety of crops, including trees, vines, cereals, and legumes, all with different and complementary schedules of planting and harvesting. Wheat planted at a variety of elevations ripened at different rates and was harvested at different points throughout the year, thus making a larger wheat harvest manageable for one household. For other crops, especially vines, harvesting was so labor intensive that it required the cooperative efforts of several households within a village (Forbes 1987: 158-197, 230-286, 351-352).

The territory of a given village encompassed the whole vertical range of microclimates and any given household would possess land holdings scattered across a variety of elevations and climatic zones. Scattered landholdings helped households maintain economic stability and resist the effects of low yields and crop failures due to weather fluctuations by investing in numerous crops in different environmental settings (Forbes 2008: 187; 1987: 324-330). When families first settled an area, they would claim a section of hillside for cultivation. Farmers and their sons would build of terraces during the slack periods of the agricultural year, a slow and arduous process (*ibid*. 2008: 321). Landholdings would become fragmented over time through various lines of inheritance (*ibid*. 2008: 202), but Forbes found that the construction of terraced fields could still be attributed to certain families. A well-built series of terraces was a point of pride, lasting monuments in the landscape to the particular people and families who built them (*ibid*. 2008: 325).

The upland regions of the Mediterranean are known to have been heavily cultivated the early modern period, that is, the 18th – early 20th centuries (Sarti 1985, Forbes 2007, Bevan et al. 2003). Likewise, agricultural decline and abandonment of terraced during the 20th century is common and well known (Grove and Rackham 2001: 91-92, 107; Douglas *et al.* 1996; Rackham and Moody 1996: 126). The origins of Mediterranean terracing, however, is a question of ongoing debate. The earliest literary references to terracing appear in the 16th century (Grove and Rackham 2001, 112-113, 117). There is no mention of terracing as an agricultural practice in any canonical Greek and Latin literature, leading Lin Foxhall to argue that terracing was not a significant agricultural strategy practiced in ancient times, and if it did exist it was only undertaken by independent lower class farmers (1996: 44-67). Price and Nixon propose that the Greek word *αἱμασιά*, which in most cases refers to a free-standing stone wall or an enclosure, could refer to a terrace wall in certain epigraphic documents (Price and Nixon 2005: 2-5).

Straightforward and unambiguous archaeological examples of ancient terracing are rare, and seem to depend on special circumstances of preservation (Krahtopoulou and Frederick 2008; Bull, Betancourt, and Evershed 2001; French and Whitelaw 1999; Rackham and Moody 1996: 128. Terraces are notoriously difficult to date by traditional means. Artifacts within the fill behind a terrace wall may pre-date or post-date the construction of the terrace, and a terrace may be used for centuries if the wall and the soil fertility are properly maintained. Terraces can be tentatively dated if they are closely associated with datable archaeological sites. Datable carbon in organic soil A-horizons buried underneath the wall can give a possible *terminus ante quem* for the wall construction (Denevan 2001: 172; Treacy and Denevan 1994: 104-106). Terraces in the Andes have been successfully dated by this method to as early as 2400 BCE, with most predating

1600 CE (Denevan 2001, 173, 198-199). Price and Nixon suggest that a combination of criteria should be used to propose dates for terrace walls: datable material in the fill, age of trees growing out of the wall, construction style, association with other structures and archaeological features in the area, extent of degradation and lichenization of the terrace wall, and knowledge of what time periods experienced the greatest pressure on agricultural resources (2005: 6; cf. Grove and Rackham 2001: 112-113).

A handful of terrace sites in Greece and the Aegean have been dated to the Classical and Hellenistic periods based on combinations of criteria. On the island of Delos, extensive terracing was found associated with a series of small ancient farm sites; the terraces themselves were similar in construction to ancient houses, and partial excavations found Classical and Hellenistic pottery in the terrace fill (Price and Nixon 2005: 6). On Keos, surveys have interpreted numerous terraces as ancient based on their construction style and association with Classical/Hellenistic period sites; it has also been hypothesized that given the topography of Keos, the large Classical population could not have been supported without terracing, and there is no other period except antiquity when population pressures would have prompted such intensive cultivation. Abandoned terraces have often been noted in association with ancient sites in Attica, and scholars have suggested that they are contemporary on the basis of style and stone condition (*ibid.* 2005: 7). Some terraces in Sphakia, Crete have been dated to the Hellenistic and Byzantine periods based on tree rings from ancient olive trees growing on top of their walls; these terraces are located close to ancient structures in “relict landscapes” that have not been heavily reused in recent periods (Grove and Rackham 2001: 113; Price and Nixon 2005: 10-11).

Some studies in the Aegean have suggested that terraces may date to as early as the Bronze Age. Stratification of sherds and soil development from manuring within the massive check-dam terraces on the islet of Pseira, off Crete, date them to the Middle Minoan period; the islet was only settled in the Bronze Age and Byzantine periods (Bevan 2002: 232; Bull, Betancourt, and Evershed 2001; Rackham and Moody 1996: 143; *ibid.* 1992: 128-129). Bevan's analysis of surface survey data on Kythera indicates a pattern of dispersed rural settlements involved in very intensive agriculture that would have favored cross-channel terracing of drainage channels (2002: 232).

Grove and Rackham suggest that agricultural terracing in the Mediterranean is indeed an ancient practice that was well-established by the Middle Ages and reached its greatest extent during the early modern period. Undisturbed ancient terraces are found only in the most remote areas, where they have not been disturbed by later cultivation. Most ancient terraces would be those constructed on better agricultural land, and tend to be the ones that are still in use (Grove and Rackham 2001: 117).

Though terracing in the Mediterranean is typically associated with 18^{th}-19^{th} century population pressures and considered to be indicative of marginal land cultivated by the poorest farmers, as Grove and Rackham point out, "terraced slopes are not always the worst land, nor are mountain settlements necessarily late and poor." (2001: 117) The idea that terracing represents a 19^{th} century "over-shoot" that quickly exhausted fragile mountain environments is tempered by alternative theories that mountains offered greater food security than urbanized and agriculturally developed areas (*ibid.* 83). The varied micro-environments of mountain landscapes prompt crop diversification and allow for greater stability of the subsistence base, a point which has consistently been demonstrated by ethnographic studies of Mediterranean communities and mountain societies generally (Forbes 2008, Holden and Purcell 2000: 175-230, Netting 1993). Terracing in the Mediterranean remains poorly understood from historical, social, and economic, as well as archaeological and geological perspectives. A detailed investigation of terracing on Monte Pallano, both in antiquity and in the early modern period, therefore has much potential to contribute to the growing literature on the cultural ecology of the Mediterranean region.

6. Terraces and the SVP: a new approach to landscape history

In the Sangro Valley, terraces have frequently been associated with archaeological sites, both as components of ancient sites and as later constructions. Phase 1 extensive survey in the Upper Valley identified scatters of ancient tile and pottery across a series of terraces climbing the wooded flanks of Colle Santa Maria; rectangular dry-stone foundations at the summit of the hill suggested a small village or hamlet (Lloyd *et al.* 1997: 29). Reconnaissance in the Upper Valley also found series of rectangular field enclosures at Piana della Corte "clearly intended to create level terraces and to retain the unstable soils of the upper slopes, where landslip is much in evidence." (Lloyd *et al.* 1997: 29) The date of the fields is unclear, but the rectilinear layout closely resembles Roman-era centuriation in North Africa. Early SVP excavations at the Hellenistic-Roman settlement on Monte Pallano noted that ancient walls and structures appeared to underlie many terrace features in the surrounding terrain, and in some instances components of ancient structures had dismantled to form agricultural terraces (SVP 1999-2000 season reports). Excavations at ACQ 8000, discussed above, revealed multiple phases of terracing associated with an agricultural processing site dating to the sixth century BCE. The evidence from this site suggests that terracing may be a land modification strategy that has been employed in this area for several millennia.

As objects of archaeological study, terraces possess the advantage of being detectable even under heavy vegetation where ceramics scatters are invisible. Additionally, they are stable landscape features that do not present the same issues of displacement as artifact scatters (though they are certainly subject to erosion and decay). Terracing is indicative of heightened production and pressure on agricultural resources, often associated with population growth. It indicates the need for more careful land management and greater social organization and cooperation. A study of agricultural intensification through terracing is thus an essential component in addressing questions of population and settlement growth, and the development of complex society in the

Sangro Valley. Terraces offer a new way of investigating questions of past population and land use to complement the data from excavations and fieldwalking survey. Macro-scale examination of terrace distribution through GIS mapping can be integrated with micro-scale examination of terrace soils through micromorphology and palaeoethnobotany for a holistic and innovative investigation of a widespread feature of the Mediterranean cultural landscape.

Beginning in the 2010 field season, the author engaged in a reconnaissance survey to record and map abandoned agricultural terrace walls in the forested upper slopes of Monte Pallano. This survey was designed to assess the spatial distribution of terracing in these areas and describe patterns of form and construction style. The survey was continued in the 2011 season, and expanded to include experimental shovel testing and environmental sampling of select terraces in order to characterize terrace stratigraphy and identify potentially datable material in the terrace fill. The development of the survey and sampling strategy is described in Chapter 2, and the results of survey and sampling program are detailed in Chapter 3; Chapter 4 will discuss the results of the field data in light of other ethnographic and archaeological case studies, and our present knowledge of the history and archaeology of central Apennine Italy, with suggestions for future work.

The 2010 and 2011 terrace survey produced a new set of spatial data on the distribution of terracing on Monte Pallano. It identified at least three major networks of terraced fields on the eastern, southern, and western faces of Monte Pallano, distinct from each other in wall style and field morphology. Although dating evidence for the terraces remains elusive, the findings of this study suggest that numerous features of the modern agricultural landscape may be closely associated with the ancient landscape, and that these archaeological features are worthy of continued study in future seasons.

Chapter 2
Terrace study objectives and methodology

1. Introduction

The Sangro Valley Project's 2010 and 2011 seasons incorporated a focused study of agricultural terraces in the environs of Monte Pallano, consisting of field survey, GIS mapping and spatial analysis, and test excavations of select terraces. The goals of the survey and mapping program were to assess the spatial distribution of terraces on Pallano and to describe major patterns of terrace form, construction style, abandonment and degradation. Excavations aimed to provide more detailed information on terrace construction, characterize any stratigraphy and search for potentially datable material within the terrace fill. This was an exploratory study, designed to provide a broad overview of terrace morphology and distribution in a specific area of the Sangro Middle Valley and to assess the potential of these features for future investigation by the SVP.

2. Terracing typology and terminology

An "agricultural terrace" is any artificially flattened area of a hillslope used for cultivation, typically with a stone wall or vegetation to retain the planting soil. Various systems of classification for terrace types are offered in the archaeological literature, and no unified typology or nomenclature yet exists. Rackham *et al.* identify several common types for the Mediterranean (Grove and Rackham 2001: 107-109; Rackham and Moody 1992: 123):

(a) *Stepped terraces*, forming parallel series, following the contours of the hill.

(b) *Braided terraces*, with staggered walls that zigzag up the slope.

(c) *Pocket terraces*: small, crescent-shaped terraces to provide a foothold for individual olive or fruit trees.

(d) *Terraced fields*: square, upraised areas that may not follow the slope

(e) *Lynchets*: accretional terraces formed as soil moves down a plowed slope and piles up against a hedge or other cross-slope obstruction

(f) *Check-dam* terraces: walls built across a stream or channel, causing sediment to accumulate behind it.

(g) *False terraces*: modern unwalled terraces, created by digging out the slope with a bulldozer.

Morphological features of terrace fields are largely influenced by topography: steeper slopes, for instance, will feature narrow terraces with high walls, while shallower slopes will display low walls and broad fields (Treacy and Denevan 1994: 96). Terrace forms can also be associated with particular crops: high, well-built step-terraces are commonly used for growing vines, and more poorly built braided-terraces are typically used to grow grain and legumes (Rackham and Moody 1992: 125). Rackham's typology was used as an initial guide for describing and classifying terraces on Monte Pallano. From independent observations of wall styles a new typology was later created, specific to Monte Pallano terraces.

Terraces can be constructed in various ways. They may possess a stone wall, or have an unwalled embankment, which is often stabilized with thick vegetation. The field they enclose may be flat or sloping, irrigated or rain fed; the sediment behind the embankment can be filled in artificially, or accrue gradually through alluviation. A typical stone wall terrace is constructed by simultaneously building up a wall and filling in sediment behind. The sediment is usually redistributed from the hillside above the terrace, but can be brought in from elsewhere. Alternately a free-standing wall may be built laterally across a drainage area and sediment allowed to accrue behind it. The area immediately behind the wall is often filled with smaller stones and rubble, to improve drainage for the field and prevent sediment from seeping out through the larger wall stones (Frederick and Krahtopoulou 2000; Treacy and Denevan 1994, 96-102). The terrace wall is referred to as the *riser*, the flattened planting surface is called the *tread,* and the sediment making up the interior of the terrace behind the riser is referred to as the *fill* (Frederick and Krahtopoulou 2000: 80). Frederick and Krahtopoulou suggest six main components for the theoretical stratigraphic profile of a terrace: (1) the pre-existing ground surface (palaeosol); (2) the riser, which may be a masonry wall or earthen embankment; (3) the riser fill, the commonly-occurring V-shaped wedge of rubble immediately behind the masonry wall; (4) the tread fill; (5) the cultivation surface; and (6) post-abandonment fill (*ibid*. 84). The fill is the most important component of the profile, whose composition and structure will vary according to the construction and use history of the terrace, whether the terrace was filled by hand, or developed accretionally through controlled erosion. Buried soil horizons of the original hillslope may be found towards the bottom of a profile, below the anthropogenic fill. In cases where terraces have been constructed by redistributing the local topsoil, it is common to find material from the B-horizon subsoil overlying an A-horizon. Multiple strata of anthropogenic fill might indicate multiple construction and reconstruction events. Other anthropogenic additions can include artifacts and organic material from manuring. Cultural material may display some amount of stratification that informs on the period of construction, though pre-existing deposits of artifacts may also appear within the fill of a terrace during construction and redistribution of hill slope sediments. The most common feature of terrace fill is a poorly sorted and unstratified matrix, as plowing and tilling will tend to obliterate any stratification that would otherwise develop (Frederick and Krahtopoulou 2000: 85-86).

3. Terrace Survey

3.1 Objectives

Given that agricultural terraces on Monte Pallano had never been the subject of systematic study by the SVP, we lacked a set of basic information on their form and distribution. The survey of terraces on Pallano was therefore designed with several objectives in mind: (1)

locate and describe terraces in terms of appearance and stylistic features; the shape, wall style, and relative degree of degradation of a terrace might give insight into its function, cultural association and age; (2) describe terrace surroundings: slope, associated structures, and vegetation cover, the age and density of which might be a rough indicator of how recently the terrace was abandoned; (3) map terrace locations and project them in a digital environment for spatial analysis; and (4) examine the environmental factors influencing the distribution of terracing and the spatial relationship of terraces to modern settlements and archaeological sites.

3.2 Predictive modeling

Prior to beginning fieldwork, ESRI's ArcGIS software was used to create a digital map of Monte Pallano and the surrounding area, which would serve as a platform to input terrace spatial data from the survey. The GIS included aerial photos, topographic maps, vector layers (points, lines, and polygons) representing roads, political boundaries, cultural sites—consisting of both modern settlements and known archaeological sites—springs and streams, land use, and rasters (pixel grids) of elevation, slope, aspect, and insolation (sunlight).

The GIS also allowed for the creation of a predictive model to determine the most probable zones of Monte Pallano to contain agricultural terraces. The process of building and testing the model helped to focus survey on specific areas of the landscape and inform our understanding of what factors do influence terrace spatial distribution of agricultural terracing in this area. GIS-based mapping and modeling of terraced landscapes on the Aegean island of Kythera by the Kythera Island Project has shown that terracing is strongly correlated with certain environmental variables, namely steeper slopes, proximity to settlements, southerly aspects which receive higher amounts of sunlight over the course of the year, and bedrock types of Eocene flysch and Neogene regressive conglomerates (Bevan et al. 2003). A small amount of data on terrace locations in the Sangro Valley existed from previous SVP surface surveys. These geographic coordinates were added to the GIS as a point layer, and values were extracted to these points of seven environmental criteria hypothesized to be influential in determining terrace location, and which were available in the SVP data archive in georeferenced vector or raster format:

1) Proximity to settlements, archaeological sites, and surface scatters

2) Proximity to roads and paths

3) Proximity to springs

4) Proximity to streams

5) Flow accumulation[1]

6) Slope

7) Insolation during the growing season (modeled as April-October)

In creating a predictive model from these variables it was assumed that: a) terraces would favor steeper slopes, b) they would likely be concentrated close to cultural sites, such as villages and major structures (Bevan *et al.* 2003, 220), c) they would tend to be located near roads for ease of access, d) they would favor proximity to sources of water, e) terraces might be preferably built near drainage areas in order to catch more run-off, and the existence of cross-channel terraces built over streams is well-documented in other regions of the world; f) terraces would presumably also favor southerly aspects with high levels of insolation (Bevan *et al.* 2003: 222). Each of the seven variables was represented as a raster layer. These rasters were reclassified into 2 new value classes, 1 representing values more suitable, and 2 representing values less suitable for terracing. Optimal values for each variable were determined based on the average values at the recorded terrace points. For proximity rasters, this meant optimal distance values between the average and 0; optimal values for flow accumulation, slope, and insolation were modeled as the average to the highest possible value for the raster. The reclassified variables were each given a

[1] A raster model of alluviation, depicting the accumulated weight of all cells flowing into downslope cells in a digital elevation model.

[2] A preliminary version of this revised predictive model was developed after the 2010 season, based on terrace data in the western and eastern survey zones. The 2010 revised model retained

percent weight and combined in a weighted overlay, using the ArcGIS "weighted overlay" tool. This function calculates new values for each raster cell that is the sum of the seven input variables multiplied by their percent weight, as in the equation below:

new cell = (variable 1 • %) + (variable 2 • %) + (variable 3 • %) + … + (variable 7 • %)

This overlay created a new raster grid with cell values of 1 and 2, where 1 indicates higher suitability for terracing and 2 indicates lower suitability. Two versions of the weighted overlay were performed, with different percent weights given to test how the model responded when greater weight was given to cultural or natural variables. The values used in reclassifying the variables and the weights given in the two overlays are given in Table 1, below. Figure 5 illustrates the resulting predictive models.

