Continuity and discontinuity in the history of upland pastoral landscapes: the case study of Val Molinac and Val Poré (Val di Sole, Trentino, Eastern Italian Alps)

Journal: Landscape Research

Manuscript ID: CLAR-2016-0153.R2

Manuscript Type: Standard Research Paper

Keywords: Alps, pastoral landscapes, landscape evolution, Punctuated Equilibrium Theory

Abstract:
This paper addresses the question of the formation and evolution of upland rural Alpine landscapes. The case study presented here refers to two upland valleys – Val Molinac and Val Poré – located in the Alpine region of Trentino (Italy). Archaeological fieldwork in the area has revealed a complex landscape, the main features of which are dry-stone structures (enclosures, huts and rock-shelters), mainly related to pastoralism. Archaeological data and documentary sources show that the investigated landscape underwent distinct formative phases or ‘tipping points’ – in the 15th-16th centuries AD and in the late-18th to early-19th centuries AD – and suggest that its evolution has neither been gradual nor incremental, as generally assumed. "Punctuated equilibrium paradigm", derived from evolutionary theory, is applied to address the discontinuous evolution of the upland landscapes of Val Molinac and Val Poré, and theoretical implications for the study of rural landscapes are discussed.
Continuity and discontinuity in the history of upland pastoral landscapes: the case study of Val Molinac and Val Poré (Val di Sole, Trentino, Eastern Italian Alps)

Abstract. This paper addresses the question of the formation and evolution of upland rural Alpine landscapes. The case study presented here refers to two upland valleys – Val Molinac and Val Poré – located in the Alpine region of Trentino (Italy). Archaeological fieldwork in the area has revealed a complex landscape, the main features of which are dry-stone structures (enclosures, huts and rock-shelters), mainly related to pastoralism. Archaeological data and documentary sources show that the investigated landscape underwent distinct formative phases or ‘tipping points’ – in the 15th-16th centuries AD and in the late-18th to early-19th centuries AD – and suggest that its evolution has neither been gradual nor incremental, as generally assumed. “Punctuated equilibrium paradigm”, derived from evolutionary theory, is applied to address the discontinuous evolution of the upland landscapes of Val Molinac and Val Poré, and theoretical implications for the study of rural landscapes are discussed.

Key Words: Alps, pastoral landscapes, landscape evolution, Punctuated Equilibrium Theory

1. Introduction

Alpine landscapes have been widely recognized as the product of long-term human activities; along with climate and environmental change, human impact is one of the main causes of landscape transformations that occurred in the Alps during the Holocene (Previtali, 2011). In particular, seasonal pastoralism (namely the summering of livestock in mountain uplands) is considered the strategy that most contributed to shaping these upland landscapes (Barker & Grant 1991; Carrer, 2015). Paleoenvironmental and archaeological investigations have shown that upland grazing-areas were exploited by pastoral groups since the 4th-3rd millennia BC, with increasing intensity during the 2nd to 1st millennia BC (Festi et al., 2014; Kothieringer et al., 2015; Moe et al., 2007; Walsh et al., 2014) and mostly during the Middle Ages and early-Modern times, up to the mid-19th century (Andres, 2015; Avanzini & Salvador, 2015; Sauro et al., 2013).

Relying on this backdrop of long term intensification in exploitation, archaeologists and paleoecologists have often perceived upland landscape evolution to be a continuous, cumulative process, driven by the overlaying effects of intensification or abandonment over time. This perspective conforms to the traditional perception of landscape as palimpsest, a term used in archaeology to conceptualise landscapes as the result of a juxtaposition of features with distinct functions and chronologies (Bailey, 2007). However, landscape is not the mere sum of its features, but also an array of related features – a web of relations, that mirror related activities (Ingold, 1993; see also Hicks 2016). This implies a functional coherence within the landscape that could be referred to as "landscape character" (Turner, 2006). It can be argued that landscapes are not only the cumulative product of unrelated human actions, but also the result of coherent landscape-shaping plans that have occurred in distinct periods and are aimed at adapting the territory to specific...
human activities and needs. These inferences, in turn, suggest a discontinuous evolution of landscape structure: abrupt phases of human-driven transformations alternating with longer phases of stability or gradual development. Upland landscapes provide a perfect example of this trend, since their seasonal exploitation and marginality (at least in historical times) have favoured their stability through time, while their extreme climatic conditions and low productivity have forced human communities to test different risk management strategies (Walsh, 2005).

