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Part II
Population Dynamics in the South Alpine Area from the End of the Bronze Age until Romanization
Eva Carlevaro

Prefazione

Introdurre la pubblicazione che presenta i dati desunti da *Leventina – prähistorische Siedlungslandschaft. Besiedlung, Umwelt und Wirtschaft im Alpinen Tessintal 1500 BCE – 15 AD,* un progetto sottoposto al Fondo nazionale svizzero per la ricerca scientifica nel 2006 dal Dipartimento d'Archeologia preistorica dell'Università di Zurigo in stretta collaborazione con l'Ufficio dei beni culturali del Cantone Ticino, è per noi motivo di orgoglio.

La ricerca in alta Valle Leventina, diretta dal professor Philippe Della Casa, si è svolta su più estati, coinvolgendo numerosi studenti dell'ateneo zurighese e permettendo anche a giovani collaboratori dell'Ufficio dei beni culturali di confrontarsi con nuove tecniche di indagine sul terreno e con approcci interdisciplinari innovativi, da riferire ad analisi ecologiche e archeobiologiche.

Le campagne di scavo – mirate a fissare le tappe del precoce popolamento della Valle Leventina – si sono perlopiù concentrate ad Airolo-Madrano, Dalpe, Osco, sui Monti di Airolo, all'Alpe Pontino, all'Alpe di Pinett e all'Alpe di Tom, dove gli archeologici coinvolti hanno eseguito ricerche inseribili in quel filone definito di *Landscape archeology* e di *Settlement archaeology,* nei quali accanto alle tecniche tradizionali di ricerca sul terreno vengono affiancati approcci metodologici transdisciplinari e viene utilizzato il Sistema informativo geografico o territoriale, meglio noto come GIS.

Più discipline a confronto per rispondere a una serie di domande sulla storia dell'uomo e del suo insediamento nell'odierna Valle Leventina dall'età del Bronzo antico alla fine dell'età del Ferro. Lunghi secoli nei quali si è assistito ad un temporaneo deterioramento climatico, a cambiamenti della vegetazione naturale dovuti al disboscamento e ad altre forme di conquista del territorio, quali lo sfruttamento dei boschi, l'introduzione della cerealicoltura e della flora avventizia, e non da ultimo alla trasformazione degli ambienti naturali nelle adiacenze dei siti d'abitato.

I risultati di questi anni di ricerca vengono ora presentati in un volume ricco di dati, approfondimenti, ipotesi ricostruttive e modelli digitali del terreno indagato, che permettono all'uomo moderno di penetrare una realtà territorialmente a lui vicina, ma lontana per epoca e consuetudini di vita.

La ricerca sul terreno e sui materiali portata avanti dal professor Philippe Della Casa e dall'Istituto universitario da lui diretto è da anni punto di riferimento per il Cantone Ticino. Basti ricordare i tre volumi dedicati alla rivisitazione e allo studio approfondito della Necropoli di Giubiasco, una delle più importanti riportate alla luce a partire dalla fine del XIX secolo, volumi dati alle stampe in collaborazione con il Museo nazionale svizzero di Zurigo fra 2006 e 2010; le prospezioni eseguite per conto dell'Ufficio dei beni culturali sul Passo del San Gottardo nell'area interessata dall'insediamento del Parco eolico; le consulenze mirate in diverse indagini condotte nell'ultimo decennio dal Servizio archeologico cantonale: dai sondaggi sul tracciato AlpTransit agli scavi di salvataggio che hanno permesso di riportare alla luce, anche alle nostre latitudini, insediamenti da riferire alle età del Bronzo (Minusio, Gudo, Bellinzona-Carasso) e del Ferro (Arbedo-Molinazzo).

Un approccio transdisciplinare – quello ormai consolidato fra Cantone Ticino e Università di Zurigo – che ben si inserisce nella fitta rete di sinergie fra Archeologie cantonali, Università, Musei e Laboratori, che permetteranno anche in futuro di ampliare le conoscenze sapientemente desunte dalle analisi sul terreno.

Questo e altri traguardi sono auspicati dall'Archeologia cantonale ticinese, che dalla metà degli Anni Novanta del secolo scorso cerca di attivare e alimentare sinergie con Università, Istituti e Laboratori specializzati svizzeri ed esteri, nell'ottica di sopperire alla ormai cronica mancanza di personale debitamente formato all'interno del proprio organico.

Dare giusta visibilità al potenziale archeologico presente nel nostro territorio con imprese editoriali come questa che introduciamo, permetterà forse alle future generazioni di creare anche in Cantone Ticino una struttura moderna ed efficiente, che veda attivo personale specializzato – oggi costretto a cercare lavoro altrove –, in grado di completare la ricerca sul terreno con lo studio e la valorizzazione di un patrimonio che appartiene allo Stato, ma purtroppo al momento rimane appannaggio di pochi addetti ai lavori.

Rossana Cardani Vergani,
responsabile Servizio archeologico cantonale del Ticino

Preface

It is a source of pride for us to introduce the publication which presents the results obtained from *Leventina – Prehistoric Landscape. Settlement, Environment, and Economy in the Alpine Ticino Valley 1500 B. C. – 15 A. D.,* a project carried out with support of the Swiss National Science Foundation from 2006 by the Department of Prehistoric Archaeology at the University of Zurich in direct collaboration with the Ufficio dei beni culturali of the Canton Ticino.

The research in the upper Leventina Valley, directed by Professor Philippe Della Casa, took place over several summers, involving many students from the University of Zurich. It also enabled young members of staff from the Ufficio dei beni culturali to tackle new investigative field techniques and innovative interdisciplinary approaches, with reference to environmental and archaeobiological analysis.

The excavation campaigns – focussed on establishing the early stages in the peopling of the Leventina Valley – were largely concentrated at Airolo-Madrano, Dalpe, Osco, on the Monti di Airolo, and on the Alpe di Pontino, Alpe di Pinett and Alpe di Tom, where the archaeologists involved conducted research within that branch of the discipline defined as *Landscape Archaeology* and *Settlement Archaeology,* in which transdisciplinary methodological approaches accompany traditional methods of field research, and the Territorial or Geographic Information System, better known as GIS, is employed.

Data from several disciplines were collated to answer a series of questions about the history of the people and their settlement in the present-day Leventina Valley from the Early Bronze Age to the end of the Iron Age. Lengthy centuries passed which witnessed a temporary climatic deterioration, changes in the natural vegetation due to deforestation and other forms of impact on the landscape, such as the exploitation of woodlands, the introduction of cereal culture and of adventitious plants, and finally the transformation of the natural environments in the vicinity of settlement sites.

The results of these years of research are now presented in a volume rich in data, detailed analyses, hypothetical reconstructions and digital models of the landscape under study, which permit a modern person to get inside a world that is geographically close, but remote in time and way of life.