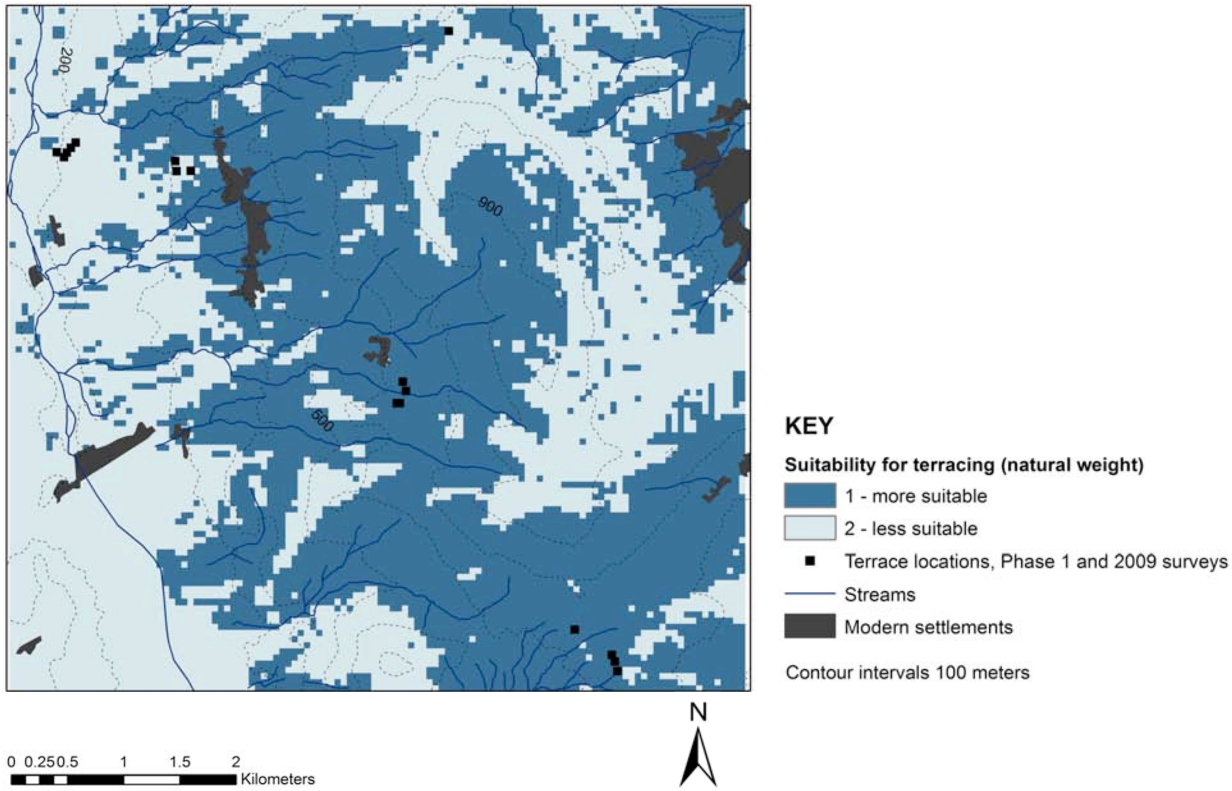
Table 1: Environmental characteristics of previously recorded terraces; reclassified variables and predictive model parameters

		Settlement proximity (meters)	Road/path proximity (meters)	Spring proximity (meters)	Stream proximity (meters)	Flow accumulation	Slope (degrees)	Insolation (Watt hours/square meter)
(total number of terrace locations = 17)	Minimum	0	10	70.71	20	0	4.26	953,930
	Maximum	610.33	89.44	1050	296.98	55	12.55	1,090,400
	Mean	292.72	37.07	553.96	178.59	12.88	8.55	1,017,400
	St. Dev.	179.53	21.2	309.46	96.44	16.65	2.56	51,981
	1st Quartile	143.57	20.59	360.36	90	3	6.26	970,760
	Median	275	33.03	507.23	218.4	5	9.25	999,700
	3rd Quartile	442.94	39.94	862.5	286.36	20.75	10.37	1,070,900
Reclassified values	1	0-293	0-37	0-554	0-179	13-10,276	4-52.5	1,017,400-1,160,264
	2	293-14,890	37-780	554-5580	179-1380	0-13	0-4	601,450-1,017,400
Percent weight in overlay	Fig. 5a	5%	5%	18%	18%	18%	18%	18%
	Fig. 5b	25%	25%	10%	10%	10%	10%	10%

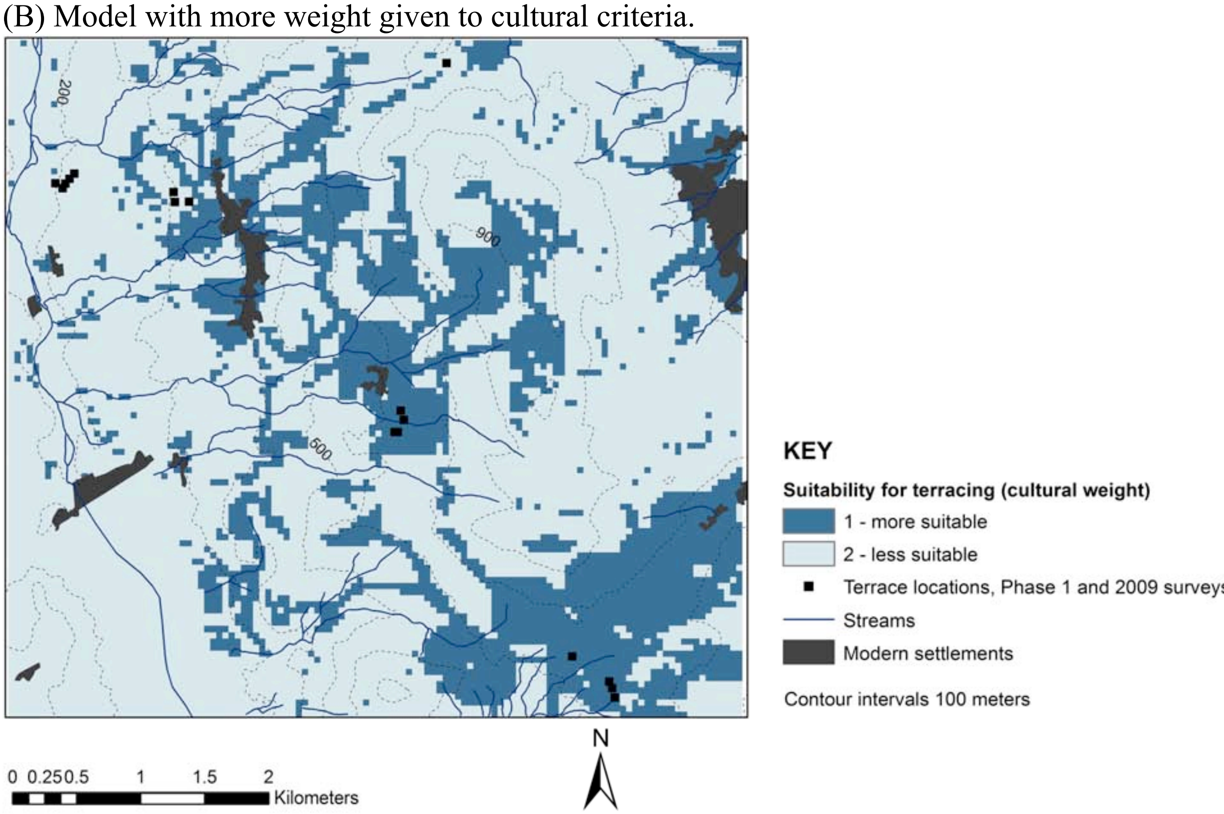
These initial models appeared rudimentary, limited by the resolution of the input rasters and by the small number and uncertain positional accuracy of the previously recorded terrace coordinates. The model nevertheless provided a starting point for selecting particular areas to survey in detail. The survey zones sampled areas that the model predicted to be favorable and

Fig. 5: Predictive models of probable terrace locations, based on environmental characteristics of previously recorded terraces.

(A) Model with more weight given to natural criteria.



(B) Model with more weight given to cultural criteria.



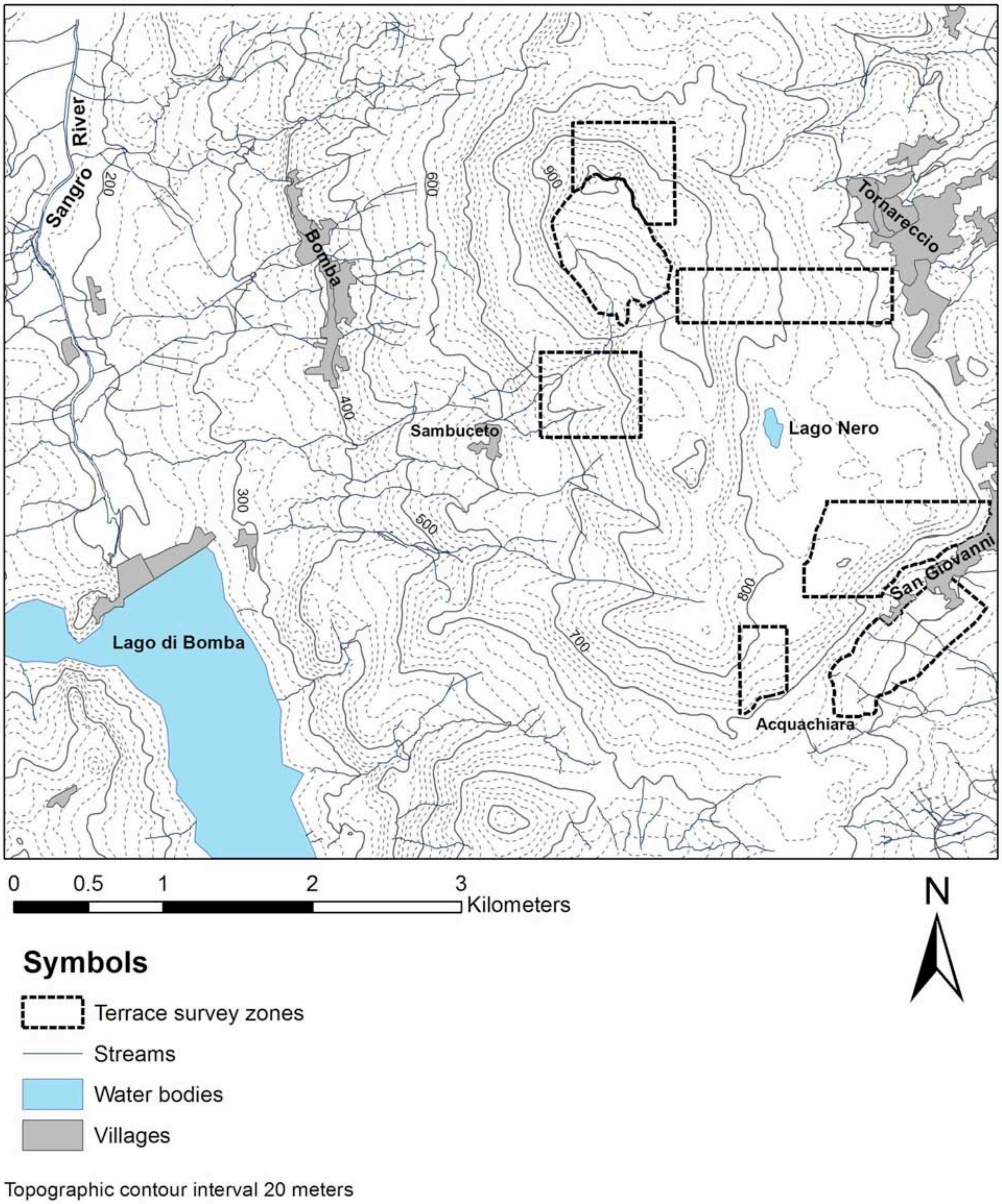
areas predicted to unfavorable for terracing. The new data to be collected in each area would therefore test and refine the model of which cultural and environmental criteria were most influential in determining which areas of Pallano were terraced.

Two survey areas were selected for survey in 2010, one on the west side of the mountain running between the Fonte di Benedetta and the modern village of Sambuceto, and another on the east side running from the Iron Age megalithic walls to the edge of the modern village of Tornareccio. Five additional survey zones were explored in the 2011 season: a section of the north face of Pallano, a transect across the north half of the upper ridge – often referred to as the "saddle" of Pallano, by its shape -- two areas on the south face of Pallano--one above Acquachiara and one running between San Giovanni and Lago Nero, and an area of currently-cultivated fields west of San Giovanni. These areas contain between them a representative sample of the range of topography and vegetation cover across Monte Pallano, and encompassed areas of both of the two suitability classes of the predictive models. (Fig. 6)

3.3 Survey methods

The dense vegetation and variable terrain of Monte Pallano required a flexible, reconnaissance style of survey. The linear transects standard to fieldwalking survey were not possible in many of the areas selected for survey. For those zones that were densely wooded, survey teams of two to three followed the numerous forest trails and abandoned farm roads to explore the area, generally moving from the top of the slope downwards towards the modern settlement. The upper ridge of Pallano and the areas around San Giovanni are mostly open meadow or cultivated fields, and these were walked in 10-20 m intervals running east-west and north-south, respectively.

Fig. 6: Areas selected for terrace survey, 2010-2011.



3.4 Data Collection

Each terrace encountered was given a number and photographed. UTM coordinates were recorded along the edge of the riser using a Trimble GeoXT handheld GPS receiver. Standardized survey forms were used to record the dimensions of terrace walls and to record observations on the construction style and surrounding environment (See Appendix B). The surveyors recorded the length and height of the terrace riser, the width across the top of the stone wall, where visible, dimensions of three sample wall stones, the approximate slope and orientation of the hill, as well as the slope of the terrace tread. Observations on the construction style of the terrace were recorded through a combination of check boxes and written descriptions; these included whether there was a stone wall, if the stones were coursed and/or faced, and, initially, which of Rackham et al.'s Mediterranean terrace types the terrace fell into. After the 2010 season, Rackham's typology was abandoned in favor of an independently derived typology, described in Chapter 3. Observations on surrounding vegetation, also recorded with check boxes and verbal descriptions, included the relative age of density of trees and whether the area was predominantly woodland, grassland, scrub, or cleared/cultivated field. The degree of erosion and lichenization of the terrace was estimated with a qualitative 1-5 scale, 1 being minimal and 5 being extreme. Survey forms also noted the presence of any stone piles, field boundary walls, paths, or other terraces in the vicinity.

3.5 Post-field work analysis

The GPS coordinates recorded in the field were projected in ArcMap and these points were used as vertices to build polylines representing the edges of terrace risers. All information recorded on survey forms in the field was then attached as an attribute table to the terrace polyline layer in the GIS. The new terrace spatial data was used to refine the predictive model and reevaluate the environmental criteria influencing the construction of agricultural terracing in this area. The results of these analyses are described in Chapter 3. The SVP was also in possession of RAF aerial imagery of Monte Pallano from 1943, showing the mountain at a time when most of the currently forested slopes were bare of trees and under cultivation. The 1943 aerial photographs, together with modern aerial photographs for reference and correction, aided in locating terraces not recorded by the survey. After mapping the locations of all surveyed terraces, the aerial imagery was used to trace additional lines of terraces, providing an even more extensive map of terracing on Pallano to augment the findings of the ground survey.

3.6 Limitations

The survey methodology was inevitably biased towards recording terraces closest to the navigable roads and paths. Many other areas were inaccessible due to steep terrain and dense vegetation. Time constraints during the short summer field season prevented the survey teams from exploring each survey zone in its entirety, and some zones were traversed more completely than others, depending on time, accessibility, and the frequency of terraces within each survey area. Aerial photography allowed for more extensive mapping of terrace systems, though tree cover in the modern aerial photographs, as well as low resolution and limited extents of the 1943 aerial imagery, means that even remote sensing has not been capable of detecting every terrace present on the mountainside. The picture gained of terracing within the survey areas, while substantial, is not necessarily complete. The goal was to explore as many different areas as possible and obtain a representative sample of terraces from all sides of Pallano.

4. Terrace Excavation

4.1Objectives and methods

The 2011 season terrace survey included a program of test excavation of five terraces in the Benedetta-Sambuceto zone that displayed variation in size, wall condition, and style. The purpose of these excavations was to investigate in more detail the construction of the terrace wall, characterize the stratigraphy of the fill, and to identify which sampling methods might be most useful for determining the terrace's age and use. In particular, excavation sought to locate the relict ground surface predating the terrace's construction and identify datable material within this horizon. Several rectangular trenches (generally 50 x 100-200 cm) were excavated in the center of the tread to expose the stratigraphic profile of the fill. Teams also cleared the buried face of one stone wall riser (Terrace 40) to expose the foundations, and excavated across top of one wall (Terrace 47) to examine thickness, stone placement, and the nature of the fill immediately behind the wall. Plans and sections of each trench were sketched and photographed in the field; stratigraphic contexts were numbered and their component sediments described in standardized context record sheets.

4.2 Sampling

The excavation teams gathered bulk sediment samples from each terrace trench to recover botanical remains by flotation, and collected small bag samples from each trench profile at ~10 cm. These smaller samples aided in recording more detailed descriptions of terrace fill sediments in the lab, especially when time for direct recording in the field was short. Such sampling also has potential use for quantitative soil analyses, including magnetic susceptibility, Ph, organic carbon, phosphate, and phytolith analysis, data that can provide information on the development and anthropogenic impact on the soil (Goldberg and MacPhail 2006: 342-352). These samples were discarded at the end of the season, however, as they lacked adequate context and control samples to make further laboratory analysis useful.

The major sampling technique applied to terrace excavations was the extraction of block samples for thin section analysis of soil micromorphology. Micromorphology is a geological approach, with growing application to the field of archaeology, which applies microscopic examination of soils and sediments in thin section to elucidate mineral contents, sediment structure, and microstratigraphic features. This technique has the advantage of preserving the original structure of the sediment, allowing features to be carefully observed and recorded out of the field but still in their original horizontal arrangement. Block samples from the field are impregnated with resin, dried, and cut with rock saw into smaller sections which are mounted onto glass slides and ground to a thickness of ~30 µm.

Three block samples were taken from a terrace site in the Benedetta-Sambuceto survey zone, two from the profile of a terrace fill, and one from a below the base of an exposed terrace wall. Following standard protocol, the blocks were transported to the MicroStratigraphy Laboratory at Boston University where they were impregnated with polyester resin and subsequently cut open using a tile saw. Cut slabs of the blocks were brought to the Geology Department at Oberlin College where a series of consecutive thin sections were made. After a preliminary visual description at Oberlin, these thin sections were returned to Boston University for specialist analysis. The sections were examined using a petrographic microscope and characterized in terms of particle size, structure, and mineral constituents, with standard descriptive terminology and interpretive guidelines provided by Stoops (2003), Courty et al. (1989), and Bullock et al. (1985).

4.3 Limitations

Excavations of abandoned terraces in forested areas were difficult due to the frequency of large gravel and modern roots. Excavation teams could carry only small hand tools and a limited number of larger picks and shovels to the remote terrace sites. This combination of factors meant that excavating even a small test pit took approximately 3 hours. All digging had to be completed in one day and the trench then back-filled at the end of the day. The time constraints severely limited our ability to expose complete profiles of the terrace fill. Furthermore, it was expected that disturbance from plowing and post-abandonment vegetation growth would greatly disturb any potential stratigraphy in the fill, and indeed, as shall be discussed in the following chapter, identifying stratigraphic variation of the terraces chosen for excavation proved to be problematic.

Sampling strategies and subsequent analysis were contingent on time constraints and the expertise and availability of the SVP's botanical and geological specialists. Most of the bulk samples from the terrace excavations were floated, but these flotation fractions could not be sorted by the end of the 2011 season. These samples still await analysis and the results of this work are not included in the present report. Constraints on time and lab space at Boston meant that only two of the three block samples, MM2 and MM3 from Terrace 42, could be prepared and analyzed during the 2011-2012 academic year. The block sediment sample from the excavation of Terrace 40 still remains to be processed and analyzed.

Terrace excavations were small in scale and largely experimental, designed to test techniques of sampling and excavation, and assess the conditions and practicality of in-woods excavation of agricultural terraces. Likewise, the results of these excavations, though suggestive of the kinds of information that can be gleaned from these features, cannot be taken as universal. Further excavation and sampling is needed to more fully understand the relationship between human landscape modification and the sedimentary record on Monte Pallano.

5. Conclusions

This study was designed as a preliminary investigation of agricultural terracing on Monte Pallano, a large and complex component of the human landscape that had not been addressed by previous survey programs. The primary objectives of the study were to document terrace morphology and spatial distribution, and to test sampling and excavation strategies. Given the difficult nature of the survey areas in terms of terrain and vegetation cover, as well as the notorious intractability of terracing to traditional methods of archaeological interpretation, it was understood from the outset that this study could never address all of the ecological, economic, historical and cultural aspects of terrace agriculture discussed in chapter 1. It seemed however, that some effort was better than none. Several techniques were tested, yielding a number of different types of data. The following chapter will discuss the various findings of field survey, GIS mapping, and test excavations of terraces.