In this study, the landscape history (from the Middle Ages to the Modern period) of two upland valleys of the Italian Alps will be investigated. ‘Tipping points’ in the anthropogenic reconfiguration of landscape structure will be highlighted, their possible socio-economic and cultural causes will be evaluated, and the legacies of these discontinuities in the current landscape will be pointed out. This example will provide the baseline for a general discussion about the concept of continuity and discontinuity in the history of landscapes. Theoretical paradigms addressing evolutionary discontinuity will be recalled, with particular attention to “Punctuated Equilibrium Theory”, which explains change as an alternation of stability and ‘punctuated’ revolutionary periods.

2. The case-study: Val Molinac and Val Poré (Trento, Italy)

2.1. The land and the landscape

The sample areas investigated in this study are two upland valleys belonging to the Val di Sole catchment basin, in the north-western part of Trentino province (Italy). Val di Sole is an Alpine valley, the main axis of which is oriented ca. WSW-ENE. Due to its peculiar orientation, almost parallel to the main Alpine watershed (Figure 1), Val di Sole is one of the few valleys (like Valtellina, Inntal, Pustertal or Gailtal) longitudinally linking distinct sectors of the central-eastern Alpine chain. Traditional land use in Val di Sole is arranged on a ‘vertical’ basis; permanent villages are set along the valley bottom or on natural terraces of the north (south-facing) valley slope up to ca. 1500 m altitude. Above this level, there are only communally-managed – often village-owned – seasonal dwellings called malghe, exploited by herders for livestock grazing and cheese production.

Since 2010, the two upland valleys named Val Molinac and Val Poré have been the main study-area of the “ALPES” archaeological research project. They are part of the territory of the villages of Ortisé and Menas (municipality of Mezzana) and are located along the south-facing slope of Val di Sole (Figure 1). The valleys are N-S oriented and are tributaries of the river Noce, the main watercourse flowing through Val di Sole. Their upland sector is located above the slope break of the last glacial (Würm, according to Alpine climatostratigraphy) truncation, which reaches an altitude between 1700 and 1800 m asl1. The heads of Val Molinac and Val Poré exhibit periglacial features, while their bottoms are relatively broad and occupied by extensive grassland. The valleys are subject to Alpine highland climate, with average annual mean temperature around 0 °C, annual precipitation of ca. 1000 mm/a and about a half of the annual cycle dominated by frost and snow (see Angelucci et al., 2014 for details on the geographic, geomorphological and climatic context of the study area).

---

1 The height of land features and anthropic structures is reported here as altitude above mean sea level of the Mediterranean sea and not as elevation above the theoretical equipotential surface of the WGS84 ellipsoid, as the latter figure may differ substantially from the former in upland areas.
Although Val Molinac and Val Poré are relatively remote and marginal valleys (Figure 2), some landscape features are still in use today. Herders grazing in these pasturelands still exploit two *malghe* located at around 2100 m – respectively Malga Bronzolo and Malghet di Mezzana. Two other *malghe* are located at lower altitude: one (Malga Menas) is currently abandoned, while the other has recently been reclaimed as an alpine refuge (Malga Stabli). All these sites include both dwelling structures and buildings for stabling the livestock. The only hiking path of the area runs in Val Poré (path 121 and 121A, managed by the Italian Alpine Club). In Val Molinac, a mountain hut has recently been built by the Mezzana Municipality (Bait degli Alpini) at about 2150 m, and the Forestry Corps have opened a new trail (Alta Via degli Alpeggi) to access the neighbouring upland valley called Vallenaia.