For many years the research carried out both in the field and on the material by Professor Philippe Della Casa and the university institute directed by him has been a point of reference for the Canton Ticino. Suffice to remember the three volumes dedicated to the re-examination and in-depth study of the Cemetery of Giubiasco, one of the most important discovered since the end of the 19th century, published in collaboration with the Swiss National Museum in Zurich between 2006 and 2010; the investigations carried out on behalf of the Ufficio dei beni culturali at the St Gottard Pass in the area affected by the installation of a windfarm; the advice directed at the various investigations conducted by the canton's Servizio archeologico in the last decade: from the surveys along the AlpTransit line to the rescue excavations that enabled the discovery, even at our latitudes, of settlements dating to the Bronze Age (Minusio, Gudo, Bellinzona-Carasso) and Iron Age (Arbedo-Molinazzo).

A transdisciplinary approach – as has been long-established between the Canton Ticino and the University of Zurich – which is deeply embedded in the network of synergies between cantonal archaeological services, universities, museums and laboratories, will continue in the future to widen the knowledge obtained with great expertise from the field investigations.

This and other objectives are hoped for by the Canton Ticino's archaeological service, which from the middle of the 1990s has sought to activate and foster synergies with universities, institutes and specialist laboratories in Switzerland and abroad, in order to make up for the chronic lack of adequately trained staff within its own workforce.

To give proper exposure to the archaeological potential present in our region with publications like the one which we are introducing, will perhaps enable future generations to create in the Canton Ticino, too, a modern and efficient structure, which sees the participation of specialists – nowadays forced to find work elsewhere – capable of completing research by studying and enhancing a heritage which belongs to the State, but regrettably for the present remains the preserve of a few insiders.

Rossana Cardani Vergani,
Director of the Servizio archeologico of the Canton Ticino

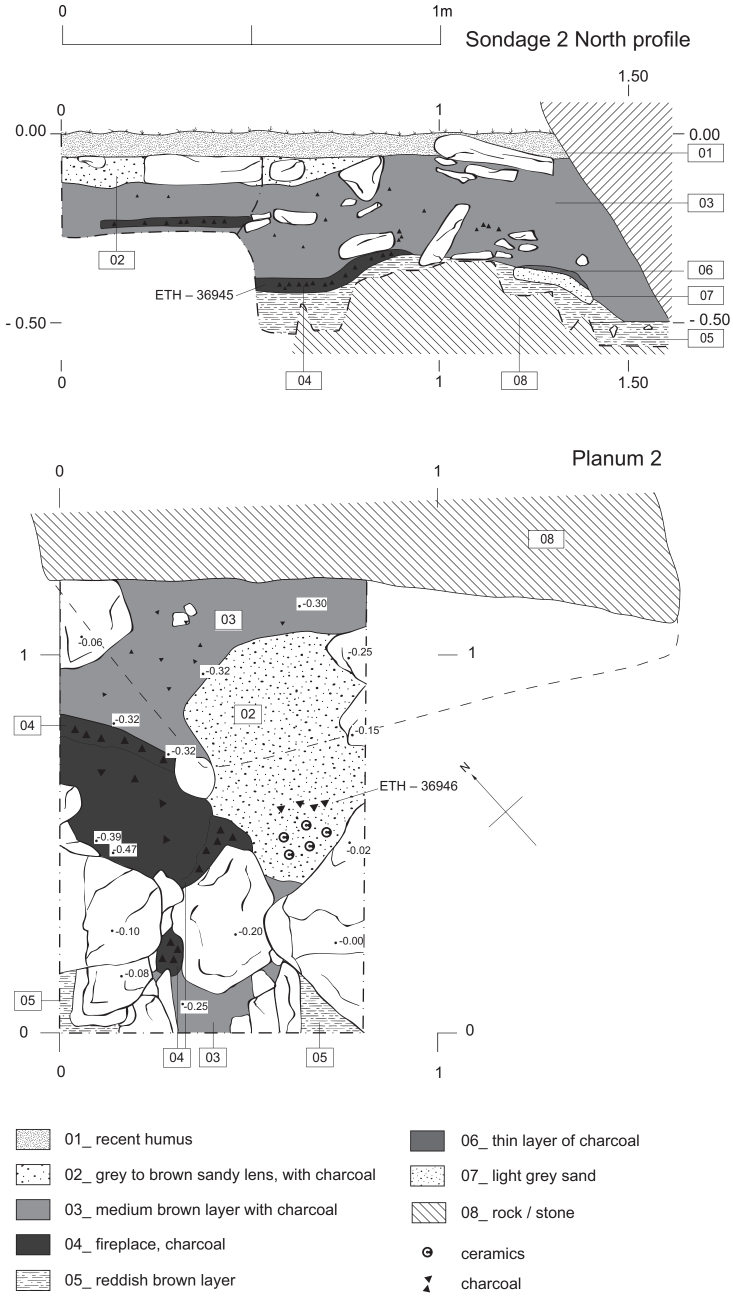


Fig. 3.7. Archaeological features in sondage T2 at Buco di Pontino. Scale 1:20 (release J. Bucher).

3.1.3. Quinto: Lago di Tom, Alpe di Tom (sites 82–89)

It was the chance discovery of a rock crystal scraper close to Lago di Tom during an extensive survey in 2007 that first drew our attention to this archaeologically rich area. The high density of subalpine sites subsequently registered both to the North (Alpe di Tom) and South (Alpe di Pinett) of artificial Lago Ritóm is well evidenced on the survey map (Fig. 3.2). Further planimetric details on the investigated zones are given in Annex 1.3.

Lago di Tom I

Lago di Tom (2020 masl) with its characteristic white dolomite beach ("Zuckerdolomit" – "sugar-like dolomite") is a small natural lake of 0.13 sq km in surface area. It is embedded in a densely structured landscape of small troughs, valleys and terraces. The outflow is underground and emerges beneath a small cave about 150 m west of the lower end of the lake. The area was used for Alpine economy until recently at Alpe di Tom.

A sondage opened on the spot of discovery of the scraper (cf. infra Fig. 3.52: 39), on the southwestern shore of the lake, did not produce any anthropogenic features, only a few additional rock crystal surface finds.

Lago di Tom II

This (undated) site consists of a charcoal layer close to the lateral (western) inflow to the lake. An anthropogenic origin cannot be ruled out (no site entry in database).

Lago di Tom III

A small hillock at the upper (northern) end of the lake carries the altitude indication "2066" (masl). The position is exposed and has all-round visibility (Fig. 3.8). A trowel test revealed a fireplace immediately beneath the alpine lawn, containing charcoal radiocarbon dated to the mid-2nd mill. BCE. A rock crystal bladelet is associated with this find (Fig. 3.47: 3).

Fig. 3.8. Investigating point "2066" (masl) above Lago di Tom (photo Ph. Della Casa).

Fig. 3.9. Quinto-Alpe di Tom I, terrace overlooking access valley to the Lago di Tom area (photo Ph. Della Casa).

Alpe di Tom I

Access to Lago and Alpe di Tom from the south is through a narrow and rather steep valley with rocky ledges to the right and left. We decided to test an exposed flat terrace dominating the access path (Fig. 3.9). The results were roughly the same in all three test trenches (1–2 sq m): overlapping fireplaces consisting of ash and charcoal occurred in the reddish alpine soil beneath the lawn, at depths between 15 and 40 cm, sometimes set with small stones (Fig. 3.10).