Chapter 3: Results of terrace survey and excavations

1. Introduction

This chapter will describe the new information on Monte Pallano terracing gathered from survey and excavation and discuss the overall picture of land use produced by this study. The mapping and reconnaissance survey identified three major zones of terracing on the west, east, and south flanks of Monte Pallano. In addition to their differing topography and orientation, these zones display marked differences in terrace style and spatial organization. A new typology was created to categorize terraces on Pallano, based on the presence or absence of a stone riser and the style of masonry. Small excavations of selected terraces within a terrace system on the west flank of Pallano illuminated some aspects of terrace construction, but displayed little stratigraphy in the fill and yielded minimal evidence for dating.

2. Patterns of form and construction style of Monte Pallano terraces

Agricultural terraces on Monte Pallano fall into several of the styles described by Rackham's terrace typology (see chapter 2). Most terraces at the higher elevations of Monte Pallano, above ca. 700 meters, are stepped terraces with stone-walled risers. Lynchets are common at lower elevations, especially on the south flank around San Giovanni and Acquachiara. A few examples of pocket terraces and square terraced fields are also represented.

It became more useful to categorize Pallano terraces according to wall masonry style than the Rackham typology. All of the terraces with visible stone risers appear to be constructed of local limestone and can generally be described as possessing "rough-cut" dry-stone masonry, but the walls vary in the apparent effort taken to cut and fit the stones. Some show a clear vertical wall face and well-delineated courses of stones, while others are simply embankments of piled uncut stones with sediment filled in behind. Most terraces fall in between, with wall stones roughly faced but often not coursed, or coursed but not faced. Many other terraces do not have visible stone walls at all. Four major categories of terrace wall were created based on field observations from 2010, and this typology was used again to characterize terraces in the 2011 season:

Type A: wall built of cut stones, usually coursed and faced. (Fig. 7)

Type B: wall constructed of uncut or roughly cut stones, usually with a distinguishable wall face but no coursing. (Fig. 8)

Type C: uncut stones, piled in a line to form an embankment, no coursing or facing, with sediment deposited behind to form a level surface. (Fig. 9)

Type D: an artificial break in slope with no visible stone wall of any kind; this may be a stone wall that has eroded away or become buried, or a lynchet-style terrace consisting of an earthen embankment lined with vegetation to stabilize it (called *ciglioni* in Italian). (Fig. 10)

Type B walls account for the highest percentage of terraces on Pallano, 49.5% of all terraces surveyed in 2010 and 2011. Type A terraces make up 24.2%, Type C 14.2%, and Type D 17.37%.

Further field observations during the 2011 survey found that this typology did not perfectly account for the variations in masonry style across the ridge. Distinction between Type A and Type B terraces, for example, was often unclear, some faced walls (as Type A and B) had piled stones along the top edge of the wall (as Type C). Those walls that seemed to cross the boundary between multiple types were labeled AB, BC, and so forth. Nevertheless, the 2011 season concluded that although the divisions between these types are far from strict, they nevertheless reflect meaningful differences in masonry style.

Figure 7: Examples of Type A terraces

Fig. 8: Examples of Type B terraces

Fig. 9: Examples of Type C terraces

Fig. 10: Examples of Type D terraces

Terrace walls on Pallano can be best understood as occupying a spectrum, from walls carefully constructed of cut stones (Type A), to those constructed entirely of uncut stones (Type C) or possessing no stone riser at all (Type D), with most terraces appearing somewhere in the middle. Moreover, these differences in wall type were found to correlate with the spatial distribution of Pallano terraces, as will be seen below.

3. Spatial distribution of terracing on Monte Pallano

From the seven small areas selected for survey, terrace systems on Pallano appear to fall into three broad zones of terracing, on the west, east, and south faces of the ridge. These zones are distinct in geographic orientation, their apparent association with settlement areas, and to a large extent by the distribution of terracing styles within them. The sections below describe the general features of terracing in each major zone. Summary statistics of terrace wall features by area are provided in Appendix A.

3.1 West face and north ridge (Figs. 11 & 12)

The west face of Pallano, between Fonte Benedetta and Fonte Canalone and the villages of Bomba and Sambuceto, is intensively modified with parallel step terraces. These terraces follow the natural contours of the slope and cover virtually the entire hillside from the springs to the modern settlements. Aerial photographs indicate that they continue in similar patterns well beyond the area covered by the ground survey. The terraces form close parallel series, varying in size from 6 meters to 40 meters between each riser. Many were clearly built together, either by one landowner or by multiple landowners working in cooperation. The walls tend to be well constructed, neatly faced, and level planting areas. Type A-masonry predominates in this area at nearly 53%, with Type B making up 31% of the recorded terraces (Appendix A). Approximately 12% were classified as Type D, given that no stone wall was visible; though as excavations of

Fig. 11: West face, terrace systems and survey zones.

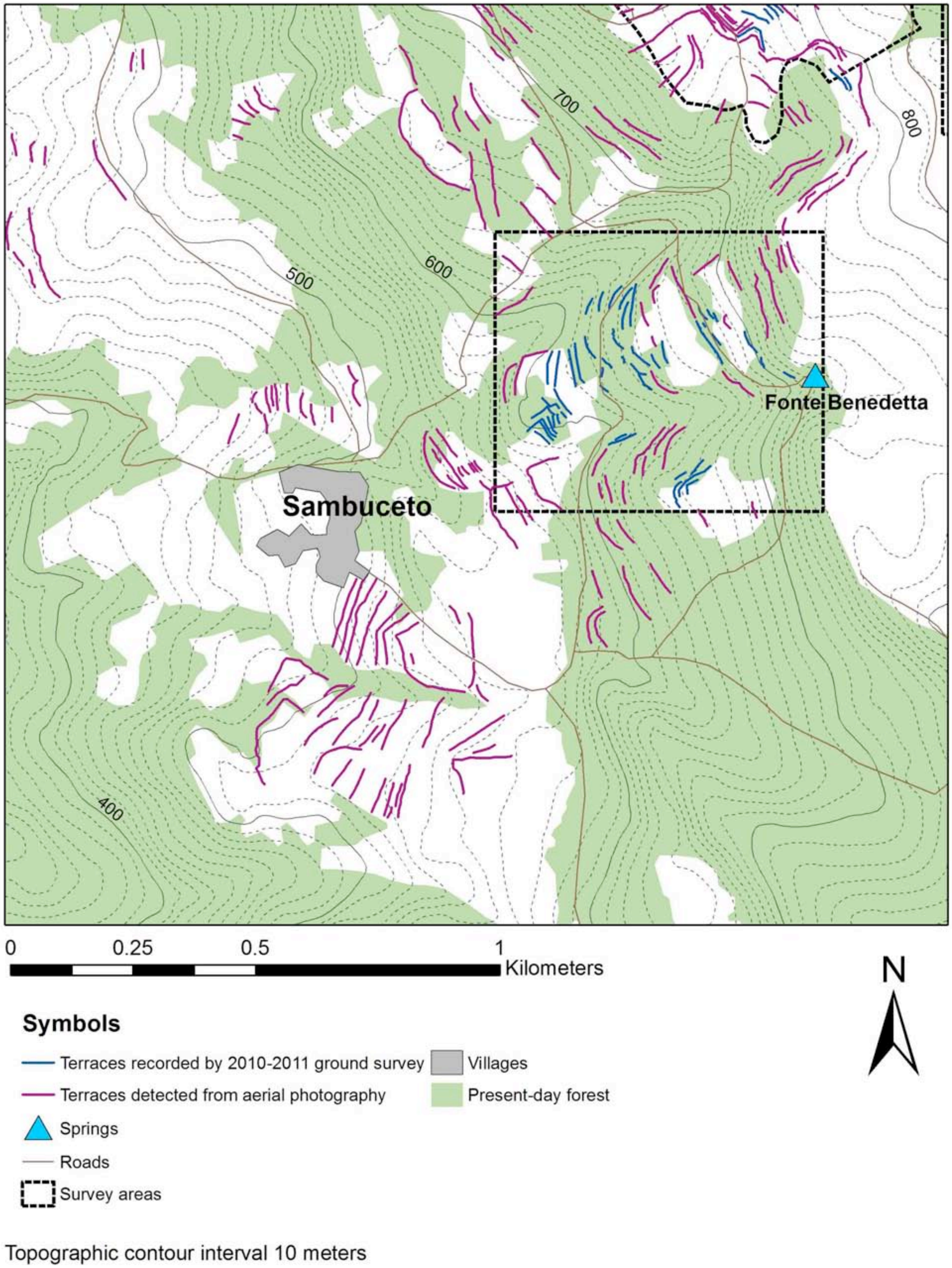
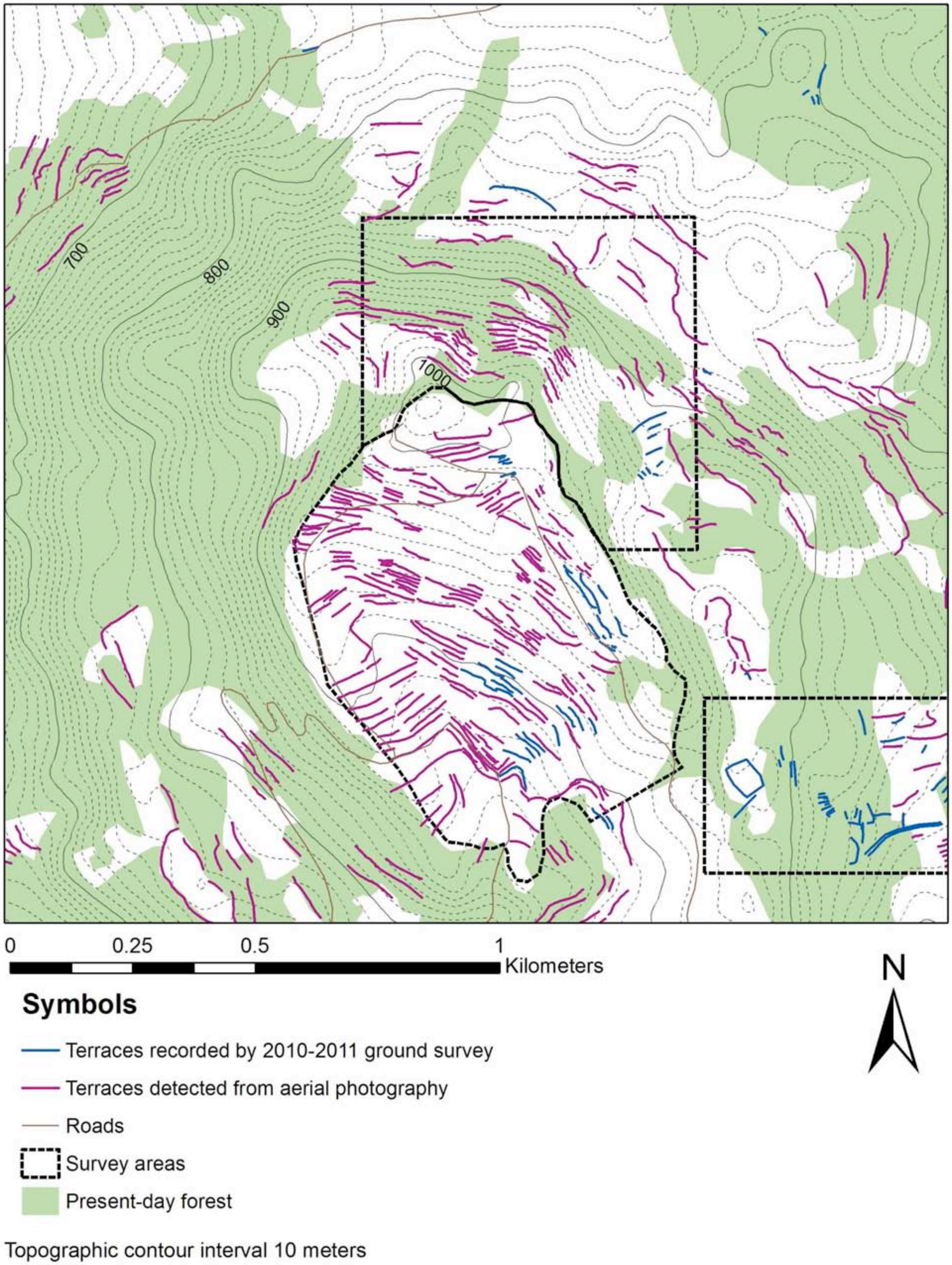


Fig. 12: Upper ridge and north face, terrace systems and survey zones



Terrace 40 indicated, this may be due in numerous instances to the fact that the stone wall has been buried by sediment and overgrown by vegetation (see below). The terraced fields vary in size, probably a partial effect of topography but also indicative of a variety of crops: larger fields could be more easily plowed and planted with grain crops, while the narrower terraces might be planted with vines and vegetables. Variable vegetation and states of disrepair of terraces indicate gradual abandonment of this area, with the worst eroded terraces at the highest slopes, and more intact terraces down the hill towards Sambuceto. Some of the larger fields are still open meadow, indicating comparatively recent abandonment. One field on the west face appeared to be still in use. It was planted with legumes in 2010 and had been recently cut when it was revisited in 2011. Most terraces, however, are covered in young woods, with dense undergrowth. A few collapsed field huts were found built over terrace walls, which appeared to be early modern constructions.

The upper ridge of Pallano (often referred to as the “saddle”, by its shape), which is mostly open, grassy vegetation, with scattered trees, exhibits intensive terracing visible in both historical and modern aerial photographs. This system appears to be largely contiguous with that on the west face transect between Fonte Benedetta and Sambuceto, as both systems are comprised of closely-spaced series of parallel stepped terraces, following the natural contours and orientation of the slope. The terraces in this area form the densest system of terracing observed by the survey. They cover the entire northern half of the upper ridge, regularly spaced at 10-20 m intervals. Most of the southern half of the upper ridge, by contrast, is un-terraced; there are, however, frequent “pocket terraces” to assist with tree cultivation. It is unclear if these were once flourishing mountain-top orchards, as most of the pockets are empty pits that do not appear to have ever contained trees. Though they share similar orientation and spatial patterning to the terraces on the west face above Sambuceto, most of the terraces on the upper ridge are Type B and/or Type C (80%) rather than Type A, which suggests that they represent a different phase of terrace construction. The terraces are in generally similar states of preservation across the ridge, indicating that they were all abandoned around the same time. Furthermore, the vegetation cover – meadow and scattered trees – suggests that they were in use more recently than the systems downslope that are covered in thick woods.

3.2 East and northeast faces, Lago Nero (Figs. 12, 13, & 14)

The east face of Pallano displays widely dispersed terracing that corresponds with highly variable terrain and vegetation. A series of steep, densely wooded slopes alternate with flatter ridges that contain open meadow. Terracing in the area is similarly variable, with some badly decayed walls in the dense woods, but most agricultural fields avoiding the steeper slopes and favoring the series of level ridges that descend towards the village of Tornareccio. Rather than directly following the major contours, many parallel series of terraces on the east face are constructed perpendicular to the main east-west slope, running north or south along the gentler slopes of the ridges. Parallel risers range from 10 to over 50 meters apart. Many terraces in the east face are of Type C construction; these are especially common on the southeast slopes, in the vicinity of Lago Nero, where Type C terraces make up 50% of the assemblage. These are characterized by exceptionally broad fields – 58.7 meters long on average and 20-50 meters between each riser – and thick walls averaging 2.5 meters in width. There is also notably high incidence on the east flank of other, non-terrace structures that demarcate agricultural land: field boundary walls, collapsed field huts, and large stone piles from field clearing. Terracing in this area was clearly just one component of a larger land management strategy, focused on dividing parcels of land and improving planting soil through the removal of stones. Many wooded areas on the steeper slopes are mature forest, while the light, grassy vegetation of the gently sloping ridges is suggestive of recent abandonment. The 1943 aerial photography confirms that many of these steeper slopes were forested in the early 20th century. The distinct contrast between