Excluding the aforementioned structures and paths, all the other landscape features in Val Molinac and Val Poré are relict and can be attributed to the historical exploitation of the area. A crucial element here is the network of artificial canals (of unknown origin but still in use until the mid-20th century to water the meadows) and the paths giving access to the valleys, as they create the framework within which different anthropogenic landscape features are embedded. These features are mainly dry-stone structures (cairns, huts, rock-shelters and enclosures) characterised by significant size, shape and functional variability. Several huts, showing distinct degree of preservation, are scattered in the landscape – sometimes incorporated within large enclosures (see below). They are small (max. inner surface 20 m$^2$) and exhibit recurrent structural characteristics: roughly rectangular shape, low dry-stone walls, partially belowground. Only a few of them still retain a roof, made of sheet metal, planks or slabs overlaying a timber frame. Historical cartography suggests that recently abandoned huts in the lower part of Val Molinac were probably related to the exploitation of alpine meadows (Angelucci & Carrer, 2015: 73). Poorly structured rock-shelters (ephemeral dry-stone walls constructed across the entrance) were probably used as marginal storage-structures or refuges. They are all located under isolated boulders, rather than rock-walls, and their dimensional variability depends on the size of the boulder as well as on their supposed functional diversity. Rock-shelters are mostly located at the head of the valleys, mainly because of the higher stoniness. The third type of dry-stone features includes enclosures, which were used as pens to gather the livestock for milking and staying overnight. A number of small- or medium-size enclosures (up to few hundred square meters) were detected in Val Molinac and Val Poré, but the features that stand out among all the others are large enclosures (up to one thousand square meters), both single and compound. Each valley includes three large enclosures, which stand as evident landmarks; due to their complexity and importance for the local landscape, compound enclosures deserve a more detailed description.

It is worth pointing out that historical data on the origin and evolution of the aforementioned dry-stone structures are very poor, while ethnographic information simply reports the marginal exploitation of huts and enclosures until the mid-20th century (see below). This makes archaeological data the main source of information for reconstructing the history of anthropogenic upland landscapes in Val Molinac and Val Poré.
2.2. The compound enclosures

The large enclosures of Val Molinac are located in three different altitudinal sectors of the valley. The lowest enclosure, at 1959 m, is named MZ037S. It is a single enclosure, 650 m² large, with walls preserved for less than 1 m above ground level. Interviews with local inhabitants suggest its use until the mid-20th century. The main structure of the valley is MZ001S, located some hundred meters upstream, at a place known as Sassel (2293 m) (Figure 3). It is the largest compound enclosure of the whole area (1800 m² of internal surface) and is composed of three single enclosures. A well-preserved dry-stone hut is incorporated to the south wall of its biggest enclosure. A potsherd found within the hut reveals that this site was still in use during the second half of the 19th century (Dell’Amore, 2014-2015; Dell’Amore, in press), while local interviews suggest its definitive abandonment during the mid-20th century. The highest enclosure (2374 m) is MZ002S, a double rectangular-shaped structure which includes a poorly preserved hut (Figure 3).

In Val Poré, only two compound enclosures, located 65 m apart from each other, are found. The lower one is MZ005S, a 914 m² large site which is located in a gently sloping basin between 2253 and 2262 m and comprises three enclosures and two huts (Figure 4). Another compound enclosure, MZ004S, is located nearby, at 2290 m. It is composed of two single enclosures: a western trapezoidal structure and a poorly preserved eastern curvilinear structure. The highest enclosure of Val Poré is MZ003S (2373 m), a single rectangular structure with a 200 m² internal surface, leaning on the ramp of the rock-glacier that dominates the valley head (Figure 4). Smaller and poorly preserved structures in the surrounding area might be functionally and chronologically related to the use of this enclosure.

All these structures show interesting similarities (Table 1). MZ037S, MZ002S and MZ003S are rectangular, as much as most of the secondary enclosures that compose MZ001S and MZ005S. Besides, there seems to be some sort of standardization in the enclosure size: their average size (median) is 600 m² in Val Molinac, while a bimodal trend can be suggested for Val Poré (200-250 and 400-500 m²). The building technique is fairly similar in all the large enclosures (see Angelucci & Carrer, 2015). The aforementioned characteristics, as well as the similar degree of preservation and incorporation within topsoil of the dry-stone walls, suggest a contemporary construction of the compound enclosures of Val Molinac and Val Poré.

2.3. Accessibility and spatial organisation of landscape features

The exploitation of alpine landscapes is deeply related to seasonal mobility (Le Couédic, 2012). Upland areas are occupied during the summer, and upward mobility within these areas is driven by the gradual vegetation development according to the seasonal cycle (Šebesta, 1991). The location of anthropogenic features is therefore constrained by the accessibility of pasturelands and meadows. According to these insights, one of the most suitable analytical approaches for understanding the characteristics of upland landscapes is simulating the ideal access route from the nearest villages. Moreover, the spatial relationship of landscape features with the simulated path can be used as a proxy to disclose potential functional and chronological correlations between these features. Chronologically and functionally correlated pastoral sites in Val Molinac and Val Poré are expected to

---

2 Anthropic features were named according to the "ALPES" project standard classification, as there is no direct relationship between structures and local land names. The label reads as follows: capital letters indicate the municipality in which the feature is found (e.g.: MZ = Mezzana); three-digit figures refer to the serial number given to the feature; last capital letter denotes the type of feature (e.g.: S = dry-stone structure).
be sited along an ideal pathway that connects lower pastures (exploited early in the season) with valley heads (exploited at the end of the season). This observation led to the use of least-cost path identification method (Gietl et al., 2008) to study the spatial relationships among pastoral structures of the valleys.