Three ^{14}C samples out of various fireplaces date to the EBA and MBA. There is a well documented rock crystal production sequence, mostly from F1/2008, with a prism, a microcore, preparation tools used as scrapers, microlithic tools and fragments of bladelet working (Fig. 3.49; Fig. 3.47: 5-11). Except for quartz and crystal debris, no further finds appeared in the archaeological layers.

Alpe di Tom II

The small cave above the outflow of Lago di Tom was considered to be an interesting location for further archaeological investigation (Fig. 3.11). The cave is 1.5–2 m high and only a few meters deep, but offers an even internal surface area of approx. 5 x 4 m for dwelling (Fig. 3.12). In this area we opened a sondage of 1 x 1m to clarify the intermittent strat-

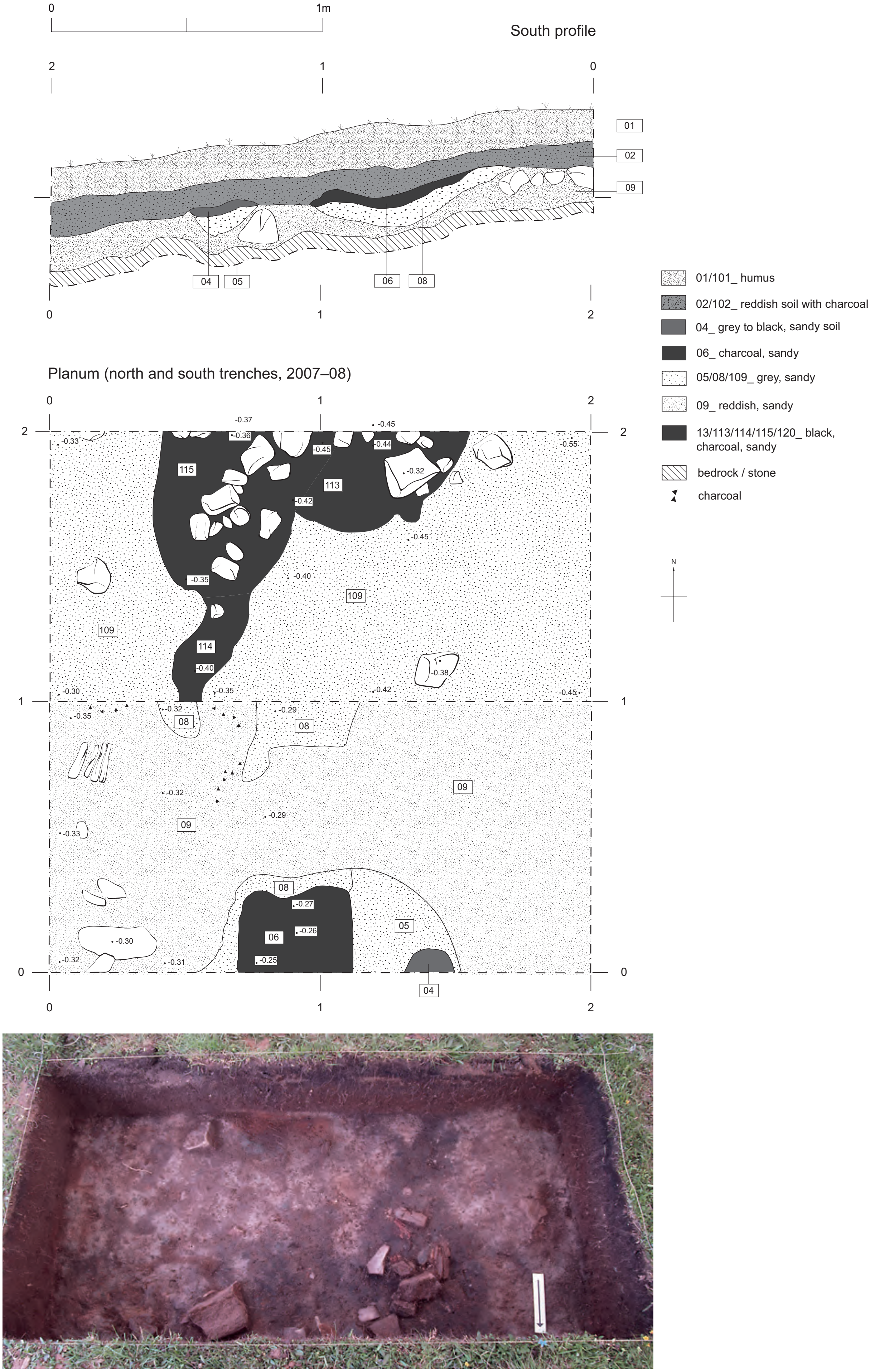


Fig. 3.10. Alpe di Tom I, Bronze Age fireplaces in test trench F1: profile and stratum 2007–08 (Scale 1:20), situation photo in 2007 (release J. Bucher; photo E. Jochum Zimmermann).

Fig. 3.11. Cave and underground outflow of lake at Alpe di Tom II (photo Ph. Della Casa).

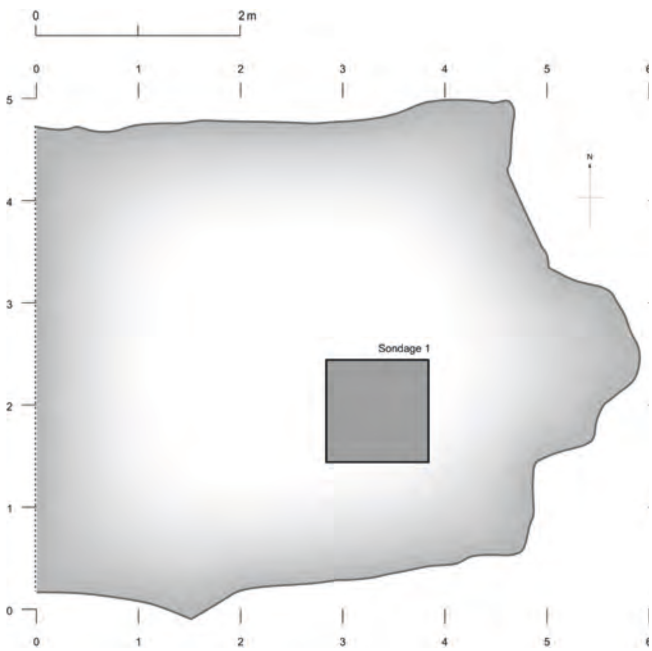


Fig. 3.12. Quinto-Alpe di Tom II, ground area of cave and sondage 1 (release J. Bucher).

ification of dolomitic and humic layers obtained through cores (Fig. 3.13)

We noted debris of rock crystal working throughout the stratigraphy, as well as lots of charcoal. The upper cultural layers also contained fragments of subrecent glass, wood, iron nails, bones of small ruminants and birds (some calcinated) and a small flint flake. Only the lowest level (Pos. 08: –90 cm) was dated by radiocarbon (7th–10th cent. AD/Early Medieval period) and a soil probe was taken for archaeobiological analysis (cf. Chap. 8.9).