Fig. 13: East face, terrace systems and survey zones

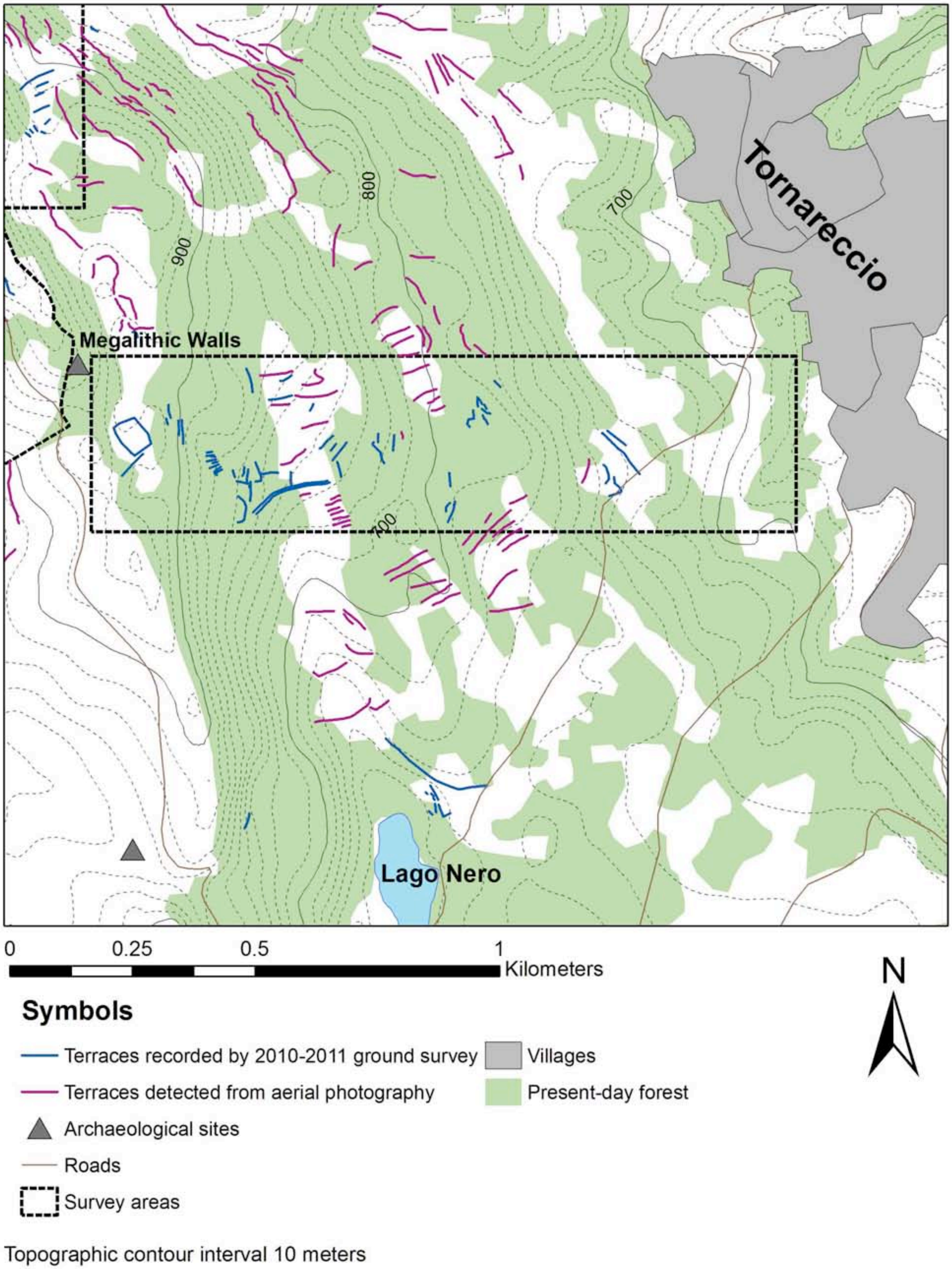
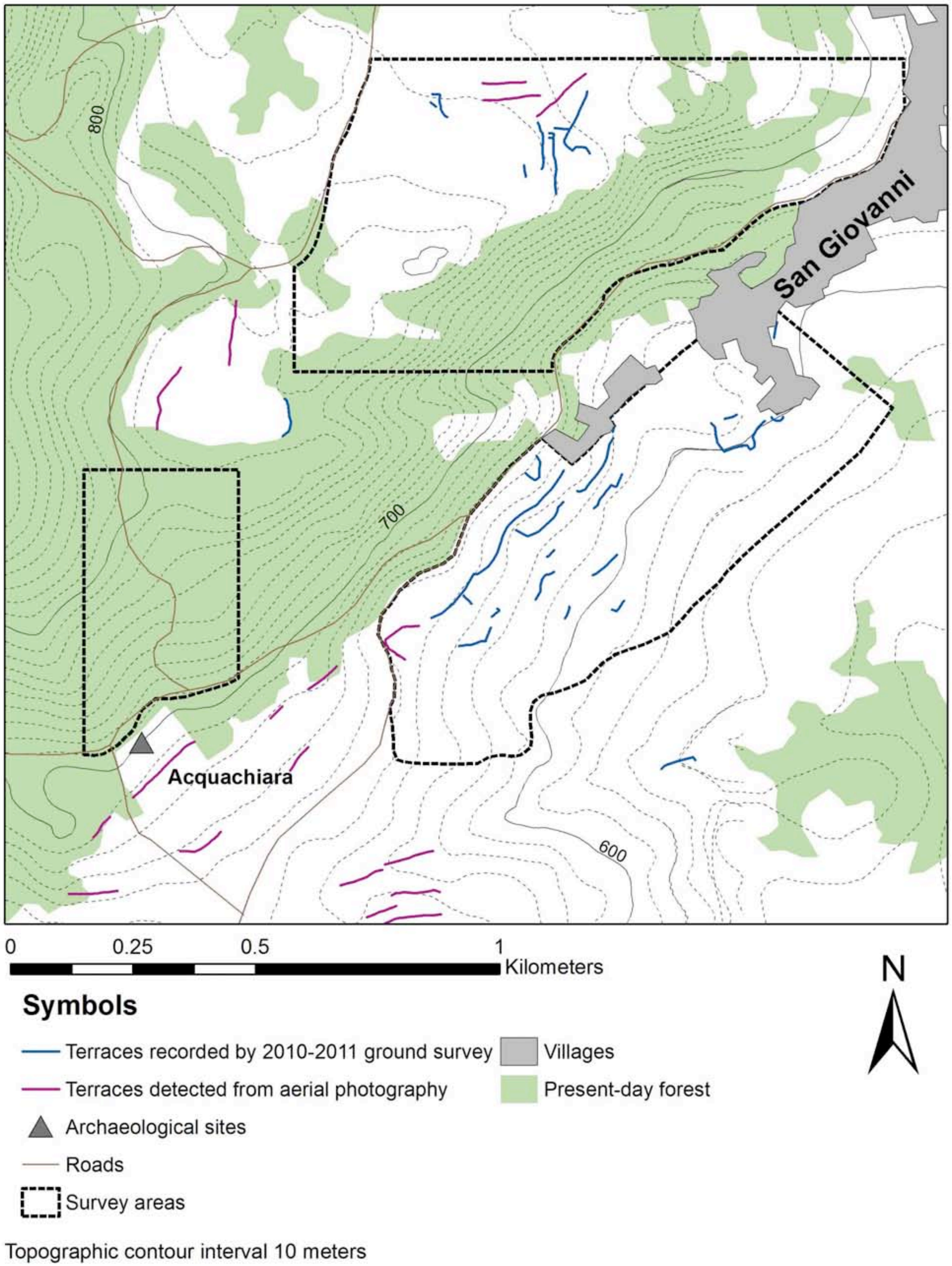


Fig. 14: Southeast face, terrace systems and survey zones



vegetation types indicate that the steeper terraced areas were abandoned comparatively early, while the flatter ridges continued to be cultivated up into recent decades.

The survey recorded a sporadic distribution of terraces on the north face of Pallano, similar to that observed on the east face. This may, however, be a product of the present inaccessibility of this area due to terrain and vegetation. The northern flank of Pallano is steep and densely wooded, and lack of trails and access points impeded easy pedestrian survey. A small set of terraces was mapped for this area, with no large systems or distinctive spatial distribution apparent. Historical aerial photographs show a distinctive system of terracing on the north flank that was visible in the 1940s, indicating that terracing in the area may have once been much more intensive than what is currently visible.

3.3 South face, San Giovanni, and Acquachiara (Fig. 14)

The south slope of Pallano between San Giovanni and Acquachiara, an area currently under cultivation and the site of dense archaeological material, was surveyed for terraces to help contextualize the data from other SVP excavations and field-walking survey. The terrace survey found artificial embankments in many of fields with Type D risers, closely resembling terraces referred to in the literature as *lynchets*, or *ciglioni* in local terminology. A few terraces did display short segments of dry stone walling or scattered stones protruding from the embankment, suggestive of more extensive stone walling underlying the terrace that has now become buried by sediment and vegetation. Type D terraces in this area are not constructed in close parallel series, as on the higher slopes, but rather seem to develop incidentally where agricultural soil builds up along trees and hedges planted at the lower edges of sloping fields. The fields are exceptionally broad, displaying the widest ranging wall lengths of any area surveyed, with the shortest terrace just 6.85 meters long and the longest embankment over 418 meters long. Height of the risers was also highly variable, ranging from less than 1 to over 5 meters. All of the terraces in the San Giovanni-Acquachiara area are fields that are under modern cultivation. The presence of numerous archaeological sites and surface scatters in this area, as described in chapter 1, indicates that this was also an area of dense agrarian settlement during the Iron Age and Roman Empire.

The steep southeast slope between the Lago Nero ridge and the village of San Giovanni was found to be completely bare of terracing, as well as any other demarcations of agricultural fields. The vegetation is fairly light, however, suggesting that it is recent growth. It is possible that this hillside was historically used for pasturing rather than agriculture. The existence of a sheep pen just at the top of the ridge supports this hypothesis. Terracing reappears at the top of the ridge, and continues towards Lago Nero.

The southwestern slope of Pallano, north of the spring line, also lacks any remains of terrace features. The forest in this area appears much more developed, and indeed the southwestern face of Pallano appears forested even in the 1943 aerial photo. This area may represent a consistently managed forest that has never been cleared for agricultural cultivation in the recent past.

3.4 Other reconnaissance in the valley

A handful of terraces were recorded incidentally during fieldwalking survey in 1994-1998 and in 2009, the former south of Sambuceto and the latter to the east of Bomba. Geographic coordinates for these terraces were used to create the predictive model described in chapter 2. We attempted to relocate these terraces to confirm their positional accuracy during 2010. We were only able to relocate with certainty two of the terraces near Bomba, and found several other terrace features in the vicinity. These were, however, not stone terraces of the same type as found higher up on Pallano. They more closely resemble lynchets, and the modern bulldozed “false terraces” of Grove and Rackham’s typology (2001: 108). Their location at a lower elevation, in a fluvial environment close to the Sangro river, and on a geologic substrate of clay rather than limestone, seems significant in consideration of their form.

In the upper valley, we observed frequent lynchet/ciglioni fields along the river, very similar in appearance to fields around Acquachiara. Very badly degraded terraces were found in the forested hills above a Roman site near Opi; built on top of these were the remains of small rectangular structures of unknown function. The implication of these observations is that terracing observed on Pallano represents a widespread practice throughout the valley.

4. Remote sensing and GIS modeling

For each terrace recorded during survey, geographic coordinates were collected using a portable GPS, and these coordinates were used to construct a digital map of the terrace systems encountered in the field. Lines were drawn representing terrace walls, which were projected onto aerial photographs. Matching the terraces observed in the field to aerial imagery made it possible to recognize other remains of terraces visible in both current and historic aerial photographs. These images were then used to trace additional lines of terrace embankments in areas that were not covered by the ground survey, thus building a more extensive map of the terrace systems on Pallano (Fig. 15).

The new set of terrace spatial data gathered from survey was used to revise the original GIS model of terrace placement. Points were plotted along the lines of each of the ground-surveyed terrace walls corresponding to every 20 meters of walling. The values of the seven environmental criteria (slope, insolation, proximity to settlements, roads, springs and streams, and flow accumulation), along with the values of the predictive models, were extracted to these points, and their spread compared to the values in the early predictive models (Table 2). The model giving weight to natural criteria was the more accurate of the two, encompassing 77.5% of the newly recorded terrace points. The cultural-weight model accounted for only 42.4% of the terrace points.

Fig. 15: Overview map of terraces recorded by survey and traced from aerial photography

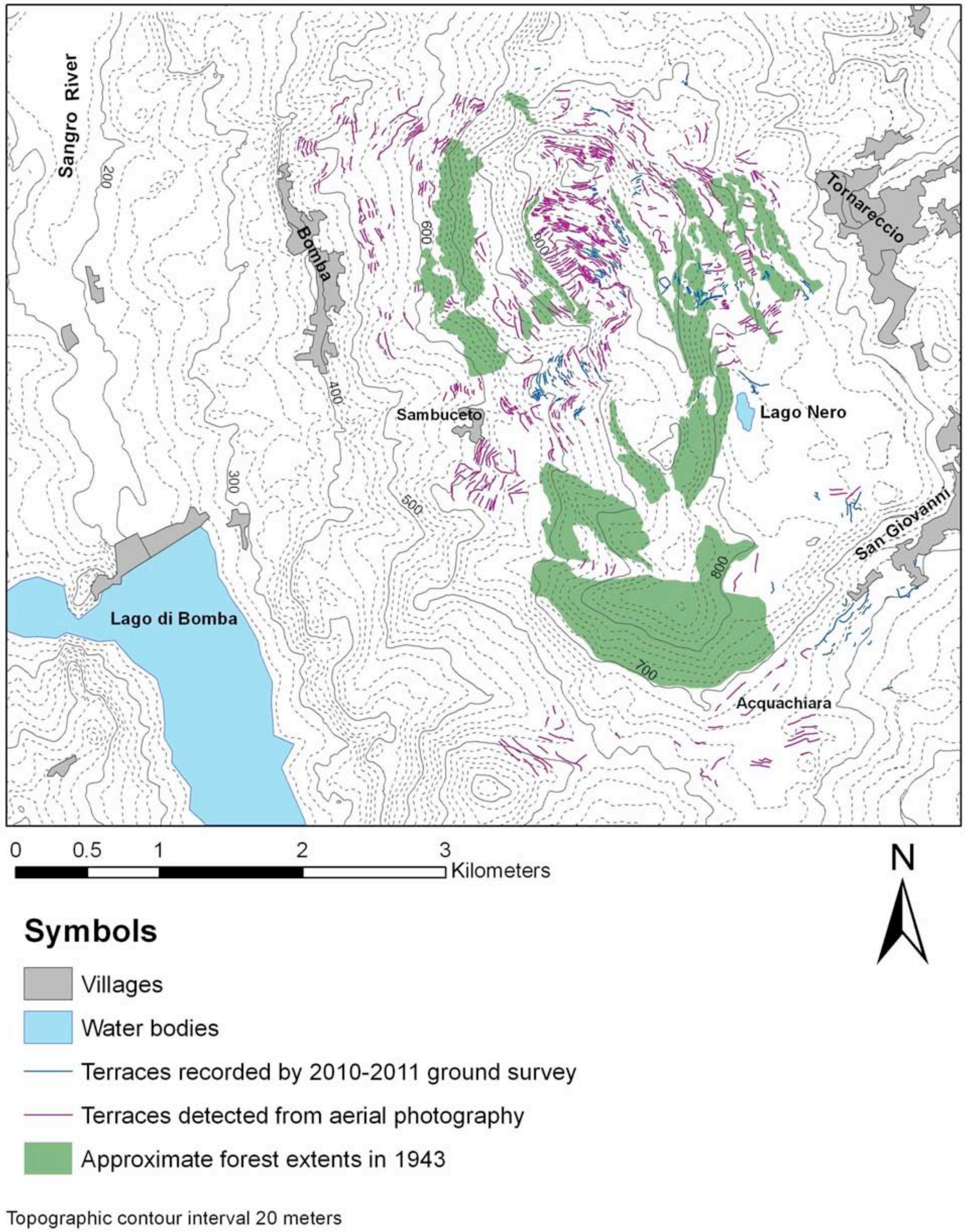


Table 2. Environmental characteristics of surveyed terraces

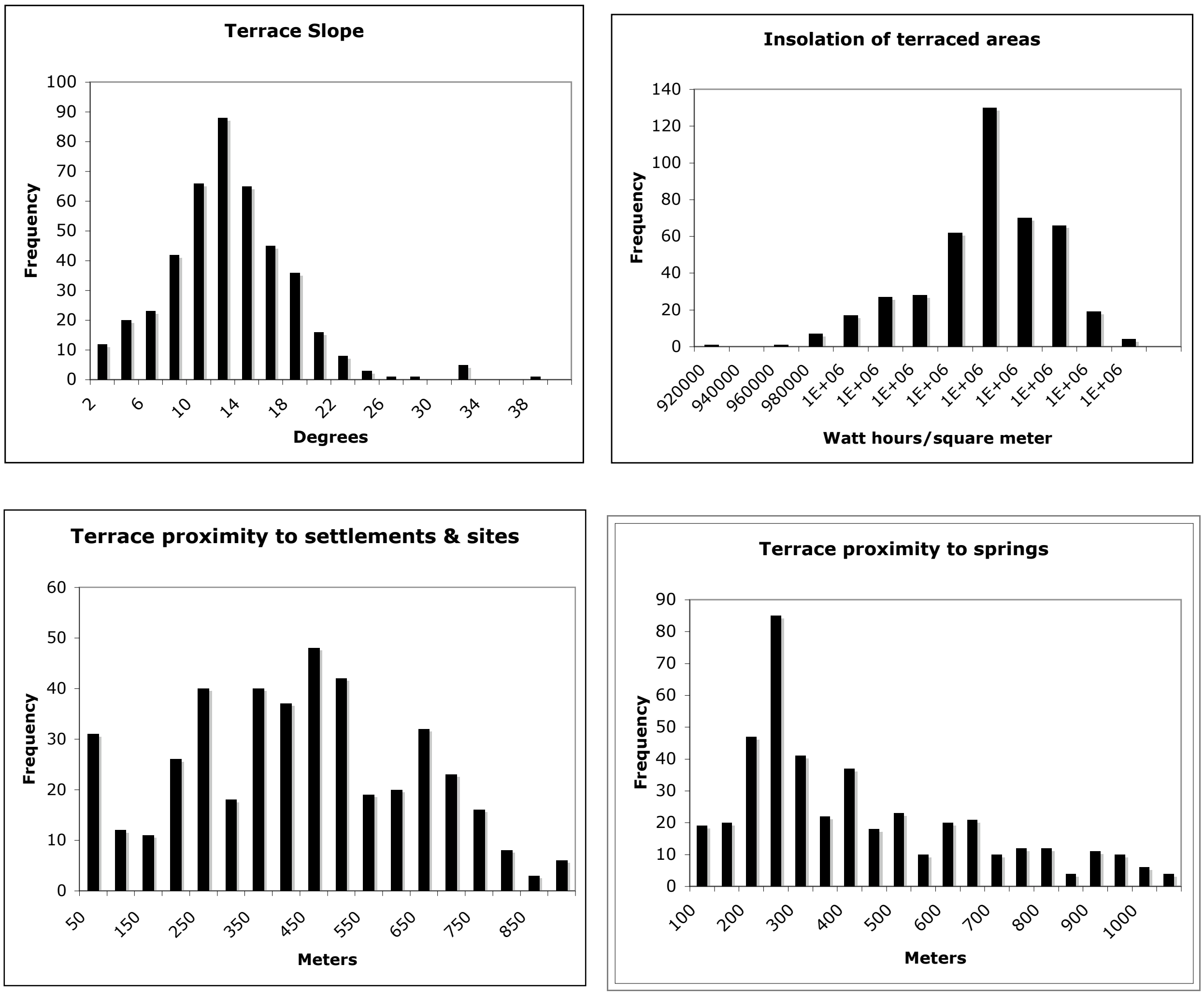
Total number of points = 432	Settlement proximity (meters)	Road/path proximity (meters)	Spring proximity (meters)	Stream proximity (meters)	Flow accumulation	Slope (degrees)	Insolation (Watt hours/square meter)
Minimum	0.00	0.00	50.00	10.00	0.00	0.00	903050.94
Maximum	855.86	348.18	1050.00	756.64	1746.00	36.64	1148174.88
Mean	393.15	77.72	392.03	330.37	26.19	11.51	1068372.46
St. Dev.	204.69	71.33	235.97	206.24	162.57	5.20	37296.38
1st Quartile	250.00	22.38	206.16	141.16	1.00	8.75	1048934.91
Median	403.11	50.05	304.14	289.31	5.00	11.31	1072571.75
3rd Quartile	541.95	126.61	553.96	498.60	10.00	14.31	1092866.16
Range	855.86	348.18	1000.00	746.64	1746.00	36.64	245123.94
Interquartile Range	291.95	104.23	347.80	357.44	9.00	5.57	43931.25

Table 3. Accuracy of preliminary predictive models

Suitability categories	Natural weight	Cultural weight
1 (more suitable)	331 terrace points	181 terrace points
2 (less suitable)	96 terrace points	246 terrace points

Neither of the initial predictive models encompassed the terraces in their entirety, and the greater accuracy of the natural-weight model suggested that not all of the variables used to create the models were as important in influencing terrace placement as originally supposed. Of the seven variables, slope, insolation, proximity to springs, and proximity to cultural sites exhibited the most informative distribution: a set of strong bell curves and narrow interquartile ranges showed the terraces favoring slopes between 8 and 14 degrees, insolation levels of 1.05 to 1.09 million Watt hours per square meter, and distance to springs and paths between 200 and 550 meters (Fig.16). Other factors seemed to have less of an effect on terrace distribution than originally hypothesized. The terraces varied widely in their proximity to streams, suggesting that this variable was not factoring strongly into terrace placement. Though statistically there appears a strong tendency for terraces to be located close to roads, this effect seems very likely to be a bias of the survey methods; field teams had difficulty accessing areas far from navigable roads and paths. Field survey also found that the roads represented in the GIS shapefile layer were only a fraction of the numerous abandoned trails and paths that wind around the slopes Pallano and

Fig. 16: Histograms of environmental parameters with most centralized distributions: slope, insolation, proximity to settlements and cultural sites, proximity to springs. Hypothesized to be most influential in determining terrace distribution.



presumably once permitted access to agricultural areas. Nearly all of the terraces were found in areas of 0 or extremely low flow accumulation, the implication being that no terraces were built across drainage areas; in other words, the survey found no examples of check-dam terraces. Since most of the digital landscape falls into areas of 0 flow accumulation, this variable is not a strong predictor.