The analysis was conducted using \textit{r. walk} and \textit{r. drain} in Grass 6.4 (Neteler & Mitasova, 2008). The first step was the creation of the “cost-surface” used to simulate the “least-cost” path. For the estimation of the cost, friction maps were created from a terrain model (DTM, 10 m resolution). These maps were designed to privilege the mobility in specific areas and to prevent it in others, according to basic hiking rules. In order to favour gentle slopes over steeper ones, slope categories were created and weighted: slope angle from 0 to 5 degrees was given a value of 1; 5 to 15 degrees a value of 5; 15 to 30 degrees a value of 100; 30 to 45 degrees a value of 500; and >45 degrees a value of 1000. Mountain paths usually avoid ridges, due to their exposures to winds and lightening; ridges were thus extracted from an inverse elevation map using \textit{r. watershed}, and a 10-m raster buffer was created around them and given a high friction value. In order to prevent the simulated path to be located within streambeds or around them, a distance-from-streams map was created (considering the morphology) and a high friction value was given to areas within or close to the streams. Two anisotropic cost-surfaces were thus estimated: one with Ortisé as starting point and MZ002S as target (head of Val Molinac), the other with Menas as starting point and MZ003S as target (head of Val Poré). Two least-cost paths were simulated from the aforementioned cost-surfaces (Figure 5).

The simulated least-cost path of Val Molinac intercepts Malga Stabli, as well as the intermediate enclosures (MZ037S and MZ001S), and corresponds to an existing visible path, currently abandoned. The spatial relationship among pastoral structures seems to indicate that all these sites were part of the same system of exploitation of the high pastures, and that they were created and managed in the same period.

Different conclusions can instead be drawn for Val Poré. Here the simulated path does not intercept MZ005S and MZ004S but runs close to the current pastoral site of this valley (Malga Bronzolo), a few hundred meters to the west of the sites. The distinctive morphology of Val Poré might have forced the location of the intermediate enclosures outside of the access route to the valley. Interestingly, the simulated path approximately coincides with the current hiking trail that climbs from Malga Bronzolo to the upper valley.

2.4. The archaeological evidence

Similarity in shape, size and building technique of the enclosures, as well as the spatial correlation highlighted in Val Molinac, account for functional relationships between these landscapes features. In order to assess this assumption and reach a more detailed understanding of the evolution and chronology of the dry-stone enclosures and related features, archaeological techniques were employed. Since 2011 hand-augering, test-pitting and stratigraphic excavations have been carried out at some of the main enclosures of the study area, in particular MZ005S (Val Poré).

Topographic surveys and the analysis of the stratigraphic relationships among structural elements (ES) at MZ005S suggested five phases of development for this compound structure (Angelucci et al., 2013, Fig. 8). The first phase saw the construction of a small sub-circular enclosure. During the second phase, the southern rectangular enclosure was built across the former, thus suggesting its defunctionalisation; a further structural element, preliminarily interpreted as basement of a dry-
stone hut, can be also hypothetically attributed to this phase. Phase three corresponds to the construction of the north-eastern rectangular enclosure; the existence of a passage linking this structural element and the southern enclosure shows that both were in use at the same time. During phase four the southern enclosure was restored and the northern one abandoned. The last phase saw the construction of the dry-stone hut overlaying the southern and north-eastern enclosures.

The architecture of MZ005S indicates that the current character of this site and of the other compound enclosures of Val Molinac and Val Poré (in particular MZ001S and MZ004S) results from the aggregations of different structural elements over time. The accretion of new enclosures to pre-existing compounds could be motivated either by the increase in animal number or by the development of different herding strategies (e.g.: sex-/age-based separation of the livestock, alternate use of each enclosure over the season, etc.).