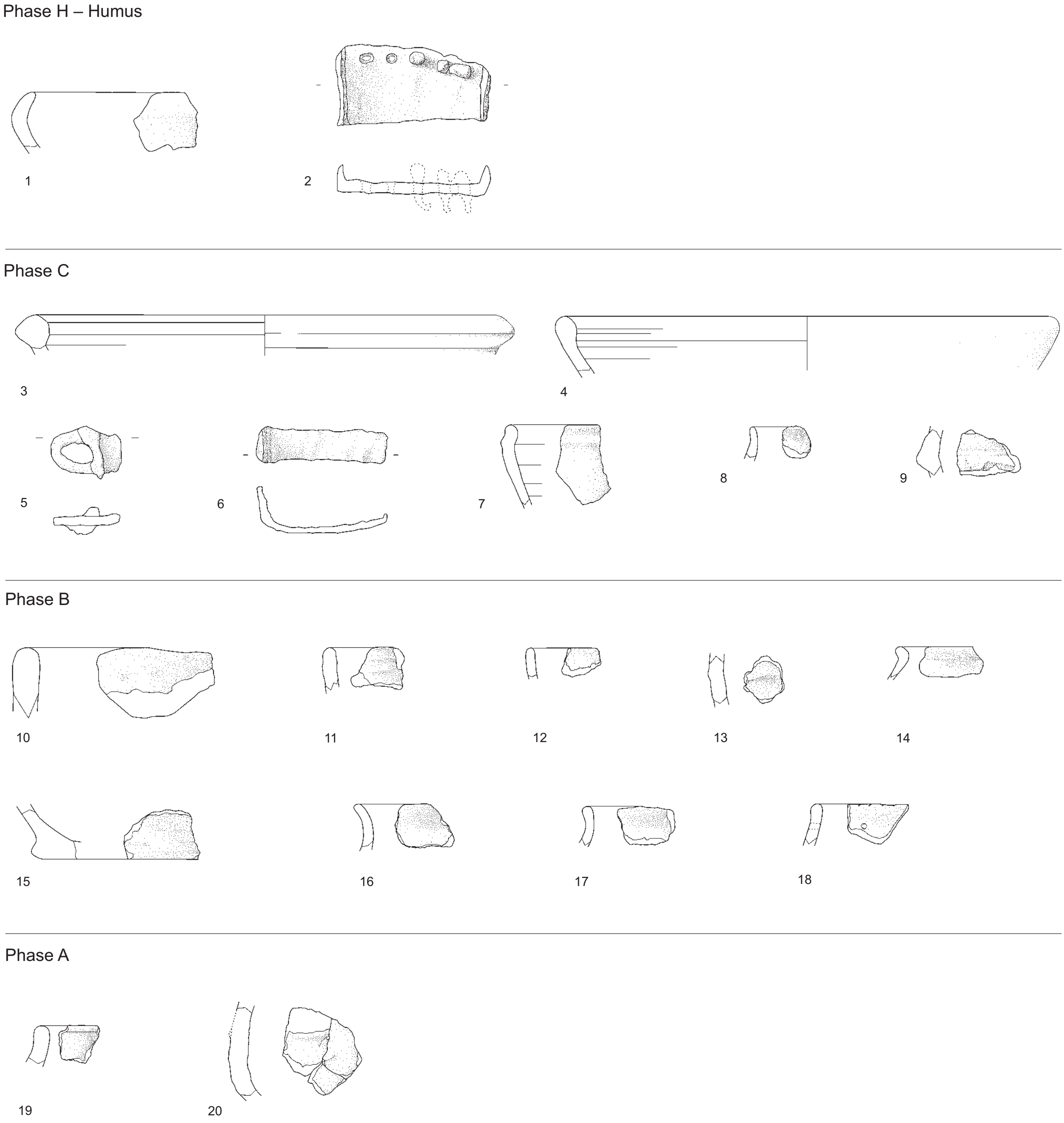
Alpe di Tom III

Immediately to the south-west of the Alpe di Tom cave lies a gentle little valley sprinkled with archaeological features belonging to an abandoned Alpine summer dairy farm (Fig. 3.14). Most of the structures are densely overgrown. However, we observed and recorded a series of small plots (possibly cheese cellars) to the left and right of a small creek (structures A–N), several hut layouts (structures M, O, P), and a two-piece stable pen (structure Q), as shown on Figure 3.15.

A test trench of 2 x 4 m was set on the dividing dry stone wall of the structure Q (Fig. 3.16). The occupation level is not clearly marked, only charcoal and a few rock crystal fragments were noted; carbon-14 dating attests to a late Medieval use of the stable pen.

A second trench was opened in structure O (Fig. 3.17). The peripheral stones belong to a roundish hut of c. 3 m diameter, with a slab paving, a possible entrance to the Northeast, and filled with collapsed stones. Charcoal from the interior space gives a subrecent date for the use of this building.

Digging under the paved floor, we discovered the remains of a stone built hearth at approx. –30 cm (Fig. 3.18) with EIA related radiocarbon dating. Rock crystal was pres-



1 Bowl; brown glaze, fine temper.
2 Cattle shoe; iron.
3 Bowl with outturned rim; fine temper, oxidising atmosphere, light mica slip.
4 Plate (or bowl) with inverted and slightly thickened rim; fine temper, oxidising atmosphere, light mica slip.
5 Belt buckle; iron.
6 Bracket; iron.
7 Bowl with thickened rim; fine temper, oxidising atmosphere.
8 Cup; semi-fine temper, reducing atmosphere.
9 Biconical pot; coarse temper with copious mica, reducing atmosphere.
10 Pot; coarsely tempered, reducing atmosphere, traces of soot.
11 Pot; coarsely tempered, reducing atmosphere.
12 Small pot; fine temper with crushed stone, reducing atmosphere.
13 Small pot; fine temper, oxidising atmosphere, three-dimensional decor.
14 Beaker or small pot; coarse temper with crushed stone, oxidising atmosphere, traces of soot.
15 Pot; semi-coarsely tempered, oxidising atmosphere.
16 Small pot with thin, outturned rim; fine temper, oxidising atmosphere, burnished.
17 Small pot with thin, outturned rim; fine temper, reducing atmosphere.
18 Small pot with thin, outturned rim and notched lip; fine temper, reducing atmosphere.
19 Pot; semi-coarsely tempered, reducing atmosphere.
20 Pot; coarsely tempered, oxidising atmosphere, three-dimensional decor, maybe remnants of a handle.

Fig. 5.5. Airolo-Madrano 2015, pottery and small finds. Scale 1 : 3 (P. Kohler)

Fig 5.6. Airolo-Madrano 2015, rock crystal industry. Scale 2 : 3. (Photos P. Kohler).