The four variables that appeared to be most influential in determining terrace locations – slope, insolation, proximity to streams, and proximity to cultural sites – formed the parameters of a new predictive model. Proximity to roads, proximity to streams, and flow accumulation were eliminated due to the considerations described above. In order to create a more nuanced model that reflected a spectrum of terracing probability, the four most influential variables were reclassified into four new value classes, rather than two. The new classes were defined based on the mean and standard deviations of the variables at the new terrace locations. As with the original models, it was assumed that areas of higher slope and insolation, and areas closer to springs and settlements, were more likely to be terraced. Values within one standard deviation above and below the mean were given a value of 1, representing high probability of terracing. For slope and insolation two standard deviations above the mean defined the limits of class 2; for site and spring proximity, class 2 was between 0 meters and the lower value of class 1. Classes 3 and 5 were defined by the maximum and minimum possible values of the rasters (Table 4).[2]

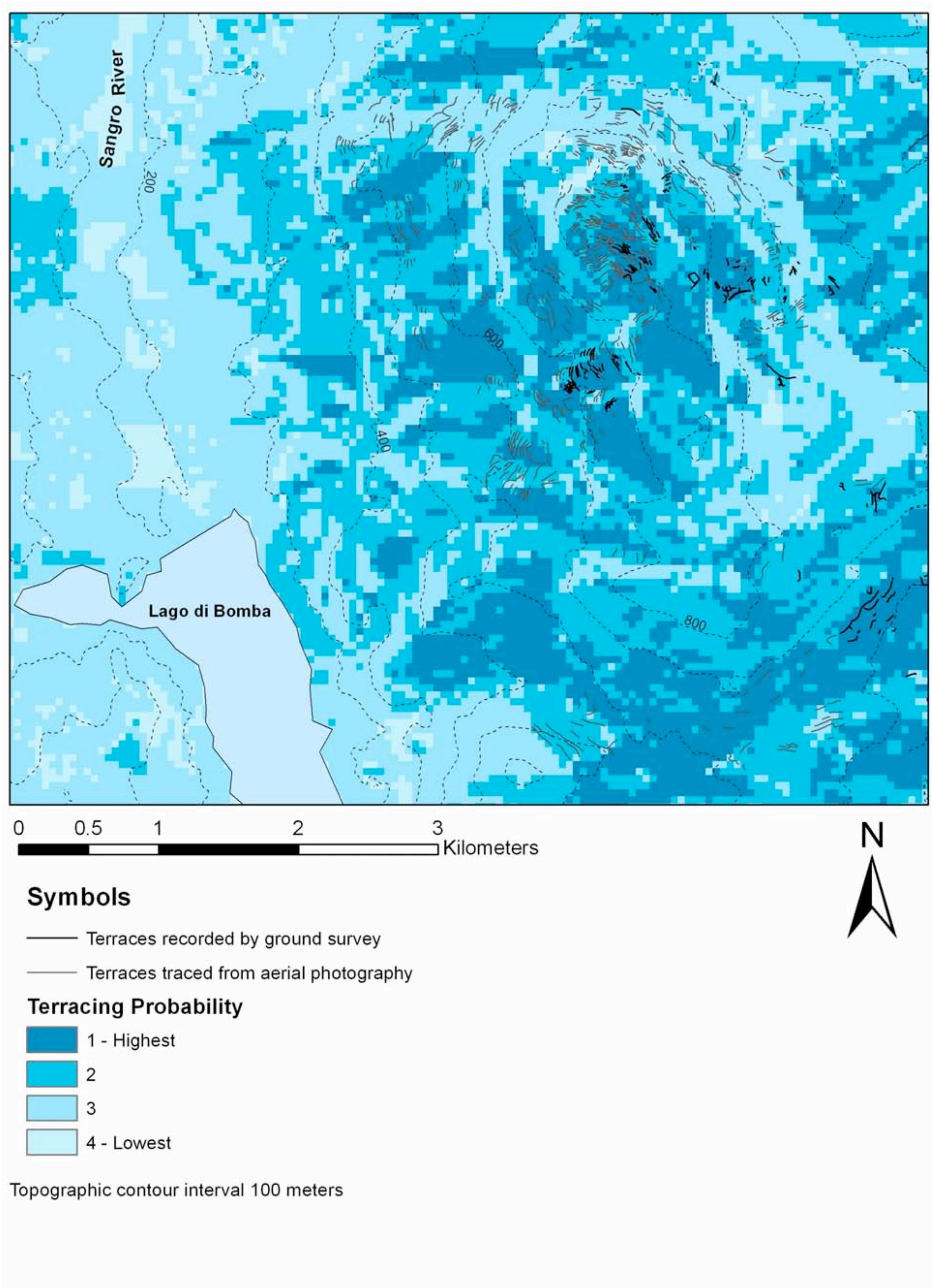
Table 4. Reclassified values of environmental parameters used to refine the predictive model.

	Reclassified rasters			
Reclassified value	Site proximity (m)	Spring proximity (m)	Slope (degrees)	Insolation (Watt hrs/sq.m.)
1	188.46-594.84	156-628	6.31-16.71	1,031,076-1,105,669
2	0-188.46	0-156	16.71-21.91	1,105,669-1,142,965
3	594.84-802.53	628-864	21.91-52.45	1,142,965-1,160,260
4	802.53-14,890	864-5578.5	0-6.31	1,031,076-601,450
% weight in model	20%	20%	30%	30%

These reclassified variables were combined in a weighted overlay in the same method as described in chapter 2, with 30% weight given to slope and insolation, and 20% weight given to site and spring proximity. This weighted overlay model reclassified the landscape of Pallano in

[2] A preliminary version of this revised predictive model was developed after the 2010 season, based on terrace data in the western and eastern survey zones. The 2010 revised model retained all seven environmental criteria and used a 1-5 reclassification scale. Two models were created, using the same weighted overlay percentages as in the original, pre-survey models. The environmental statistics of terraces in the 2010 survey areas, and the results of reclassification, were much the same as those described here, with the first two value classes encompassing 96-100% of the terrace points. The 2010 revised model was presented in a conference paper in 2011: Countryman, Carrier, and Kane. "Predictive Modeling: A Case Study of Agricultural Terraces at Monte Pallano (Abruzzo, Italy)." CAA2011 Revive the Past: the 39th Annual Conference of Computer Applications and Quantitative Methods in Archaeology, Beijing, China, 12-16 April 2011. (Accepted for publication in the conference proceedings, forthcoming.)

Fig. 17: Revised predictive model, showing areas of highest and lowest probability for terracing.



a spectrum of values 1-4, where 1 represents areas of highest terracing probability and 4 represents areas of lowest probability (Fig.17).

The new model appears much more powerful than the first. The model contains all of the surveyed terraces within the first 3 classes, with the 59% falling into category 1 and 34% in category 2 -- the areas most theoretically likely to be terraced based on the parameters of slope, insolation, and proximity to springs and cultural sites.

Table 5. Accuracy of new predictive model

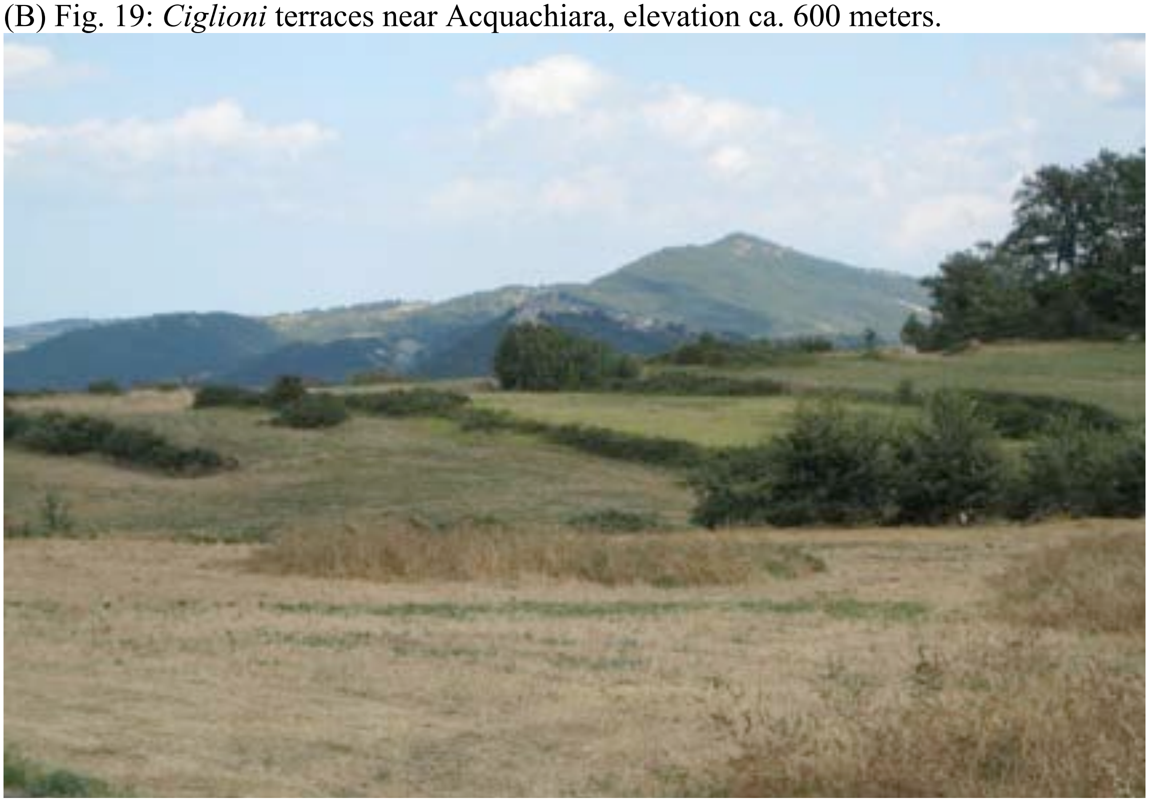
Probability categories	# of terrace points in each class
1 (highest)	255
2	149
3	28
4 (lowest)	0

The model does not account for all of the spatial variation in terracing on Pallano, however. The additional terraces mapped from the aerial photos offer a preliminary visual test that confirms many terraces do indeed fall within the bounds of the first two probability classes, but also helps illustrate the shortcomings of this model. Many areas that appear to be terraced in aerial photographs are in categories 3 and 4, especially the extensive north-facing systems around the peak of Pallano. Several areas modeled as most probable or highly probable for terracing (classes 1 and 2) appear to be woodland, scrub, and pasture in 1943 aerial photography. The model does not effectively illustrate the frequency of narrow stone terraces on the upper slopes of Monte Pallano as compared to the change to broader, lynchet-style terracing below the spring line (Fig. 18), or the general absence of terracing lower in the river valley. Survey on the southern flanks in 2011 demonstrated that terracing will not automatically favor southerly aspects with greater insolation – large areas of the southern flanks of Pallano, which display most of the ideal parameters of slope, insolation levels, and proximity to springs and settlements, are

Fig. 18: The variable forms of terracing on Monte Pallano

(A) Parallel step terraces on the upper ridge of Pallano, elevation ca. 900 meters.

(B) Fig. 19: *Ciglioni* terraces near Acquachiara, elevation ca. 600 meters.



not terraced. The implication is that the decision to terrace particular hillsides was affected by more than just the four environmental variables contained in the predictive model.

5. Test excavations: terrace sediment profiles on the macro-scale

Five terraces in the Benedetta-Sambuceto transect were selected for test excavations. This area contains a well-defined system of terraces of similar style that display varying degrees of wall degradation, and may therefore represent different phases of terrace construction. Teams of two to three excavators, primarily Sangro Valley field school students, lead by the author, dug small test trenches to investigate the construction of the wall and the stratigraphy of the fill. The excavations also sought to collect any kind of environmental sample that might help pinpoint dates for the construction and use of the terrace. Each of the five terrace excavations were assigned a trench number T. 2000-6000, following the main excavation in 2011, T. 1000 in San Giovanni.

5.1 Fill excavations

Two test trenches were excavated into the fill of Terrace 49 (T.2000). This terrace represents one of the more well-preserved terraces in this system. The two trenches were placed on an axis perpendicular to the line of the riser, so as to track the changes in the fill profile from the front to the back of the terrace. The first test pit was positioned 100 cm back from the edge of the riser, and dug 50 x 75 cm wide, to a maximum depth of 39 cm. The second pit was placed 255 cm from the edge of the riser, and dug 60 x 60 cm wide, to maximum depth of 40 cm. Four contexts were assigned to each test pit based on subtle changes in sediment color and composition, but the interfaces were extremely graded, and in fact the profiles were fairly homogenous. Both pits consisted of a layer of dark organic-rich sediment 5 cm thick, followed by gravelly clay silt extending to the bottom of the profile, with large limestone inclusions becoming more frequent at 15-25 cm. At the bottom of pit 2 the excavation team encountered a thin layer of white sandy clay (context 2009) overlying a layer of rocks, apparently a C horizon of weathered bedrock. Time constraints and the greater depth of soil closer to the edge of the riser prevented the team from reaching a C horizon in pit 1.

A similar pair of test trenches was dug into the fill of Terrace 42 (T.3000). Terrace 42 represents one of the more degraded terraces in the system: most of the stone wall seems to be buried under sediment and vegetation. Excavations revealed deeper sediment fill and a more developed soil profile than that of TER.49. As with Terrace 49, we dug two pits positioned on a perpendicular axis to the riser to expose stratigraphic changes across the fill. Pit 1 was placed 150 cm from the edge of the riser and dug 50 x 100 cm wide; pit 2 was placed 450 cm from the edge of the riser and dug 50 x 150 cm wide. Pit 1 was dug to 40 cm and exhibited a similar profile as seen before, with dark organic-rich material from 0-8 cm, and below this a thick layer of gravely clay silt becoming rockier with depth. Pit 2 was dug to 60 cm deep; the profile consisted of an organic-rich horizon 0 to 10-16 cm deep, gravelly clay silt from 10 to 40 cm, and below this a layer compact orange-brown clay. Below this clay was white-colored sandy clay substrate and weathered bedrock. The orange-brown clay was unlike anything seen in the other trenches. It contained frequent dark inclusions; we took a large bulk sample of this layer for flotation to extract possible carbon. The excavators also cut two block samples encompassing the entire profile of pit 2 for thin section micromorphology analysis. The results of thin section analysis for the block samples of the complete profile Terrace 42 T. 3000 are described below. This trench also happened to yield the only artifact found in any of the terraces: a fragment of worked flint, which appeared in the first 10 cm of sediment while carving block samples out of the section walls.

As a comparison for Terrace 49 and Terrace 42, a team excavated a third terrace in a similar manner at Terrace 11, which is located further up the hillside in a different cluster of terraces. Here, a single, 2-meter-long trench (T.4000) was attempted in the center of the tread between terraces 11 and 12. Due to time constraints and the overall size of the terrace (the riser ca. 2 meters high) the diggers were not able to expose the complete profile of the fill; the trench reached a maximum depth of 50 cm without showing any significant stratigraphic variation. Similar to the profiles in T.2000 and T.3000, this profile consisted of a layer of dark, organic-rich sediment 0-8 cm, followed by dark brown, gravelly clay silt. Gravel and rocks became larger and more frequent around 20 cm, but the excavation did not reach the sterile substrate. It seemed likely that this larger terrace had a generally thicker fill of plow soil.

5.2 Wall excavations

Simultaneous to excavation and sampling of Terrace 42 T.3000, the team exposed a 70 cm wide segment of the buried wall of Terrace 40 (T.5000), which lies immediately upslope from 42. This terrace was identified in 2010 as likely to be a very old terrace wall that has become buried by sediment and vegetation so as to appear as only an artificial embankment with no supporting wall. A single course of stones protruding from a section of the embankment suggested the presence of a buried wall, and this excavation revealed that there is indeed a fully coursed and faced wall supporting this terrace. Three courses of large wall stones were exposed and excavated down to the sterile substrate. Possible soil horizons of a relict ground surface were exposed below the wall, and a block sample of these contexts was extracted for micromorphological analysis. There was no evidence of foundation trenching; the terrace wall appeared to have been constructed directly on top of the existing ground surface (Fig. 19).

A 35 x 110 cm test trench (T.6000) was also cut across the top of the wall of Terrace 47 to ascertain the thickness of the wall and characterize the stratigraphy immediately behind it. This excavation indicated that the wall had been constructed with a facing of large, cut stones along the front, approximately 30 cm thick, with a 50 cm thick layer of gravel and uncut stone rubble fill packed behind. The sediment profile behind the wall consisted of a dark, organic-rich horizon 0-6 cm followed by gritty clay silt, with frequent gravel throughout that increased in size and frequency towards the bottom of the profile. The trench was dug to a total depth of 35 cm.

Fig. 19: Exposed face of the buried wall of Terrace 40, showing A-B-C horizons of a palaeosol beneath the wall.

6. Micromorphology of sediment sample thin sections[3]

Three blocks of intact sediment were taken from the excavations of terraces 40 and 42 for microscopic examination of the sediment profile in thin section. Of these samples, thin sections of MM2 and MM3, from the excavation of Terrace 42 (T.3000), were prepared and analyzed during the 2011-2012 academic year (procedures described in chapter 2).

The two overlapping block samples from the fill of Terrace 42 encompass the three

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[3] This section has been prepared with the generous assistance and consultation of Nicholas Wolff, Boston University, Department of Archaeology, who oversaw sampling in the field and provided specialist analysis of the thin sections.

stratigraphic contexts identified in the field: 3003 (0-ca.15 cm), an upper horizon of loose, dark, organic-rich clay; 3004 (roughly 15 to 40 cm), medium gray-brown clay with dense limestone gravel; and 3005 (40-60 cm), a layer of thick, orange/red-brown clay with frequent black mottles and some limestone gravel. MM2 covers 0-30 cm in depth, MM3 from 25-55 cm (Fig. 20). The two blocks were each cut into five sections, for a total of ten sections numbered 1-10. Detail descriptions of each slide are given in Appendix C.

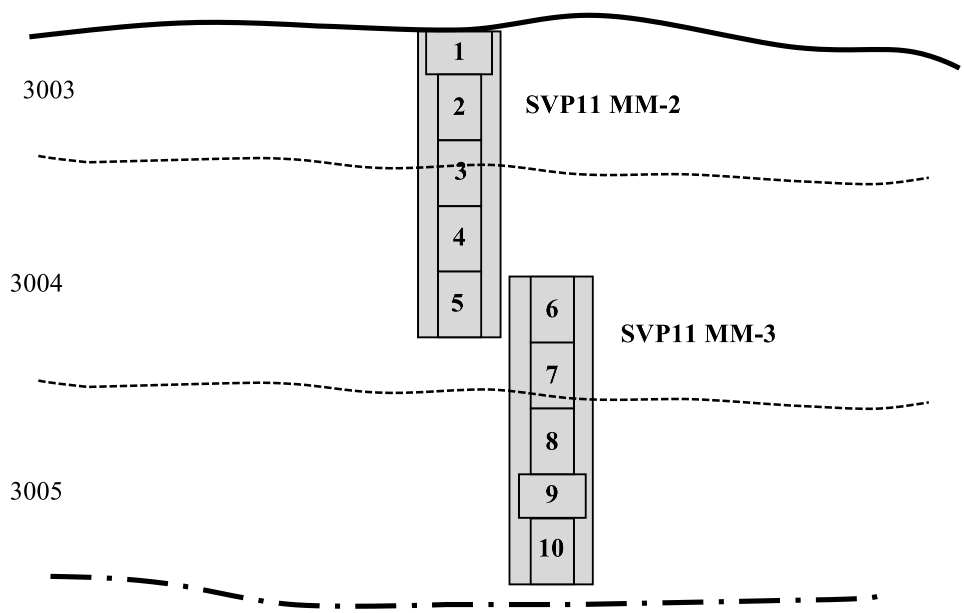


Fig. 20. Schematic profile of Trench 3000 in Terrace #42, showing context changes observed during excavation (3003, 3004, 3005), location of the two block samples collected (MM-2 and MM-3), and placement of the ten thin sections produced from the blocks. Each numbered thin section measures 5x7.5cm. (Figs. 21-25 courtesy of Nicholas Wolff, Boston University)

Observations during excavation suggested that the primary contextual differences through the vertical profile were largely pedogenic, i.e. indicating the development of A-B-C soil horizons, rather than representing lithostratigraphic changes. This impression was confirmed by the thin sections. Throughout the samples there is a marked consistency in the range of minerals present from top to bottom. All of the thin sections were found to have a fabric composed of poorly sorted material of widely varying sizes. Clay is dominant throughout, comprising at least 50% of the material. Limestone fragments ranging in size from fine to very course sand and pebbles are very frequent, 15%-25% in most slides. In addition to the larger carbonate clasts, silt- and sand-sized particles of quartz, feldspar, and various heavy minerals are common throughout all the slides. Structural attributes of the sediment were also fairly uniform, with granular fine particles and larger clasts ranging from sub-angular to sub-rounded blocky types.