Chronological data on the construction and restoration of MZ005S are provided by archaeological assemblages collected during excavations and by radiocarbon dating. Most of the finds recovered from the site are dated to late-Medieval and early-Modern times (15th to 17th centuries AD): fragments of *invetriata graffita* pottery (end of the 15th – first half of the 16th centuries), gunflints (probably 17th century), a lead bullet (15th – 17th centuries), a double loop oval buckle (mid-14th – mid-17th centuries) and an iron key (12th – 16th centuries; Dell’Amore 2014-2015; Dell’Amore, in press). Particularly useful for refining the chronology of site occupation are a Venetian bronze coin (*sesino* or *mezzo quattrino*) of Gerolamo Priuli, doge of Venice (1560s to 1603; see B. Marcinik in Angelucci & Carrer, 2015), and a “gooseberry-type” glass bead produced in Venice since the 14th century (Medici et al., 2013) (Figure 6). The late-medieval – early-modern finds come from a buried soil A horizon: this corresponds to a former surface horizon which stratigraphically rests against the enclosure wall, thus proving the contemporaneity between them. This chronologically consistent assemblage was complemented by few potsherds typologically attributed to the Late Bronze Age - Early Iron Age (Luco-Meluno group, 12th-8th centuries BC), providing evidence of human occupation of this upland sector in Protohistoric times (Angelucci & Carrer, 2015).

Charcoal samples collected during the excavation (mostly spruce and larch) were used for radiocarbon dating. Most of them returned dates consistent with the chronology of the material culture recovered (16th – beginning of the 17th centuries AD), while one specimen gave a much earlier date from the 8th century AD. Noticeably, though, no dates match the protohistoric finds collected at the site. Archaeobotanical data suggest that plant composition was quite consistent during the Medieval and post-Medieval periods, with the exception of the possible increase of larch since the 18th century, which could be related to a stronger pastoral pressure on upland ecosystems (see M. Cottini and M. Rottoli in Angelucci & Carrer, 2015).

These data reveal that the main phase of construction and occupation of the MZ005S site started in the 16th century, preceded by a protohistoric and (possibly) early-medieval occupation of the same area. This information seems to confirm previous inferences based on paleoenvironmental analyses, which report evidence of human impact on the environment during the Bronze Age, as well as in the early Middle Ages, with an intensification since the late Middle Ages (Favilli et al., 2010).

Archaeological deposits were also investigated within other enclosures in Val Molinac and Val Poré. Hand-augering at MZ002S (the highest enclosure of Val Molinac) yielded a burned wood (conifer) sample that provided a radiocarbon date spanning from the mid-16th to the early-17th centuries AD. Although no archaeological materials were recovered from this site, this date is consistent with the
chronological framework of MZ005S and suggests that the main phase of exploitation of MZ002S can be attributed to the same time span.

2.5. Historical reconstruction of the local taskscape

Documentary sources enable the social and economic evolution of alpine communities to be disclosed, and the evolution of their productive strategies to be investigated. The historical reconstruction of socio-economic trends, in turn, sheds light on the origin and evolution of human landscapes (see Salvador & Avanzini, 2014). Unfortunately, documents and maps providing information on pastoral management of upland areas are rather scarce, in particular for late-Medieval and early-Modern times. A survey of local and regional archives was undertaken by Giordana Anesi and Matteo Rapanà, in order to record any historical evidence of the exploitation of the pasturelands of Val di Sole from the 13th to 18th centuries AD (see Angelucci & Carrer, 2015).

Former studies have already shown that the economic history of the Alps underwent a phase of significant development since the late 15th - early 16th centuries AD. Demographic growth and agrarian development triggered an intensification of livestock-raising that peaked during the 19th century (Mathieu, 2009). This general pattern had local declinations: in the Val di Sole, part of the Tyrol region of Austria, Count Federico fostered the development of wool industry, which in turn increased the importance of sheep husbandry (Varanini, 2004). Sheep were predominant in this region until at least the end of the 17th century, when cattle took over for the decreasing importance of the wool market and the increasing focus of local communities on cheese and butter production (Coppola, 2002).

An interesting aspect of land management strategy in this area was the renting of high-altitude pastures to foreign herders (Franceschini, 2011). Transhumant shepherds coming from the Republic of Venice (in particular from the neighbouring area of Valcamonica) are recorded in Val di Sole during the 16th, 17th and 18th centuries. It is worth pointing out that “Venetian” products were collected from MZ005S – such as the glass bead and the bronze coin, but also the gunflints, probably obtained from chert of the Lessini Mountains near Verona. Although the large circulation of these objects prevent them from being realistically associated to herders coming from the neighbouring Venetian state, yet it is quite interesting that some of the most valuable objects recovered from the MZ005S enclosure are exotic and come from the same bordering state (see Angelucci & Carrer, 2015; Dell’Amore, 2014-2015; Dell’Amore, in press).