1	core (US 3)
2–3	crested flakes (US 15)
4	crested blade with traces of use (US 15)
5–6	artefacts from the production process (US 3, 15)
7–13	tool-like flakes with traces of use (US 3, 2, 15, 11, 2, 26, 3)
14–15	fragments of fractured/truncated blades (US 15)

2, 3, 4, 6, 9, 12, 14, 15	Phase A, Bronze Age
1, 5, 7, 10, 13	Phase B, Bronze Age
8, 11	Phase C, Iron Age/Roman period

The Iron Age pottery continued in the southeast Alpine tradition, and so we may assume that most of the pottery was produced locally. The only Iron Age rim fragment came from a bowl with a thickened rim (Fig. 5.5: 7). Similar pieces were found in the LTB1/B2 layers of the settlement of Cama-Gesa GR (Nagy 2012, 282–288) and in the graves at Giubiasco TI (Tori et al. 2010, 205–206), which dated from LTB1 to LTC1.

The Roman presence manifested itself, amongst other things, in a small, otherwise undetermined fragment of Samian ware and a few sherds of regional provenance, which had parallels in the assemblages from the adjacent cemetery (Butti Ronchetti 2000). They included a plate (Fig. 5.5: 4) with an inverted and slightly thickened rim and a light mica slip. The form was among the key shapes in the assemblage recovered at Alpnach OW (Primas, Della Casa & Schmid-Sikimić 1992, 59) and was a long-lived type. A bowl with outturned rim and a light mica slip could also be dated to the 1st–3rd centuries AD (Fig. 5.5: 3).

5.3.2. Rock crystal

A total of 41 rock crystal artefacts were recovered from the excavated area. The new objects from Airolo-Madrano allowed us to partially reconstruct the *chaîne opératoire*, thus completing our picture of the economic organisation of the southern Alpine village.

In the Bronze Age phases, the artefacts were scattered across the entire excavated area, with a loose concentration of finds around hearth no. 12 and south of pit no. 9. Only one, slightly larger artefact was found inside a pit (no. no. 10). Splinters appeared in all sieved pit contents.

Apart from two flakes which probably exhibited traces of use, only chips and splinters were found from phase C onwards.

In contrast to the material found on the hill, which had included many, largely unworked rock crystals, there was no unworked raw material present here. Another remarkable observation was that the settlement had yielded few artefacts that may have been used as tools (Chap. 4.4.2), in stark contrast to the area recently excavated.

The rock crystals from the recently excavated area were rarely found together with their surrounding rock and no lumps of host rock were discovered, which would have attested to an initial rough working on site, as was observed e. g. in front of the Rossplattenfelsen at Hospental UR (Primas, Della Casa & Schmid-Sikimić 1992, 315).

Some of the crystals still exhibited their natural surface, which suggests that this was not considered a hindrance when using them as tools. The same retention of the original crystal surfaces was also seen e. g. on the artefacts from the Bronze Age strata of the Alpe di Rodont rock shelter (Hess et al. 2010, 189; cf. Chap. 3.8) on the St Gotthard pass.

The raw material, in this case colourless and highly transparent rock crystal, which was mined at higher elevations, had probably already been roughly prepared by the time it reached the settlement, where it was further worked and turned into flakes or blades.

Population Dynamics in the South Alpine Area from the End of the Bronze Age until Romanization

Eva Carlevaro

At the foot of this chain [the Alps], which we should regard as the base of the triangle, on its southern side, lies the last plain of all Italy to the north. It is with this that we are now concerned, a plain surpassing in fertility any other in Europe with which we are acquainted.

Polybius Histories II, 14

to Rafael and Philipp

Forward and acknowledgements
The PhD thesis presented here was part of the multidisciplinary research project *Leventina – Prähistorische Siedlungslandschaft. Besiedlung, Umwelt und Wirtschaft im alpinen Tessintal 1500 B.C.–15 A.D. (project no. 100012-111987/1), Leventina Project.*
Many people have contributed to the success of my doctoral thesis.

First of all, my thanks go to Prof. Dr Philippe Della Casa, the leader of the project, who, other than supporting and supervising the research, gave me the opportunity to undertake this study and to learn a new research tool, GIS.

Secondly, I would like to thank Heidi Amrein and my colleagues in the Swiss National Museum for their support and for putting up with me.

Amongst the colleagues who have shown interest in my research and provided much help, I would like to thank: Rossana Cardani Vergani, Luisa Mosetti, Moira Morinini Pè (Ufficio dei Beni Culturali di Bellinzona), Laura Simone Zopfi and Rosanina Invernizzi (Soprintendenza per i Beni Archeologici della Lombardia) and Giuseppina Spagnolo Garzoli (Soprintendenza per i Beni Archeologici del Piemonte and the Museo Antichità Egizie).

To the following, in strict alphabetical order, my heartfelt thanks for all they did to contribute to this work and bring it to a successful conclusion: Simonetta Biaggio Simona, Giancarlo Bullo, Maria Grazia Canepa Pucci, Anna, Silvia, Teresita and Tazio Carlevaro, Antonietta Colubriale, Luigi Corfù, Philippe Curdy, Eileen Eckmeier, Matteo Ferrari, Sergio Gallo, Filippo Maria Gambari, Pamela Greenwood, Anne Kapeller, Patrick Nagy, Manuela Palamini, Mauro Piazzi, Ueli Raz, Martin Sauerbier, Ronald Schmidt, Emiliano Soldini, Trudi and Geri Stalder, Philipp Stalder, Jenny Studer, Willy Tinner, Luca Tori, Samuel van Willigen and Elisa Vescovi, not forgetting Prof. Dr Robert Weibel for having agreed to be the joint supervisor of my thesis.

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Note to the reader
This English version is a translation of the text and material from a doctoral thesis by the author at the University of Zurich. The thesis was approved in the autumn term 2012 by Dr Philippe Della Casa and Prof. Dr Robert Weibel. The Appendices and Finds Catalogue are published with the Italian language version available at: http://opac.nebis.ch/ediss/20131827.pdf.

1. Introduction and Methodology

The aim of this work is the study of the population dynamics in the protohistoric period in southern Switzerland and its neighbouring regions with regard to the natural surroundings and socio-economic factors, from the Final Bronze Age to the period of Romanization (Fig. 1.1). The research is based on the processing of a databank of information in which the features relating to the presence of ancient settlements were systematically catalogued. Data gathered in this way could be related to environmental and socio-economic parameters by means of a Geographic Information System (GIS). Through the use of GIS we tried to identify diachronic settlement models. On the one hand, this strategy provided evidence of the influence of the environmental parameters and the economic and social factors on the ancient populations, and, on the other, it indicated the settlement preferences that characterized the various types of site.