The top of the profile displays extensive bioturbation and contains significant quantities of plant roots, woody fragments, and organic material in varying degrees of humification, as is typical of a soil A horizon (fig. 21). Further down the profile, coarse textural pedofeatures appear around 20 cm below the ground surface in the form of illuvial coatings of silt and clay (fig. 22). Also present through the middle of the profile are disorthic nodules of secondary calcium carbonate. A fragment of wood charcoal was found in section MM3.6, located at ca. 30 cm below the surface (Fig. 23). A variety of intact, undisturbed soil features appear from ca. 40 cm and downwards, including an increasingly argillic (clay-rich) fine fraction, orthic secondary calcium carbonate nodules (fig. 24) and iron or manganese impregnations (fig.25).

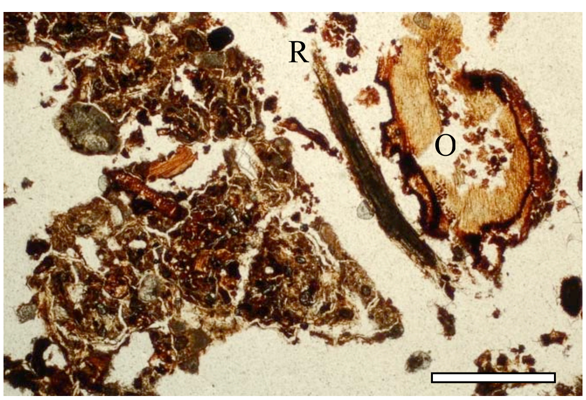


Fig. 21. Detail of sample MM2.1 showing typical A horizon features, including an open, bioturbated micro-structure, roots (R), and a large fragment of partially humified organic matter (O) containing soil fauna excrements at its center. Plane polarized light. Scale bar = 1 mm.

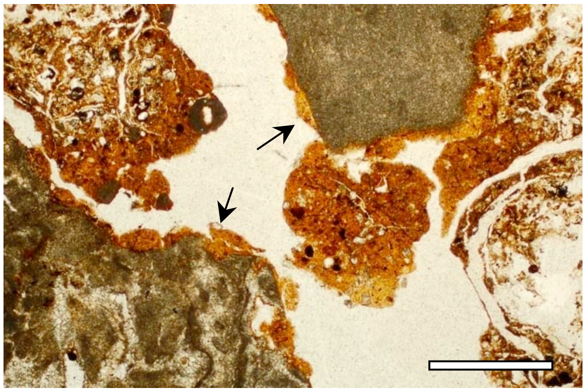


Fig. 22. Detail of sample MM2.4 showing coarse textural pedofeatures. Arrows indicate illuvial silt and clay coating limestone lithoclasts (top center, lower left) and soil aggregates. Plane polarized light. Scale bar = 1 mm.

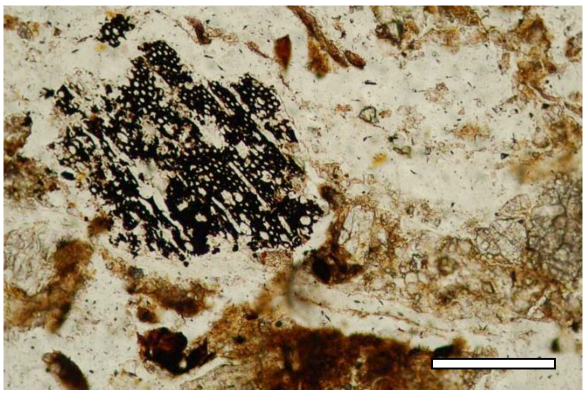


Fig. 23. Detail of sample MM3.6 showing fragment of wood charcoal, tentatively indicative of anthropogenic input. Plane polarized light. Scale bar = 200 µm.

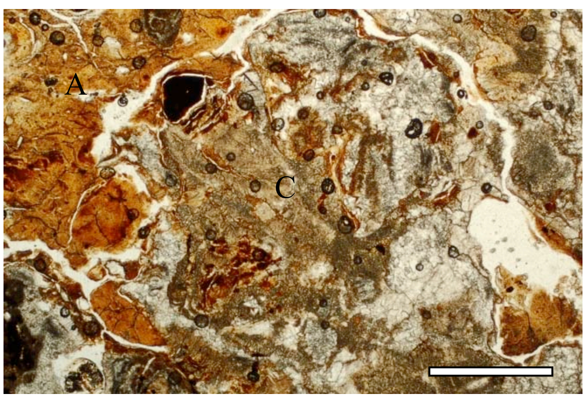


Fig. 24. Detail of sample MM3.8 showing several of the better-developed, undisturbed pedogenic features present at this depth in the profile. At center is an orthic (*in situ*) nodule of secondary calcium carbonate (C) and at left is pocket of the surrounding argillic (clay-rich) fine fraction (A). Plane polarized light. Scale bar = 1 mm.

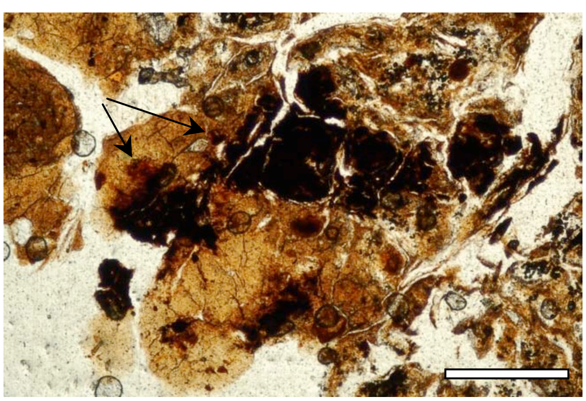


Fig. 25. Detail of sample MM3.10 showing intact iron or manganese impregnations forming within the argillic matrix (dark staining indicated by arrows). Plane polarized light. Scale bar = 500 µm.

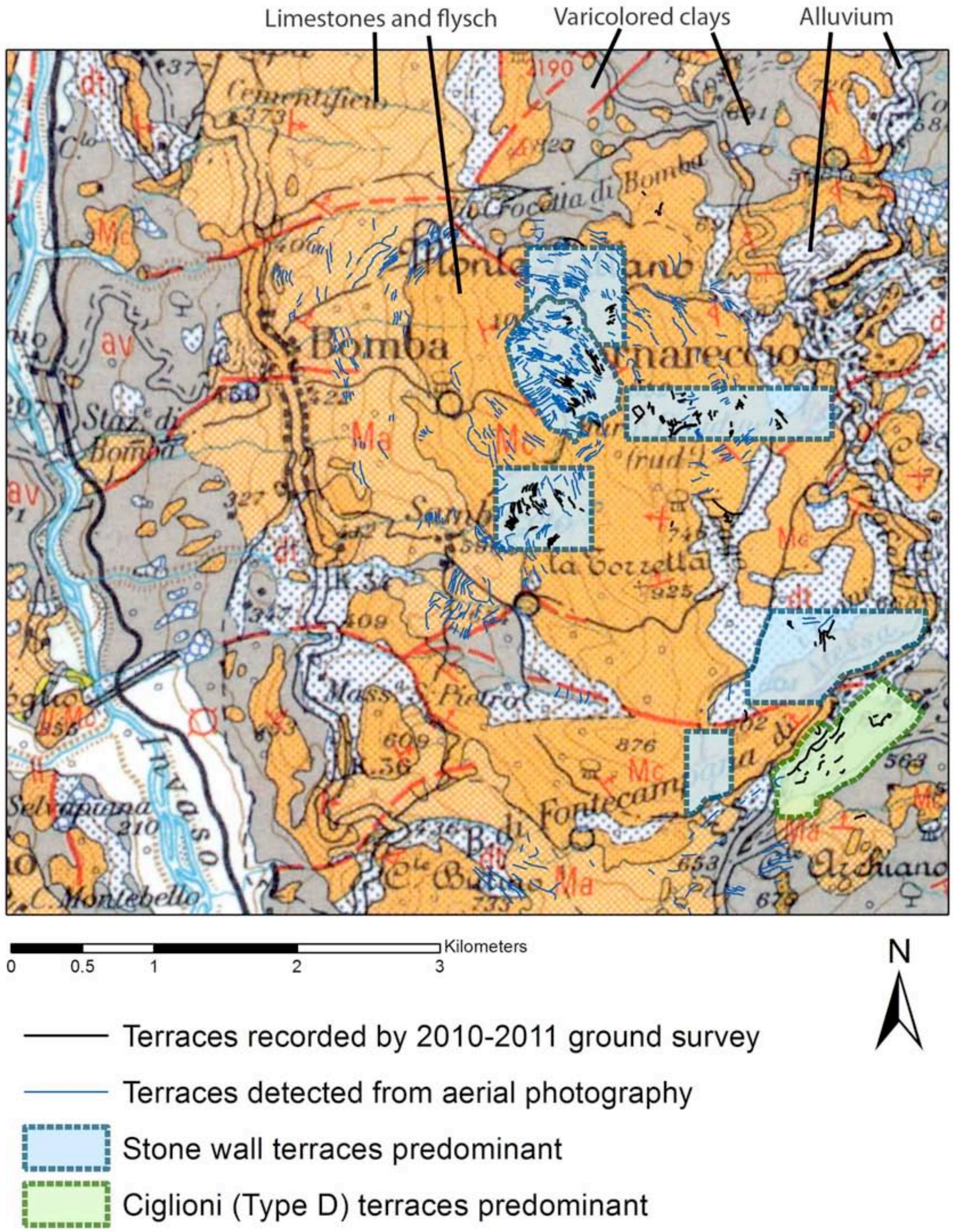
Despite its position within a definite artificial feature, this terrace soil contains remarkably few indications of anthropogenic input. The overall picture gleaned from the thin sections is of a fairly standard soil profile, with an A horizon of greater organic content and bioturbation near the top, increasing clay content with depth, and intact secondary carbonate features towards the bottom of the profile, representing either a Bk horizon of illuviated calcium carbonate, or a C horizon of the weathered limestone substrate (Wolff *pers. comm.* 29 February 2012; Goldberg and Macphail 2006: 48-50). A certain degree of recent disturbance is nevertheless apparent in the upper 20-35 cm of the profile. This disturbance is indicated by the relatively coarse texture of illuvial infillings below the A horizon, the presence of disorthic carbonate nodules (indicating that they had been shifted from their initial point of formation within the same parent material), and the fragment of wood charcoal in the center of the profile. The implication of these features is that if this terrace was ever plowed, it was only shallowly disturbed. It is clear that below about 40 cm the soil has been altered by nothing other than natural pedogenic processes (Wolff *pers. comm.* 11 April 2012).

7. *Discussion and Conclusions*

Field observations and GIS mapping of terracing within seven survey zones on Pallano, augmented by extended terrace mapping from aerial photography, suggests that the extant terraces on Pallano fall into roughly three major systems. Terraces on the west face and the northern half of the Pallano saddle are oriented west and southwest towards the villages of Bomba and Sambuceto. Terraces across these two survey areas show similar spatial organization as step terraces in close parallel series following the natural contours of the steep hillside, with Type A and B masonry predominant. Terraces on the east flank are placed sporadically, tending to avoid the steepest slopes, and often in series facing north or south, perpendicular to the main orientation of the slope. They are predominantly of type B, C, and D masonry style, with Type C especially common toward the southeast. Terraces on the east face of Pallano are components of a larger system of divided fields within the territory upslope from the village of Tornareccio. The south flank of Pallano, below the spring line, exhibits numerous examples of Type D terraces among the presently cultivated fields in the territory of San Giovanni. These are widely dispersed, lynchet-style fields that appear to be the result of different factors of placement and construction than the dense systems of stone stepped terraces at higher elevations. The upper ridge and the southeastern flank near Lago Nero may represent transitional zones between the three major systems. Average wall stone size of 28 cm on the upper ridge closely matches the average on northeast flank. Similarly, the average wall stone size in the Lago Nero area, 25 cm, is the same as that for stone terraces in the San Giovanni zone. The larger size of terrace walls around Lago Nero, with average length of 58.67 m and maximum of 243.7 m, is also suggestive of a transition to the broader fields of the southern flank, where the average wall length was 75.5 meters and maximum 418.8 meters.

The GIS predictive model, as noted above, does account for many of the systems, but does not totally encapsulate the spatial distribution of terracing on Pallano. Important variables are missing from the model and others variables may be less important than originally supposed. While many of the terraces do favor sunny hillsides, others exhibit northwestern and northeastern aspects, receiving less sunlight over the course of the year than more southerly aspects. While many shallow slopes high on Pallano are terraced, many steeper slopes at lower elevations are left un-terraced, suggesting that bedrock and soil depth must be playing a key role. A rough projection of the surveyed and remotely-sensed terraces onto a scanned geologic map of the area shows stone wall terraces distributed consistently across areas of limestone and flysch, while the transition to Type D terraces on the south flank corresponds to areas of colluvium and Miocene/Pliocene clays (Fig. 26). The fact of a different bedrock type making up most of Pallano, the ready availability of limestone scree – which must be removed for easier

Fig. 26: Terraces projected onto Foglio 147 of the Carta Geologica D'Italia. Terracing on Pallano, especially stone-wall terracing, corresponds closely to the presence of high limestone bedrock. (Map source: Servizio Geologico D'Italia, 1970)



cultivation – combined with steep slopes, seems to be the dominant factor influencing terrace placement. The relation of terraced areas to springs and settlement sites (both modern and archaeological) is informative. The terraces favor some proximity to these areas but are not, for the most part, immediately adjacent. Their distance from springs and drainage areas reinforces the interpretation that these are dry-field terraces watered primarily by rainwater rather than irrigation. The distance from springs and cultural sites suggests that settlement zones and agricultural zones on Pallano may be distinct from each other.

The GIS is notably lacking in data on soil characteristics and surface geology in the Pallano area, which were not available to the project in digital form when the models were developed. Given the functions of agricultural terracing, namely to consolidate thin soils and make use of field stones that would interfere with cultivation, these variables likely play a significant role terrace placement (Bevan, Frederick and Krahtopoulou 2003: 224; Grove and Rackham 2001: 110; Rackham and Moody 1992: 125). Much of the soil on the upper slopes of Monte Pallano is thin and rocky, and piles of scree formed from the fracturing limestone bedrock are frequent. The terraces on Monte Pallano all appear to be constructed of such stones, collected from the surrounding area. Terracing appears to be prompted as much by the desire to remove stones from the fields as much as the need to create a gentler slope on which to grow crops. Soil and the prevalence of stone building material may be the crucial factors for determining which slopes are terraced and which are not.

An element that is especially difficult to account for in computer modeling is why certain areas of Pallano that seem to be ideal in terms of slope, aspect, soil and bedrock composition, and ease of access are *not* terraced. The south-west face, for instance, immediately below the southern peak at La Torretta, appears as uncultivated forest and scrub in the 1943 aerial photography. Much of the southern flank above Acquachiara, with the exception of some precipitously steep areas, appears to be ideal for terrace cultivation, but was apparently reserved as pasture and woodland. The same is the case for the southern half of the upper Pallano ridge, which is topographically and geologically very similar to the densely terraced northern ridge. Ground survey found this slope to be unterraced, open meadow, and the historical aerial photography indicates that this was also the case in the 1940s.

Terracing on Pallano appears to be part of a larger system of management and division of the productive landscape, where some slopes are reserved for planting, some for animal pasturing, and others for permanent, managed forest and scrub. This latter is also an important productive component of the Mediterranean agricultural landscape, providing timber, wood fuel, and food from hunting and foraging (Forbes1996). It may be that the inhabitants of the area found it more efficient and productive to intensively cultivate the northern half of the upper ridge, while leaving the southern half for animal grazing. The terraces on the steep northern slopes, an area predicted to be less desirable for terracing, may have been planted with specific crops that favor less direct sunlight. The series of ridges on the eastern face of Pallano meant that cultivation could concentrate on these gentler slopes, with dispersed terracing of the steeper areas as needed. The extensive plains on the southern flank below the spring line, with their gentler contours and deeper soil, may have been sufficiently productive for the early modern inhabitants of San Giovanni, such that they did not need to clear the rocky slopes above the spring line for cultivation terraces; this area was more productive as managed woodland.

The variation in spatial organization of terracing across the ridge, while tied to natural constraints of slope and topography, probably reflects different phases of landscape modification and different socio-economic motives behind the division of agricultural land. The close parallel association of terraces on the western flanks and northern ridge is suggestive of a more corporate agricultural system, where farmers were coordinating their construction efforts, creating a network of terraces that brought nearly the entire hillslope into production. The spacing of risers and their close association to the natural contours of the slope indicates that terracing was motivated as much by the need to tame the steep topography as the need to divide landholdings. The terraces on the east face are much more frequently associated with large, bounded fields along the shallow ridges. There is less of a need here to control soil loss, and more of the energy spent in removing stones from the cultivation soil is invested in building field walls to mark property lines.

Test excavations of terraces on the west flank of Pallano, aimed to investigate features of terrace construction and stratigraphy, had mixed results. They clarified certain features of construction: namely that the wall was built directly onto the existing ground surface, with an outer face of cut stones, and filled in behind with a packing of smaller stone rubble; this latter feature is fairly common in terrace construction, designed for better drainage and stability of the soil (cf. Forbes 2008, Frederick and Krahtopoulou 2000, Treacy and Denvan 1998). We successfully located a buried palaeosol under the wall of Terrace 40; a block sample of this soil profile awaits thin section analysis, which may prove informative in identifying datable material and effective future sampling techniques. Test pits dug into the terrace fill, however, revealed minimal stratigraphic variation across the profile. All the profiles showed 5-10 cm of a slightly darker, organic layer, which can be interpreted as an incipient A soil horizon that has developed since the cessation of cultivation and plowing on the terrace. The rocky clay-rich sediment 30-40 cm deep, which underlies this, seems to represent the original plow zone. Only in the case of Terrace 42 T.3000 were we able to locate what seemed to be the end of the plow zone. The sediment below this appeared to be natural weathered subsoil, rather than a palaeo-A horizon. The lack of anthropogenic disturbance or stratified deposition in the terrace fill meant that we could not point to any layer that definitively pre-dated the construction of the terrace and may yield datable samples.

In the absence of direct evidence for dating the phases of terrace construction on Pallano, we must turn to more inferential lines of evidence, such as site association, and comparative historical and ethnohistorical data on areas of high population and agricultural intensification in central Apennine Italy. These lines of evidence will be the focus of discussion in the following chapter.

Chapter 4: Reconstructing past land use on Monte Pallano

1. Introduction

The survey of agricultural terraces on Monte Pallano has mapped large field systems across the ridge that attest to the enormous amount of land on the upper slopes once used for agricultural production. Major systems of terracing are apparent on the north ridge and west face, the south face below the spring line, and on the slopes of the east and north face. Terraces are associated with other agricultural structures including stone boundary walls, field huts, and stone heaps from field-clearing, showing that they are a component of a careful division of the land and restructuring of the rocky slopes to be more suitable for cultivation. This chapter will discuss the evidence for the chronological development and ecological significance of this agricultural system, and propose directions for future research.

2. Probable dating of Pallano terracing

Excavations found a minimal amount of lithostratigraphic development in the terrace sediment profiles. The redistribution of the topsoil during terrace construction and the effects of plowing seem to have obliterated any trace of the preexisting ground surface, except for directly underneath the terrace wall. There are no clear phases of abandonment and reuse, which suggests that this system of terraces represents a single phase of construction. Though all of the excavated terrace profiles did show signs of at least A and B soil horizons, these were not strongly distinguished. The lack of strong soil horizon development may in itself indicate a recent date for the particular terraces excavated. Similar results from excavation and micromorphological analysis of terrace sediments by French and Whitelaw on Amorgos, and by Frederick and Krahtopoulou on Kythera, have been interpreted as indicating recent construction dates for the terraces (1600-1800 or later). These studies also note, however, that recent terracing may have obliterated the traces of earlier terracing through the process of redistributing sediment and building new walls. The soil profile of Terrace 42 was more developed, supporting the hypothesis that more degraded terraces such as this one may be older. Determining exactly how old will require a more systematic study of soil development on the Pallano ridge.

The vegetation cover in terraced areas offers at least a rough estimation of when certain areas were abandoned in relation to others. The thick forests from 600 to 900 meters indicate that these mid-range slopes were abandoned and overgrown earlier than the uppermost ridge. Patches of grassy meadow on the level areas of the east face and the ridge of Lago Nero appear to have been cleared for cultivation until fairly recently. Most of the forested areas, however, are visibly quite young, and so do not give great temporal depth for terrace abandonment. Historical aerial photography from the early 1940s shows much of Pallano denuded of trees, proving that most of the present forest has developed over the last 70 years. A study of vegetation recolonization on abandoned terraces on Antikythera by Palmer et al. has demonstrated that cultivated land returns to dense woody vegetation within 20-60 years in a Mediterranean environment. We therefore cannot assume that any of the extant terraces on Pallano were abandoned before the 20th century. Vegetation growth also seems to contribute to the rapid degradation of abandoned terraces. Trees were frequently observed growing in thick clusters directly behind terrace walls, where the soil is thickest; terraces can even be identified in aerial photographs from artificially straight lines of trees running parallel to the slope contours. The roots of the trees growing behind the walls push the stones out of place, causing the wall to slowly collapse and erode away. Even in cases where a wall is badly eroded and thickly overgrown, this does not necessarily indicate advanced age.

In terms of determining the original construction date of the Pallano terraces, lacking evidence from excavation, we must rely on indirect means, such as historical evidence for periods of high population and agricultural activity, and the relationship of terrace systems to ancient and modern settlement sites. The major clusters of terraces appear to orient towards the modern villages in the area, suggesting that their construction is contemporaneous to the growth of these villages. The terraces on the south face of Pallano, in the vicinity of Acquachiara and San Giovanni, are most directly associated with ancient sites, and archaeological excavations indicate that this has been used as an agricultural area for a long span of time. The growth of towns and villages in upland areas and the clearance of forested hillsides for cultivation during the 16th through 19th centuries is supported by the historical record. Historical and ethnographic data from other Mediterranean rural communities offer models for understanding how terracing functioned within the early modern agricultural system.

3. Terracing in the early modern landscape

The terraces we see on Pallano today are plausibly the result of growing population and intensification of land use that developed gradually since the later middle ages, and reached its apogee in the 19th century. As discussed in chapter 1, this growth in population and expansion of agriculture is well attested historically for Italy and the larger Mediterranean region (e.g. Sereni 1967). Rising populations and the growth of towns in Italy during the late Middle Ages and Renaissance gradually increased the amount forest clearing and exploitation of hillsides. Terracing techniques are attested in written records by the 16th century. The explosion of Italian population during the 18th century led to a systematic exploitation of upland areas for agriculture on an unprecedented scale. This process was augmented by the abolition of feudalism in the early 19th century and the division of feudal landholdings, in which large amounts of the best land were seized by wealthy families, and small farmers were driven to cultivate more marginal areas in the uplands. The frequent association of Pallano terraces with stone field-boundary walls that serve to further divide the landscape into smaller plots is suggestive of this 19th century scramble for land.

The agricultural regime on Monte Pallano in the 18th-early-20th centuries may have been quite similar to that documented by Hamish Forbes for the peninsula of Methana, Greece: largely self-sufficient communities of farming families would have divided the landscape vertically, the territory of each village encompassing land at all elevations. Households would use the many microclimatic zones of the mountain landscape to grow a variety of crops. A rotation cycle of grain followed by legumes to maintain soil fertility would have predominated, augmented by vegetable garden plots. Vines and orchards would have favored the lower slopes, and hardier crops such as barley and vetch would have been planted on the highest terraces. The division of the agricultural land on Pallano seems to have also included areas reserved for animal pasturing and managed forest for wood fuel, grazing, foraging, and hunting. Terracing allowed more land to be brought under cultivation. Construction and regular maintenance of the terraces and a labor-intensive system of cultivation provided work and food for the large rural populations.

Ethnographic approaches to terrace agriculture have shown, above all, that terracing is a highly practical and indeed ecologically advantageous approach to productive cultivation of mountainous landscapes, if also a more laborious one. Stone-wall terracing is motivated first and foremost by the need to remove stones from fields and consolidate limited soil. In an area like Pallano, any effort to cultivate on the steep rocky slopes above 700 meters would be significantly less productive without major modifications to the structure of the slope, i.e. deepening of the arable soil and consolidation of loose stones into terrace walls. It seems unlikely that this was a novelty introduced due to sudden concerns with erosion during the Renaissance, as the traditional historical narrative would suggest (Sereni 1967: 157-164, 253-254). Forbes' study of agricultural communities on Methana has shown that settlements in rugged upland areas have the advantage of being able to cultivate numerous micro-zones suited to a wide variety of subsistence crops; peasant communities in mountainous areas are thus able to attain a high degree of self-sufficiency. It is conceivable that the locations of modern villages on Pallano represent the most strategic positions for exploiting the various micro-regions of the ridge. Terracing on the upper slopes could indicate self-sufficient agricultural villages cultivating favorable soils and microclimates for particular crops, rather than a last-resort by the most impoverished farmers to cultivate the least desirable land.

4. Agricultural intensification in antiquity

Archaeology has shown that the area of Monte Pallano has been a focal point of agrarian settlement for thousands of years, begging the question of whether landscape modification through agricultural terracing has been applied in this area beyond just the modern period. The evidence from Monte Pallano at Acquachiara trench 8000 shows that this upland area was used for agriculture during the 6th century BCE. The botanical remains from this site point to an agricultural regime similar in many ways to that of more recent Mediterranean rural communities: mixed subsistence crops well-suited to the mountain landscape, dominated by grains and legumes and augmented by grape production (Shelton 2009). The prominence of vetch in the botanical assemblage from Acquachiara 8000 is particularly reminiscent of early modern crop rotations. The nature of the site -- an agricultural processing area built on an artificial terrace -- is suggestive that some amount of hillside terracing may have developed in antiquity. Though firm archaeological evidence for ancient terracing is rare and often spurious, a handful of case studies from Greece and the Aegean islands have indicated that the technology was available from an early period.

Scholars have argued for a significant population growth and intensification of agricultural exploitation in central Italy during the late Classical period and early Roman Empire. The evidence from survey and excavation in the Sangro Middle Valley, with comparable data from the Biferno Valley, points to a period of dense rural habitation in the late Iron Age through the early Roman period. The development of upland fortified centers and growth of nucleated villages in the lowlands during the Iron Age was accompanied by increased social stratification and agricultural intensification. The Neolithic subsistence base of wheat, barley, and legumes was augmented by cultivation of olives and wine, and increased stock-keeping and wool production. The process of intensification reached its height in the late Iron Age and early Roman periods, when the rural landscape was characterized by a dense network of hillforts, sanctuaries, and scattered villages and farmsteads, and an agricultural regime centered on cereal, vines, olives, and wool.

A complex agricultural economy based on the production of a large variety of both subsistence and export crops, as well as stock-raising, would require careful division and management of the productive landscape. Large areas of agricultural land and an agricultural surplus were necessary to support large populations in central Italy, which scholars argue must have existed given the success of the Samnites' military ventures in the Classical period. Given the settlement distributions of this period, and particularly the preponderance of Samnite settlement at high elevations, a certain amount of this agricultural intensification must have included the cultivation of steep and rocky hillsides. The distribution of modern terracing, which is closely associated with the geologic structure of the Pallano ridge, suggests that terracing is a necessity for productive agricultural exploitation of the area.

The varied ancient crop base of wheat, legumes, olives and vines would have benefited from the exploitation of the varied microenvironments offered by the mountain landscape. Certain crops grow better in particular environments than others. Olives, for example, cannot be grown reliably at high altitudes; crops like barley and vetch, on the other hand, are much more tolerant of thinner soils and cooler temperatures. We might imagine a coordinated, valley-wide system of production and exchange in the Sangro Valley in antiquity, in which the coastal plains of the lower valley are planted primarily with wheat and olives (as they are today), and the higher elevations of the middle and upper valley devoted to vines and legumes such as bitter vetch. Such spatial distributions could develop on the meso-scale as well: at Monte Pallano, the steep slopes and thin soils of the limestone ridge could be terraced to grow barley and vetch, with some vines, and lower elevations (such as the plains below Acquachiara) devoted to olives and grains; animal pasturing could be carried out across all elevations, and worked symbiotically into a system of crop rotation and fallow.

If agricultural terracing occurred during antiquity, the most likely time for it seems the late Iron Age and Classical period, when density of rural settlement and agricultural exploitation of the uplands appears to have been at its height. Large-scale upland agriculture probably declined during the Roman Empire, as Roman agricultural settlement tended to favor lower elevations and landholdings were consolidated into large estates. Roman exploitation of the area was more specialized, focused on transhumance and animal husbandry. The major drop in settlement and activity in the countryside during late antiquity suggests a further decrease in the amount of cultivated land, and probably abandonment of difficult upland zones. A small rural population and a largely pastoral economy persisted into the Middle Ages, until the late Middle Ages and Renaissance when we see the growth once again of settlement in the uplands and the increasing use of the steep hillsides for agriculture.

In the mountainous landscape of central Italy, there must be a threshold of how much land can be sustainably cultivated without recourse to major landscape modification. At some point, as population increases, as society becomes more complex and stratified, and as pressure on agricultural resources correspondingly increases, that threshold will inevitably be crossed. Much of the terrain is steep and geologically unstable, and successful cultivation in many areas requires the mitigation of erosion and soil loss through terracing.

Terracing is itself a labor-intensive process that requires a certain amount of extra manpower and social cohesion/cooperation in the first place. Terracing is thus a reflexive process: terracing (a physical manifestation of intensified land use) is a product and a reflection of increased population and social complexity, that in turn creates increased population and social complexity – because it allows for more food production and the process of building terraces on a large scale requires social cooperation and coordination and careful division of the land.

A consideration of these ecological factors is vital in order to substantiate the historical narrative that claims that over the course of the first millennium BCE there arose a distinctive central Italian culture that was socially complex and stratified, with an elite warrior class that was supported by an intensive system of agricultural production and a high rural population. Also essential is the acquisition of more archaeological data on settlement, crops, and landscape organization. Archaeological research must continue to address the questions of what ancient peoples in the Sangro Valley were growing, where they were growing it, and how they adapted themselves culturally and economically to the mountain environment, as well as how they adapted the mountain landscape to meet their own productive needs. Agricultural terracing, as an especially conspicuous example of human interaction with the environment, is a useful focus for examining the interplay between human ecology and the social and demographic history of the region.

5. Future Work

Terraces are worthy of continued study by the SVP, and will be approached most effectively through a combination of archaeological, geological, botanical and ethnohistorical methods. The excavations attempted in this study found that the most information on the construction of the terrace was found by excavating around the wall. Future terrace excavations should focus on characterizing the stratigraphic profile of the sediments immediately behind and underneath the wall. Such excavations of terraces in the Maya lowlands of Belize have been successful in obtaining radiocarbon dates from buried organic soil A-horizons (Beach et al.

2002). Given that a complete A-C soil profile was found excavating beneath the wall of Terrace 40, a similar program of sampling may be able to yield calibrated carbon dates for terraces on Pallano.

Any ancient terraces, like their modern counterparts, would have quickly become overgrown and decayed after they were abandoned. Ancient terraces are probably only visible in cases where they continued to be cultivated after antiquity. The area of Acquachiara is strongly suggestive of long-term and continuous agricultural exploitation. The terrace at Acquachiara trench 8000, and other terraces like it, may be the most fruitful in terms of future excavation and geologic sampling.

The lack of anthropogenic disturbance in the soil from Terrace 42 is both surprising and puzzling, and merits further investigation into soil development on Pallano and the effects of human modification of the slopes on the sedimentary record. A systematic program of soil sampling across Pallano, both in terraced and non-terraced areas, could yield much information on the differences in horizon development and fertility between natural and anthropogenic soils in this region. Standard procedures of soil sampling, description, and chemical analysis have been applied with great success to terrace studies in the New World (E.g. Beach *et al.* 2002; Sandor *et al.* 1990). This research naturally requires the expertise and attention of an experienced pedologist, and was well beyond the scope of the present study.

A more thorough and focused remote sensing study of vegetation recolonization in the Middle Valley can elucidate the growth of forest in response to the decline in cultivation over the course of the 20th century. The SVP should endeavor to acquire more historical aerial photography for the region showing vegetation changes over a time span of several decades. Color bands in Landsat, Quickbird, or ASTER Satellite imagery, if these can be obtained by the project, may be used to develop spectral signatures for areas of low vegetation, mature forest, and middle-phase forest re-growth. Classification of aerial imagery can be used to track vegetation changes and quantify the growth of forests and the abandonment of terraced hillsides over the past fifty years.

Ultimately the most information on terrace agriculture in the Sangro Valley may come from historical and ethnographic research on agricultural practices in the 19th and early 20th century. Archival work examining census records, property records, and historical maps will provide sources of information on property ownership and land division in the recent past. Though fewer and fewer people now living around Monte Pallano were alive during the early part of the 20th century, many residents of these communities are still knowledgeable about traditional forms of agriculture, through personal experience in the agricultural sector and family history. Interviews with local residents could teach us far more about agricultural practices in the Sangro Valley than can be ascertained from the archaeological record alone. It is this kind of detailed information on crop choices, locational choices, soil characteristics, harvesting practices, and systems of crop rotation and fallow, that will allow archaeologists to model agricultural production in this region in antiquity.

6. Conclusions

A consideration of how ancient peoples in the Sangro Valley organized and modified their mountain landscape for agricultural production is an essential component in reconstructing the dynamics of past society, culture, and environment. Anthropological studies of mountain agriculture have demonstrated that terracing reflects elements of social organization and cultural ideology, besides its intrinsic ecological and agronomic benefits. The evidence from the Pallano terraces indicates that they were in use during the recent past, offering the possibility that an ethnohistorical study of early modern agriculture in the Sangro Valley may be highly informative for investigating the long-term human ecology of the region. The landscape of central Italy is diverse and challenging, and soil management through terracing appears to be vital to successful cultivation in the steep terrain of the mountains and ridges, which have been favored as central places throughout the region's long history. Scholars have long been puzzled at how the ancient Samnites developed a complex society without developing the same hierarchies of urban and rural settlement seen elsewhere in Italy. A systematic and labor-intensive agricultural exploitation of the landscape could have formed an important component of Samnite social complexity. Continued archaeological work, with a holistic focus on both settlements and fields, will bear this out. This study was, by nature, a preliminary and exploratory investigation of a neglected feature of the cultural landscape of Monte Pallano, and has opened many more doors for investigation. The work of the 2010-2011 terrace survey and mapping project established a geographical understanding for terracing on Pallano that can guide future research on these features. Continued study of agricultural terracing in the Sangro Valley will greatly add not only to our understanding of long-term human settlement in this particular region, but contribute to a broader knowledge of Mediterranean ecology and intensive agriculture in mountain landscapes.

APPENDIX A: Statistical summary of terrace survey data. Wall and field characteristics by area.

	Survey Area						
	West face	Upper ridge	Northeast face	East face	Lago Nero ridge	South face (San Giovanni)	Total
Number of terraces	51	35	18	49	16	21	190
Frequency Type A	27	3	3	7	2	4	46
Percent Type A	**52.94%**	8.57%	16.67%	14.29%	12.50%	19.05%	24.21%
Frequency Type B	16	28	9	31	7	3	94
Percent Type B	31.37%	**80.00%**	**50.00%**	**63.27%**	43.75%	14.29%	49.47%
Frequency Type C	1	9	1	7	8	1	27
Percent Type C	1.96%	25.71%	5.56%	14.29%	**50.00%**	4.76%	14.21%
Frequency Type D	6	3	5	4	0	15	33
Percent Type D	11.76%	8.57%	27.78%	8.16%	0.00%	**71.43%**	17.37%
Frequency pocket terraces	0	2	0	1	0	0	3
Percent pocket terraces	0.00%	5.71%	0.00%	2.04%	0.00%	0.00%	1.58%
Frequency of associated field structures (walls, stone piles, huts)	18	23	9	36	11	1	98
Percent with associated field structures	35.29%	65.71%	50.00%	**73.47%**	68.75%	4.76%	51.58%
Most common wall integrity	4	4	2	4	3	1	4
Most common vegetation cover	1	2	4	1	3	5	1
Most common vegetation type	Young forest, grassy under-growth	Meadow, pasture, grass	Young woods / meadow	Young forest, grassy under-growth	Meadow, pasture, grass	Cultivated land	Young forest, grassy under-growth

APPENDIX A: Continued

		Survey Area						
		West face	Upper ridge	Northeast face	East face	Lago Nero ridge	South face (San Giovanni)	Total
Wall length (cm)	Maximum	10100	10800	15000	17400	24370	41883	41883
	Minimum	500	290	850	280	500	685	280
	1st quartile	2000	2756	1215	1600	1375	2000	1800
	3rd quartile	4700	5896.5	2468	4550	8615	8737	5050
	Mean	3875	4447	2942	3559	5867	7552	4382
	Median	3850	4480	1907.5	2500	2860	3900	3300
	Mode	4400	#N/A	#N/A	4950	1000	#N/A	2000
	Range	9600	10510	14150	17120	23870	41198	41603
	Interquartile range	2700	3140	1253	2950	7240	6737	3250
	Standard deviation	2327	2481	3457	3484	6590	9357	4591
Wall height (cm)	Maximum	500	188	400	300	200	500	500
	Minimum	60	36	85	45	55	40	36
	1st quartile	85	65	102.5	85	110	95	85
	3rd quartile	130	112.5	150	145	140	187.5	140
	Mean	122	90	145	122	124.5	173	124
	Median	110	88	131.5	110	130	140	110
	Mode	80	60	150	110	110	95	110
	Range	440	152	315	255	145	460	464
	Interquartile range	45	47.5	47.5	60	30	92.5	55
	Standard deviation	73	33	73	54	35	132	72

APPENDIX A: Continued

		Survey Area						
		West face	Upper ridge	Northeast face	East face	Lago Nero ridge	South face (San Giovanni)	Total
Wall thickness (cm)	Maximum	140	270	140	300	400	50	400
	Minimum	45	35	40	35	44	35	35
	1st quartile	62.5	52.5	54	57.5	70	40.5	60
	3rd quartile	115	107.5	104	110	280	48	113
	Mean	92	89	84	92	180	44	101
	Median	95	75	85	80	130	46	80
	Mode	60	50	54	120	60	#N/A	60
	Range	95	235	100	265	356	15	365
	Interquartile range	52.5	55	50	52.5	210	7.5	53
	Standard deviation	31	51	34	59	122	8	69
Stone size -- Average (cm)	Maximum	73	46	53	52	34	32	73
	Minimum	18	17	17	13	16	20	13
	1st quartile	22	22	24	23.5	20	22.5	22
	3rd quartile	36	33	29	30	28	30	31
	Mean	31	28	28	28	25	25	29
	Median	28	25	26	27	24.5	23	27
	Mode	21	25	21	24	#N/A	#N/A	30
	Range	55	29	36	40	17	12	60
	Interquartile range	14	12	5	6.5	9	7	9
	Standard deviation	13	8	9	8.	6	5	10