1.1. Introduction to the methodology and the definition of the aims

The study falls within the broad category of Landscape Archaeology, more precisely in that branch of archaeology termed 'Settlement Archaeology', that is, in that category of studies that considers the interaction of man with the environment in which he lives. The methodological premise that forms the basis of the work is the hypothesis that the ancient natural environment would have influenced the choice of human settlement and that these models showing preferences are identifiable with the aid of spatial analysis carried out, in this specific case, by using GIS technology (Posluschny 2006, 120). Bronze and Iron Age societies must have mainly based themselves on a system of agro-pastoral subsistence (Della Casa 2002, 81; Posluschny 2006, 12). In an essentially agricultural society, therefore, the geo-environmental conditions favourable to stockbreeding and the setting up of farming must have played a fundamental role in the choice of a settlement site. Nevertheless, it would be simplistic and incorrect to describe the ancient population dynamics as solely constrained by environmental factors; of fundamental importance must have been the socio-economic factors which are much harder to quantify.[1] The investigation of socio-economic factors is therefore important for avoiding the interpretation of the settlement dynamics from a purely 'eco-deterministic' perspective, which only takes account of the variables dependent on the natural environment (Posluschny 2006, 120). For this reason the results from the close analysis of those sites that do not follow the typical choices for 'farming' are interesting. Their atypical situation could then have originated from factors that are not only economic (near a major communication route), but also socio-cultural (beliefs, sacred places, and sites visible over a vast area) (Posluschny 2006, 120).

Ancient settlement activity is not only identifiable from the traces left by dwellings. The analysis of population dynamics must also include all those finds that gravitate around settlements (cemeteries, cult sites, hoards and isolated burials) and which have left their traces on the ancient cultural landscape (Pankau 2007, 1–2). The aim of this study was to understand whether the distribution of these finds in the landscape followed a precise scheme and whether their distribution allowed both the recognition and the identification of the function of the various types of site. Recording separate categories of archaeological finds in the database allowed attention to be drawn to the traits which characterize the complex nature of the human landscape. On the one hand, it is well to bear in mind how the natural environment had influenced the choice of human settlement, but, on the other, how at times human action would have modified the original character of the landscape.

In order to carry out spatial analysis and so relate the archaeological finds and the environmental parameters, and to reconstruct some of the socio-economic factors, for example the communication routes and the intervisibility of sites, GIS[2] technology supported by statistical analysis was used in this piece of research. These methods allowed us to determine whether the models identified were due to intentional choices or could be ascribed to chance.

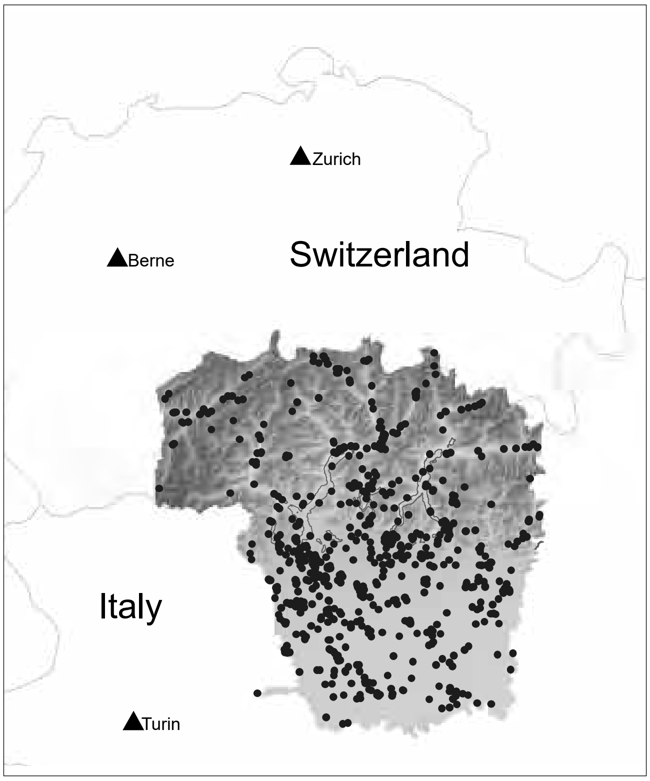

Fig. 1.1. The study area.

1.1.1. GIS as a research tool

GIS consists of a set of software designed to acquire, manage, analyse and reproduce georeferenced data.[3] GIS allows the examination, interrogation, understanding and visualization of data available for highlighting relationships, patterns and trends that exist between each other in the form of geographical maps, charts and tables. It allows the management of large quantities of different data and their combinations to obtain new information that is useful for analysing and understanding their interrelationships (Burrough 1986, 6–7).

GIS is a tool that came into use from the end of the 1960s in Canada and the United States and was originally used to manage geographical information such as the planning and management of forests or urban development in cities (Wheatley & Gillings 2002, 15–16). Thanks to its potential the use of GIS soon spread and expanded outside the realm of spatial planning. Today there are numerous areas where it is applicable and GIS supports a whole range of activities, such as commerce (market research, publicity, etc.), public administration (development of public and private transport, management of environmental resources, civil protection and heritage), and scientific research (simulation of natural phenomena or the study of wild habitats).

Developed in the English-speaking world during the 1970s, the use of GIS in archaeological research spread within a few decades throughout Europe due to commercialization making the software ever more accessible (Wheatley & Gillings 2002, 19–20). It has many applications in archaeology: for cataloguing cultural and archaeological heritage, allowing not only the mapping of sites but also the acquisition of information relating to the cultural asset in question, such as its state of preservation, typology, etc.; in archaeological excavations, or during surveys, or even in cartographic archaeology to create maps of archaeological sites. GIS is often used for investigations relating to landscape archaeology due to its feature for spatial analysis[4] (Lock 2000; Forte 2002, 95–118; Wheatley & Gillings 2002, 16–18; Conolly & Lake 2006, 33–50). This latter use has seen a noticeable increase in the last few years for archaeological projects aimed at reconstructing ancient populations (Posluschny 2002; *ibid.* 2006; Pankau 2007; Pecere 2006; Cattani 2008; *ibid.* 2011; Sauerbier & Fasler & Della Casa 2009; Part I, Chap. 11), in part associated with the creation of predictive models (van Leusen & Kamermans 2005; Mehrer & Wescott 2006; Mischka 2007; Boos & Hornung & Müller 2010; Casarotto & De Guio & Ferrarese et al. 2011). Lastly, the management of data through GIS allows the production of three-dimensional reconstructions and thus makes graphic visualization of the archaeological evidence and surrounding landscape easier (Gaffney & Thomson & Fitch 2007; Sauerbier 2009).

1.1.2. Research objectives

This study addresses the examination of the population dynamics in the area under consideration in the period between the end of the Bronze Age and the beginning of the Roman period. The work is chiefly based on the gathering of published archaeological data and on the selection of environmental and socio-economic factors which can have influenced settlement choices. The information of archaeological origin recorded in the databank consists of the sites of settlements, cemeteries, isolated burials, hoards, and, where well-documented, stray finds. Finally, the implementation of GIS allows us to relate the influence of the selected parameters with the position of archaeological sites (Fig. 1.2).

1. There are three main objectives for the analysis:

The first objective was to obtain the most complete archaeological documentation possible, starting with published data. Data so recorded form a solid platform on which to begin the processing of population models.