APPENDIX B: Sample survey forms and recording guides

(1) 2011 Survey form (*This season's forms were filled out electronically on the project iPads)

Sangro Valley Project TERRACE SURVEY RECORDING FORM **2011 Season**

Terrace No.: UTM Coordinates: (1) (2)

Zone/transect: (3) (4)

Orientation:

Length of wall (m):

Height of wall (cm):

Width of wall (cm):

Width of wall stones (cm):
(1) (2) (3)

Estimated slope of terraced field
☐ Level (c. 0-2°)
☐ Gentle (c. 2-20°)
☐ Moderate (c. 20-35°)
☐ Steep (>35°)
☐ Varied

Estimated natural slope
☐ Level (c. 0-2°)
☐ Gentle (c. 2-20°)
☐ Moderate (20-35°)
☐ Steep (>35°)
☐ Varied

Construction style:
☐ Type A (coarsed, faced) ☐ Type B (coarsed/semi-coarsed, unfaced)
☐ Type C (piled stones, uncoarsed, unfaced) ☐ Type D (no visible stone wall)
☐ Other: ____________________

Comments:

Describe surrounding vegetation (check all that apply):
☐ Dense ☐ Light ☐ Forest/woods ☐ Young trees ☐ Old trees
☐ Bushes/shrubs ☐ Grassy ☐ Open field/pasture/meadow ☐ Ploughed/planted field
Comments:

Describe state of preservation of terrace:

Wall integrity:	(perfectly intact)	1	2	3	4	5	(entirely eroded)
Vegetation cover:	(none)	1	2	3	4	5	(entirely covered)

Comments:

Associated structures (check all that apply):
☐ field walls ☐ stone piles ☐ other terraces ☐ huts/buildings ☐ paths
Comments:

Other comments:

Sketch:

Date: Recorder(s):

(2) 2010 Survey form

Sangro Valley Project TERRACE SURVEY RECORDING FORM **2010 Study Season**

Terrace No. Transect
GPS points:

Orientation (degrees)

Length of wall (m)

Height of wall (cm)

Estimated width of wall (cm)

Slope of terraced field
☐ Level (c. 0-2°)
☐ Gentle (c. 2-20°)
☐ Moderate (c. 20-35°)
☐ Steep (>35°)
☐ Varied

Natural slope
☐ Level (c. 0-2°)
☐ Gentle (c. 2-20°)
☐ Moderate (20-35°)
☐ Steep (>35°)
☐ Varied

Sample sizes of wall stones (cm)
1: 2: 3:

Type:
☐ step terrace ☐ braided terrace ☐ pocket terrace ☐ lynchet ☐ check-dam/weir

Water:
☐ dry-field ☐ irrigated

Masonry (tick all that apply):
☐ uncut/field stones ☐ rough-cut ☐ worked stone ☐ faced
☐ piled ☐ coursed ☐ no stone wall / stone wall not visible

Vegetation:
☐ Forest/woods ☐ Pasture ☐ Maquis ☐ Fallow ☐ Ploughed
☐ Cultivated: ____________________
Comments:

Preservation
Erosion/washout: (perfectly intact) 1 2 3 4 5 (entirely eroded)
Lichenization: (no lichen) 1 2 3 4 5 (entirely covered)
Comments:

Related features – field walls, scree piles, other terraces, paths, etc.

Other comments:

Date Recorder

Guide to the preservation 1-5 scales

Wall integrity

1. Very poor: Wall is almost completely gone, only discernable by a few stones and/or a slight break in slope. It may not be even 100% certain that there is a terrace here!
2. Poor: Wall is discernable but very badly eroded. Only a few sections of stone wall remain.
3. Fair: Much of the wall is intact, but may be broken/washed out in several places.
4. Good: Most of the wall is intact. There may be stones fallen out in a few places along the wall, but most of the length of the wall is still in place and visible.
5. Very good: Wall is almost perfectly intact. All stones in place. No washout.

A "very good" terrace:

A "very poor" terrace:

Vegetation cover

1. Very light: Wall is pristine. Only grass, and perhaps a few shrubs or vines along the wall. Minimal lichen and/or moss.
2. Light: Most of the wall is visible but there may be some patches of bushes, shrubs, young trees, or vines. Some lichen and/or moss cover.
3. Medium: Several sizeable patches of vegetation obscure the wall, but it is still mostly visible. Moderate lichen and/or moss cover.
4. Heavy: Patches of the stone masonry are visible, but it is mostly covered with bushes, trees, vines, moss, and/or lichen.
5. Very heavy: Stone wall is entirely covered with vegetation (bushes, trees, shrubs, vines) moss, and/or lichen.

Guide to the masonry typology:

Type A: Terrace walls with coursed and faced wall stones. "Coursing" refers to stones that are assembled in a (more or less) ordered horizontal pattern; i.e. one line of wall stones is laid down, then another on top of it, and then another line on top of that, producing clear rows of wall stones. "Facing" refers to carving the exposed edges of the stones to make a smooth wall face.

Type A terraces bear the appearance of being carefully constructed, with attention given to making sure that the stones fit closely together and that the wall is very stable.

Type B: Terrace walls with coursed, or semi-coursed, but mostly unfaced wall stones. These terrace walls are assembled (probably more quickly) from rough-cut stones. The open face of the wall has not been carved smooth. Some effort has been made course the stones, but they generally have a more jumbled appearance compared to Type A.

Type C: A terrace wall composed of piled, uncut stones. No attempt is made to course or face the stones.

Type D: A terrace with no visible stone wall. The terrace is discernable by a sharp, artificial change in slope. It may be lined with dense trees and shrubs, or it may just be covered by grass. There may be a few stones scattered along the embankment that suggest a buried stone wall, or a former stone wall that has now eroded away.

APPENDIX C: Descriptions of Terrace 42 sediment profile thin sections

MM2.1: Loose peaty topsoil with large pores. Dark gray-brown clay matrix. Several large roots and woody fragments. Fine to course sand throughout, composed of quartz, feldspar, and carbonates. Occasional muscovites. Larger limestone clasts >1 cm toward the bottom of the section. Organic material concentrated towards the top.

MM2.2: Medium gray-brown clay matrix. Organic material similar to slide 1, particularly frequent towards the top of the section. Inclusions range from fine sand to subangular--angular limestone fragments of maximum diameter ca. 1.25 cm.

MM2, #3: Similar clay matrix and range of inclusions as #2. Many carbonate particles 0.5 mm or less. Dark brown/black opaque fragments (possibly organic) are frequent. A few large roots and woody fragments. Possible muscovite. Possible chert fragment. Possible Pyroxene.

MM2, #4: Same matrix and inclusions as #3. Limestone fragments slightly larger – ca. 1.5 cm. Two apparent types of clay -- a darker gray-brown, and a light tan-brown clay that coats larger pores and carbonate fragments. Rusty-red, semi-translucent minerals concentrated in these pockets of tan clay, may be iron oxide. Some muscovite crystals.

MM2, #5: Very frequent limestone fragments (0.1 mm – 1.3 cm), still poorly sorted, but more numerous – especially the finer sand-sized particles – perhaps up to 30%. Opaque black particles throughout (ca. 01.-0.15 mm avg) and a 1mm globular fragment. Again there are pockets of light tan clay. Fine-grained quartz and feldspar appear less frequent.

MM3, #6: Similar fabric as above, medium brown clay with poorly sorted angular/sub-angular limestone clasts up to 1.3 cm diameter. Numerous mid-range birefringence minerals of varying shape and surface texture (some muscovite). Several clusters of fine-grained, low birefringence particles -- potentially chert. Pores filled with silt-sized grains of low birefringence mineral.

MM3, #7: Same fabric as above. Angular to subangular limestone clasts, poorly sorted but slightly more frequent in the center of the section. *Macro-examination:* Fragments of iron/manganese nodule are visible to the naked eye. Clay matrix ranges in color from gray-brown to orange-brown. *Under microscope:* Light-colored clay continues to become more prominent, though the slide appears to vary in thickness and the clay appear very dark in some areas.

MM3, #8: Same inclusions as above. Poor sorting. *Macro-scale:* Clay matrix beginning to change color – orange-brown clumps black iron/manganese nodules. The reddish-orange clay visible at the macro-scale appears to correspond to the pockets of light tan clay in the thin sections.

MM3, #9: Poorly-sorted angular/sub-angular/sub-rounded limestone clasts continue to be frequent; one very large limestone fragment with rough edges breaking off into smaller pieces with brown and black mottling along the edges. The clay matrix seems to become much denser. In block section, high quantity of red-orange clay. High quantities of iron/manganese impregnations and nodules. Concentrations of the light tan clay along the large pore running through the center of the slide; the interface between this and the darker clay is quite distinct, suggesting that they represent two clays (rather than varying thickness of the slide.) Much of the darker clay in the rest of the slide has been polished off. Very frequent occurrence of black iron/manganese impregnations, mostly blocky, indistinct units, smeared across the clay. Red-brown, semi-translucent, high-birefringence, fine sand –sized fragments throughout – iron oxide?

MM3, #10: Bottom of the profile. Subrounded limestone clasts. Light tan clay matrix throughout. Muscovite. Quartz grains <0.1 mm – 0.5 mm are frequent. Woody fragments and a 1.5 mm iron/manganese nodule. Slide is obscured by numerous bubbles and fragments of grinding compound.

Bibliography

Banning, E.B. 2002. *Archaeological Survey.* New York: Kluwer Academic/Plenum Publishers.

Barker, Graeme. 1995. *A Mediterranean Valley: Landscape Archaeology and* Annales *History in the Biferno Valley.* London and New York: Leicester University Press.

Beach, Timothy, Sheryl Luzzadder-Beach, Nicholas Dunning, Jon Hageman, Jon Lohse. 2002. "Upland Agriculture in the Maya Lowlands: Ancient Maya Soil Conservation in Northwestern Belize." *Geographical Review* 92(3): 372-397.

Bevan, Andrew. 2002. "The Rural Landscape of Neopalatial Kythera: A GIS Perspective." *Journal of Mediterranean Archaeology* 15(2): 217-256.

Bevan, Andrew and James Conolly. 2002. "GIS, Archaeological Survey, and Landscape Archaeology on the Island of Kythera, Greece." *Journal of Field Archaeology* 29(1/2):123-138.

Bevan, Andrew, Charles Frederick and Athanasia Krahtopoulou. 2003. "A Digital Mediterranean Countryside: GIS approaches to the spatial structure of the post-medieval landscape on Kythera (Greece)." *Archeologia e Calcolatori* 14:217-236

Bisphm, Edward. 2007. "The Samnites." In *Ancient Italy: Regions without Boundaries.* Exeter, UK: University of Exeter Press.

Bispham, Edward, Keith Swift, and Nicholas Wolff. 2008. "What Lies Beneath: Ploughsoil assemblages, the dynamics of taphonomy and the interpretation of field survey data." In *Archaeology and Landscape in Central Italy: Papers in memory of John A. Lloyd*, 53-76. Oxford: Oxford School of Archaeology.

Bull, Ian D., Phillip P. Betancourt, and Richard P. Evershed. 2001. "An Organic Geochemical Investigation of the Practice of Manuring at a Minoan Site on Pseira Island, Greece." *Geoarchaeology* 16(2): 223-242.

Bullock, P. *et al.* 1985. *Handbok for Soil Thin Section Description.* Wolverhampton, WV: Wain Research Publications.

Christie, Neil. 2008. "Of sheep and men: castles and transhumance in the upper Sangro Valley and in the Cicolano, Italy." In *Archaeology and Landscape in Central Italy: Papers in memory of John A. Lloyd*, 105-120. Oxford: Oxford School of Archaeology.

Courty, M.A., P. Goldberg, and R.I. MacPhail. 1989. *Soils and Micromorphology in Archaeology.* Cambridge: Cambridge University Press.

Dench, Emma. 1995. *From Barbarians to New Men: Greek, Roman, and Modern Perceptions of Peoples of the Central Apennines.* Oxford: Clarendon Press.

Denevan, William M. 2001. *Cultivated Landscapes of Native Amazonia and the Andes.* Oxford: Oxford University Press.

Donkin, R.A. 1979. *Agricultural Terracing in the Aboriginal New World.* Tuscon: University of Arizona Press.

Douglas, Terry, Dick Critchley and Gary Park. 1996. "The Deintensification of Terraced Agricultural Land Near Trevelez, Sierra Nevada, Spain." *Global Ecology and Biogeography Letters* 4(4/5): 258-270.

Dunning, Nicholas P. and Timothy Beach. 1994. "Soil Erosion, Slope Management, and Ancient Terracing in the Maya Lowlands." *Latin American Antiquity* 5(1): 51-69.

Faustoferri, A. and J.A. Lloyd. 1998. "Monte Pallano: A Samnite fortified center and its hinterland." *Journal of Roman Archaeology* 11: 5-22.

Forbes, Hamish. 1982. *Strategies and Soils: Technology, Production and Environment in the Peninsula of Methana, Greece.* University of Pennsylvania Ph.D dissertation. Ann Arbor, MI: University Microfilms International.

Forbes, Hamish. 1996. "The uses of the uncultivated landscape in modern Greece: a pointer to the value of the wilderness in antiquity?" In *Human Landscapes in Classical Antiquity: Environment and Culture,* edited by Graham Shipley and John Salmon, 68-97. London: Routledge.

Forbes, Hamish. 2007. *Meaning and Identity in a Greek Landscape: An Archaeological Ethnography.* New York: Cambridge University Press.

Foxhall, Lin. 1996. "Feeling the earth move: cultivation techniques on steep slopes in classical antiquity." In *Human Landscapes in Classical Antiquity: Environment and Culture,* edited by Graham Shipley and John Salmon, 44-67. London: Routledge.

Frederick, Charles D. and Athanasia Krahtopoulou. 2000. "Deconstructing Agricultural Terraces: Examining the Influence of Construction Method on Stratigraphy, Dating, and Archaeological Visibility." In *Landscape and Land Use in Post-Glacial Greece,* edited by Paul Halstead and Charles Frederick, 79-94. Sheffield, England: Sheffield Academic Press.

French, C.A.I. and T.M. Whitelaw. 1999. "Soil Erosion, Agricultural Terracing, and Site Formation Processes at Markiani, Amorgos, Greece: The Micromorphological Perspective." *Geoarchaeology* 14(2): 151-189.

Goldberg, Paul and Richard I. Macphail. 2006. *Practical and Theoretical Geoarchaeology*. Oxford: Blackwell Publishing.

Grove, A.T. and Oliver Rackham. 2001. *The Nature of Mediterranean Europe: An Ecological History.* New Haven and London: Yale University Press.

Holden, Peregrine and Nicholas Purcell. 2000. *The Corrupting Sea: A Study of Mediterranean History.* Oxford: Blackwell Publishers.

Inbar, Moshe and Carlos A. Llerena. 2000. "Erosion Processes in High Mountain Agricultural Terraces in Peru." *Mountain Research and Development* 20(1): 72-79.

Korstanje, M. Alejandra, Patricia Cuenya, and Verónica I. Williams. 2010. "Taming the control of chronology in ancient agricultural structures in the Calchaqui Valley, Argentina. Non-traditional data sets." *Journal of Archaeological Science* 37: 343-349.

Krahtopoulou, Athanasia and Charles Frederick. 2008. "The Stratigraphic Implications of Long-Term Terrace Agriculture in Dynamic Landscapes: Polycyclic Terracing from Kythera Island, Greece. *Geoarchaeology* 23(4): 550-585.

Lloyd, John, Neil Christie and Gary Lock. 1997. "From the mountain to the plain: landscape evolution in the Abruzzo. An interim report on the Sangro Valley Project (1994-5)." *Papers of the British School at Rome, Volume 65,* 1-57.London: British School at Rome, c/o The British Academy.

Netting, Robert McC. 1968. *Hill Farmers of Nigeria.* Seattle: University of Washington Press.

Netting, Robert McC. 1993. *Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture.* Stanford, CA: Stanford University Press.

Nickel, Cheryl. 1982. "The Semiotics of Andean Terracing." *Art Journal* 32(3): 200-203.

Oakley, S.P. 1995. *The Hill-Forts of the Samnites.* London: British School at Rome.

Palmer, Carol, Sue Colledge, Andrew Bevan, and James Conolly. 2010. "Vegetation recolonization of abandoned agricultural terraces on Antikythera, Greece. *Environmental Archaeology* 15(1): 64-80.

Pluciennik, Mark, Antoon Mientjes, and Enrico Giannitrapani. 2004. "Archaeologies of Aspiration: Historical Archaeology in Rural Central Sicily." *International Journal of Historical Archaeology* 8(1): 27-65.

Price, Simon and Lucia Nixon. 2005. "Ancient Greek Agricultural Terraces: Evidence from Texts and Archaeological Survey." *American Journal of Archaeology* 109: 1-30.

Rackham, Oliver and Jennifer Moody. 1992. "Terraces." In *Agriculture in Ancient Greece: Proceedings of the Seventh International Symposium at the Swedish Institute at Athens, 16-17 May, 1990,* edited by Berit Wells, 123-130. Stockholm: Svenska Institutet I Athen.

Rackham, Oliver and Jennifer Moody. 1996. *The Making of the Cretan Landscape.* Manchester and New York: Manchester University Press.

Salmon, E.T. 1967. *Samnium and the Samnites.* London: Cambridge University Press.

Sangro Valley Project. Season reports 1999-2009.
< http://www.sangro.org/sangro/Pages/reports_archive.html>

Sandor, J.A., P.L. Gersper, and J.W. Hawley. 1990. "Prehistoric agricultural terraces and soils in the Mimbres Area, New Mexico." *World Archaeology* 22(1): 70-86.

Sarti, Roland. 1985. *Long Live the Strong: A History of Rural Society in the Apennine Mountains.* Amherst: University of Massachusetts Press.

Sekedat, Brad. 2005. "Report on Shovel Testing." Sangro Valley Project archives, unpublished field report.

Sekedat, Brad. 2006. "SangroValley Project: shovel testing final report." Sangro Valley Project archives, unpublished field report.

Sereni, Emilio. 1997. *History of the Italian Agricultural Landscape.* Translated by R. Burr Litchfield from *Storia del paesaggio agrario italiano,* first published 1961. Princeton, NJ: Princeton University Press.

Silveri, Donato and Aurelio Manzi. 2009. "Horticultural biodiversity and gardening in the region of Abruzzo." In *Crop Genetic Resources in European Home Gardens. Proceedings of a Workshop, 3-4 October 2007, Ljubljana, Slovenia.* Edited by A. Bailey, P. Eyzaguirre, and L. Maggioni. Rome, Italy: Biodiversity International.

Shelton, China P. 2009. *Food, Economy, and Identity in the Sangro River Valley, Abruzzo, Italy, 650 B.C.-A.D. 150.* Boston University Ph.D. dissertation.

Spencer and Hale. 1961. "The Origin, Nature, and Distribution of Agricultural Terracing." *Pacific Viewpoint* 2(1).

Stoops, G. 2003. *Guidelines for Analysis and Description of Soil and Regolith Thin Sections.* Madison, WI: Soil Science Society of America, Inc.

Sutton, J.E.G. 1984. "Irrigation and Soil-Conservation in African Agricultural History with a reconsideration of the Inyanga Terracing (Zimbabwe) and Engaruka Irrigation Works (Tanzania)." *The Journal of African History* 25(1): 25-41.

Treacy, John M. and William Denevan. 1994. "The Creation of Cultivable Land Through Terracing." In *The Archaeology of Garden and Field,* edited by Naomi F. Miller and Kathryn L. Gleason, 91-110. Philadelphia: University of Pennsylvania Press.

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