2. In a second stage a selection was made of environmental and socio-economic parameters that could have influenced the settlement choices. In this context priority was given to factors that were stable over time and that had not undergone substantial changes, or which can be reconstructed using GIS (for example, altitude, exposure, orientation, proximity to raw materials or communication routes, intervisibility, etc.).

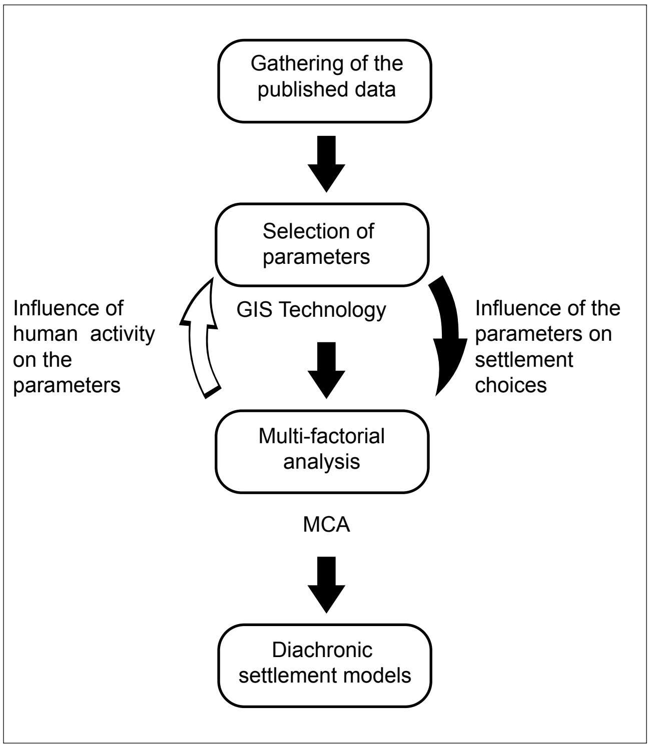

Fig. 1.2. Research framework.

3. Finally analysis was carried out of the interactions that occur between the environmental and socio-economic parameters and the choice of settlement site. Initially, through the use of the GIS technology, by examining every parameter individually (multifactorial analysis), and then by seeking to pinpoint them by multiple correspondence analysis (MCA), we sought to establish whether it is possible to identify the combination of parameters involving preferences that have influenced the choice of a settlement site, that is, whether there existed particular settlement patterns through time.

The proposed population models seek to determine, therefore, what the environmental, economic, social and cultural criteria are that form the basis of a settlement and what relationships exist between them. By a close examination of the assembled data we sought to scrutinize and visualize the changes that had occurred to the landscape between the various periods, and in the organization of the territory. Of great importance were the subsequent study of those sites that did not fit into the proposed models and the understanding of the factors that caused this mismatch.

The identification of the parameters that influence territorial organization and the examination of the interactions that existed between the different types of archaeological site can be useful for identifying areas that were preferred for settlement. It is also an effective method for the recognition of archaeological areas at risk and is particularly suitable for the analysis of areas rich in cemeteries, but poor in settlements, for example Canton Ticino.

1.2. State of Research

During the last twenty years numerous archaeological investigations have led to a better understanding of the Final Bronze Age and the Iron Age in the subalpine region. Thanks to a systematic inspection of the landscape, a series of planned excavations and new research projects to revisit and assess old excavations, studies of the protohistory of the subalpine region have made notable progress. The findings of the scientific research have involved settlement sites, cemeteries and hoards and have produced important regional syntheses (De Marinis 1981; *ibid.* 1992; De Marinis & Biaggio Simona 2000; De Marinis 2001; Gambari 1998; *ibid.* 1998a; *ibid.* 1998b; *ibid.* 1998c; *ibid.* 1998d; Gianadda 2000; Mangani & Minarini 2000; Nagy 2012; Panero 2003; Pernet & Carlevaro & Tori et al. 2006; Schindler & De Marinis 2000; Tori & Carlevaro & Della Casa et al. 2004; Tori & Carlevaro & Della Casa et al. 2010; Venturino Gambari 2006).

In recent years in particular, research has been published on the central Alpine area. These studies have been specifically engaged in the examination of the interaction between humans and the natural environment leading to new perspectives in archaeological research (Della Casa 1999, *ibid.* 2000, Schmid Sikimić 2002).

A stimulus for choice of this subject matter was also the fact that the study of protohistoric settlement has now become a field of archaeological research carried out at a European level. In fact, there are important research projects aiming to of analyse the population dynamics of Early Iron Age settlements (for example, the project led by the Deutsche Forschungsgemeinschaft, *Frühe Zentralisierungs- und Urbanisierungsprozess – Zur Genese und Entwicklung frühkeltischer Fürstensitze und ihres territorialen Umlandes [SPP 1171]*,[5] especially the part directed by Prof. Dr Krausse, Landesdenkmalamt Baden-Württemberg, *Siedlungshierarchie und kulturelle Räume,* or the French project led by Bruno Chaume, *Fonction, hiérarchie et territoires des sites d'habitats hallstattiens de France orientale*).

In the last few years, really due to the spread of GIS as a working tool, a large number of projects in Web GIS have become accessible and can be consulted online. In this respect, mention must be made of the multidisciplinary research project PO-BASyN[6] launched by the University of Milan, Dipartimento di Scienze dell'Antichità, and the University of Bologna, Dipartimento di Archeologia, in collaboration with other bodies. The PO-BASyN project was developed to study the 'developmental dynamics of ancient societies in regional terms' and also to provide a 'tool suitable for sharing, enhancing and using information relating to the cultural heritage'. The analysis of the Bronze Age population of the Po Plain was chosen as a suitable initial project to test this operating system.

Among the other Web GIS systems involved in the study of the population of Northern Italy, the APSAT-ALPINET project also ought to be mentioned.[7] This project, launched by the University of Trento and the Museum of Sciences, Trento, in collaboration with other bodies, both in Italy and abroad, has as its aims the promotion and enhancement of the archaeological heritage in the Alps. One of the outstanding merits of this research is the means by which the archaeological heritage is conveyed, promoted and made accessible to a vast audience of specialists and interested people, the internet.

1.3. Chronological and geographical setting

The area under examination lies between the Alpine watershed and the river Po, taking in the region between the rivers Sesia, to the west, and the Serio, to the east. The chronological span chosen covers the Late Bronze Age to the Augustan period. Today this area includes southern Switzerland (Canton Ticino, south-west *Graubünden* and the Upper Valais) and Northern Italy (western Piedmont and eastern Lombardy) (Fig. 1.3). The choice of this region was determined by the fact that this area is especially distinctive for its cultural continuity, which begins at the end

Fig. 1.3. The area today with modern borders.

Phase codes used in the study	Period	Regional Chronology	Century	Absolute Dating
A. Late Bronze Age 1	LBA	LBA Canegrate	13th	1300–1200
B. Late Bronze Age–Final Bronze Age	LBA			
C. Final Bronze Age 1	FBA	PG I–II	12–11th	1200–1000
D. Final Bronze Age 2	FBA	PG III	10th	1000–900
E. Early Iron Age	EIA 1	G IA1	9th	900–825/800
F. Early Iron Age 1	EIA 1	G IA2–G IC	8–7th	825/800–625
G. Early Iron Age 2	EIA 2	G IIA/B/TI A	7–6th	625–550
H Early Iron Age 3	EIA 2	G IIB–G IIIA1/TI B/C	6–5th	550–450
I. Early Iron Age–Late Iron Age 1	LIA 1	G IIIA2/A3/TI D–LT B	5th–3rd	450–280/250
L. Late Iron Age 2	LIA 2	LT C–LT D1	3rd–1st	Alps: 280/250–70/80 Plain and Pre–Alps: 280/250–89 BC
M. Romanizing period	R	LT D2–Augustan period	Beginning 1st century BC–end 1st century AD	Alps: 70/80–15 BC Plain and Pre–Alps: 89–15 BC
N. Roman Empire	RE	Augusto–Tiberian period	Beginning 1st century AD	15 BC–AD 37
O. Not precisely datable	ND			

Fig. 1.4. The phases used in the study in relation to other chronologies.

of the Bronze Age and continues, in some areas, after the Celtic invasions (De Marinis 1981a; Schindler & De Marinis 2000; Gambari 1998; *ibid.* 1998a; Janke 1994).

Despite this cultural unity, chronological mismatches exist within the study area, above all those concerning transitional periods, such as the end of the Iron Age and the beginning of the Roman period. For this reason, it was decided to produce a table based on the many published chronological studies (Fig. 1.4) to summarize and reconcile the different chronologies so allowing comparisons in the dating of the finds (Müller & Kaenel 1999, 21; de Marinis & Gambari 2005, 210; Schmid-Sikimić 2002, 290; Grassi 1995, 93). Although the scheme given here is a simplification of the complex chronology of the area being investigated, it is a valid tool to enable comparative analysis of the various types of sites in the different regions involved in the study.

During the Early Iron Age, owing to its strategic position, the area became an important means of communication between the transalpine and Mediterranean worlds (Della Casa 2004; Gambari 2001; *ibid.* 2004). Thus within the area there is a wide typological range in settlements that have economic potential and a diverse socio-economic organization, ranging from agro-pastoral centres to commercial hubs and points controlling traffic across the Alps (Della Casa 2000; *ibid.* 2002; Nagy 2012; Pernet & Carlevaro & Tori et al. 2006; Schmidt-Sikimić 2002; Spagnolo Garzoli 1999; Venturino Gambari 2006; Tori & Carlevaro & Della Casa et al. 2004). Moreover, the region under examination is interesting because it includes areas that are morphologically different: the Alps (Fig. 1.5), the Pre-Alpine zone (Fig. 1.6) and the Po Plain (Fig. 1.7). The high altitudes have created notable variations in biogeography which must have had a decisive influence on the life of ancient human communities.

Fig. 1.5. The Leventina Valley seen from the road leading to the St Gottard Pass (photo D. Stuppan).

Fig. 1.6. Lake Maggiore and the Piedmontese Pre-Alps (photo D. Stuppan).

Fig. 1.7. Lakes Varese and Comabbio against the backdrop of the Po Plain seen from Campo dei Fiori near Varese (photo M. Ferrari).

2. Cartographic sources

As was explained in the introduction, the study of settlement choice to the south of the Alps is based on the selection of a series of parameters that could have influenced it. The choice of factors that could be used in the research, however, is influenced, and in part limited, by the types of maps available.[8] Consequently, it is necessary at this point to explain briefly what sort of data can be used for this study, as well as which factors can be reconstructed using GIS technology (Fig. 2.1).

The majority of the digital maps used in the analysis of the distribution of the sites on Italian soil have been downloaded from the Geoportale della Lombardia[9] and from the map collection for the Piedmont Region.[10] These two offer a wide choice of maps and thematic maps that can be consulted, mostly without charge to the user. For Switzerland there are considerably fewer base maps in digital vector format available without charge. In order to remedy this gap, material and data published in the *Atlas of Switzerland 2* were used. The situation for thematic maps was slightly better: the Federal Statistical Office and that for the Environment have published online derivative maps in vector format relating to agricultural activity (maps of suitability for agriculture and of agricultural zones) as well as soil use maps (CORINE Land Cover).[11] The Swiss national cartographic portal also possesses a vast collection of digital maps, but the high cost of the digital vector data limits accessibility.[12]

Many of the maps used show the landscape as it is today and not how it must have been in the past.[13] It is necessary, therefore, to remember that some analyses are based on a relative comparison between the different parameters and so represent trends and not absolute values. To solve these problems in this study we sought to select parameters that were constant through time, ones that could be simulated or reconstructed through the use of GIS or even to prioritize the use of historic maps, where they exist.

	Switzerland	Lombardy	Piedmont	Analysis
Geology maps	Geomorphology map. Atlas of Switzerland 2 (tif; 1 : 250 000)	Geology map of Italy (paper; 1 : 100 000)	Geology map of Italy (paper; 1 : 100 000)	Distribution of sites according to the geomorphology of the area and mineral deposits
		Geomorphology map of the lowlands (vector; 1 : 25 000)	Map of the agricultural and forested landscape (vector; 1 : 100 000)	
		Map of the fluvial fans (vector; 1 : 10 000)	Map of the fluvial fans (vector; 1 : 100 000)	
Soil maps, base and derived	Swiss soil map. BEK 200 (vector; 1 : 200 000)	Land use capability map (vector; lowlands; 1 : 25 000; montane zone; 1 : 10 000)	Land use capability map (vector; 1 : 100 000)	Distribution of sites according to land use capability
		Map of land capability (vector, montane regions; 1 : 10 000)		
	CORINE Land Cover (vector; 1 : 100 000)	*CORINE Land Cover* (vector; 1 : 100 000)	*CORINE Land Cover* (vector; 1 : 100 000)	Influence of modern land use on the current archaeological picture
Hydrographic maps	Dufour map (digital; 1 : 100 000)	Dufour map (digital; 1 : 100 000)	Dufour map (digital; 1 : 100 000)	Proximity of sites to water sources
	Map of the major bodies of water (vector 1 : 200 000)	Water sources map (vector; 1 : 10 000)	Hydrographic map (vector; 1 : 100 000)	
	Map of springs (jpg; 1 : 200 000)	Hydrographic map of the Kingdom of Italy (paper; 1 : 100 000)	Hydrographic map of the Kingdom of Italy (paper; 1 : 100 000)	
		Map of springs (vector; 1 : 10 000)		
		Map of bodies of water 1880 (vector; 1 : 10 000)		
Digital Elevation Model (DEM)	SRTM 90; Digital Height Model DHM25	SRTM 90; Digital Terrain Model DTM20	SRTM 90; DEM 50	Distribution of sites according to altitude, slope, orientation, exposure to the sun; lines of communication; intervisibility; density of finds

Fig. 2.1. The map coverage.