No information regarding the existence of dry-stone structures is provided by the documentary sources so far inspected, and only indirect information can be used to infer the evolution of upland landscapes. In 1563, two communities of the valley stated that they would build their new pastoral cabins far from the sedumum (basement) of the previous ones, thus suggesting that permanent structures were already present on place; a cassina (dairy) and some tressa (pens) were also mentioned. Tabernacula sive tecta (cabins) for the shepherds are mentioned in a document of the mid-17th century AD. The restoration of the casera (dairy) in the communal pastures of Mezzana reported in 1797 suggests the existence, in this period, of more complex pastoral sites, similar to the current malghe. Sixty years later, in the Tyrolean cadastre (1857), casere or malghe are mapped at the same locations and with the same plans of those exploited nowadays by the local herders. This suggests that significant changes occurred during the second half of the 18th century in the upland pastures, triggered by the aforementioned pastoral intensification.
3. Discussion

3.1 Landscape evolution in Val Molinac and Val Poré

The review of archaeological data gathered in Val Molinac and Val Poré, complemented by historical and environmental data, sheds new light on the evolution of pastoral activities in the high-altitudes of Val di Sole.

Few potsherds from site MZ005S place the earliest human presence in the area between the late Bronze Age and the early Iron Age. Archaeological evidence from nearby territories shows the exploitation of Alpine uplands from the middle Bronze Age (Nicolis et al., 2015; Putzer et al., 2016), as well as an increasing human impact on alpine environments starting in same period (Favilli, 2012; Festi 2014). These data show that high-altitude pastoral activities intensified during the 2nd millennium BC, possibly as a result of the development of new economic and productive strategies (Carrer et al., 2016).

Radiocarbon dates may also indicate possible human occupation of the Val Poré in the early Middle Ages, although no material evidence ascribed to this time span was recovered during the excavation (Figure 7). For this reason pastoral activities in the study areas during the 1st millennium AD remain hypothetical, and continuity (or discontinuity) of these activities from Prehistoric times to the Medieval period cannot be assessed.

Archaeological assemblages and radiocarbon dating combine to reveal a secure late-medieval chronology for the construction of at least two of the compound enclosures of Val Molinac and Val Poré (MZ002S and MZ005S). Complementary data suggest that the large compound enclosures were probably built during the same phase: dimensional uniformity; homogeneous building technique of the walls; overall degree of preservation of the features and their degree of incorporation within the organic-rich A soil horizon of the area; spatial relationship of the three large enclosures in Val Molinac; and comparable locational pattern. The human landscape of Val Molinac and Val Poré was clearly reshaped between the 15th and 16th centuries, that is, during the transition from the Middle Ages to the Modern Age. At the same time, historical sources show that rural communities of the Val di Sole and of the whole Tyrol region experienced significant economic development and demographic growth in this period (see Bellabarba, 2002), conforming to a trend noticed in other parts of the Alpine arc (see Mathieu, 2009).

Archaeological and historical data provide a fairly coherent framework for the study area, thus favouring the understanding of the processes behind the anthropogenic reconfiguration of landscape structure in Val Molinac and Val Poré. The two valleys seem to have been occupied on a seasonal basis since late Prehistoric times, although the scarce archaeological evidence does not enable a reliable reconstruction of how human activities shaped the uplands in these earlier phases. During the 15th-16th centuries a system of large compound enclosures – coherently located in each valley – was created, suggesting that pastoral strategies had changed and new facilities were necessary to addressing the new productive goals. The degree of intensification reached by pastoralism during this time span, as suggested by historical sources, might have triggered this transformation. Interestingly enough, the landscape change that accompanies the gradual transition from medieval to modern rural strategies in the Alps is not gradual itself, but abrupt. It seems that once the local pastoral economy reached a critical intensity, upland management system rapidly changed to adapt to the new situation, thus leading to a ‘tipping point’ in landscape evolution: the
reorganization of upland landscapes and the construction of the structures detected in Val Molinac and Val Poré.

A similar discontinuity is also obvious for more recent times. Archaeological data and historical sources show that the large enclosures were repeatedly used until the late-18th and early-19th century, when they were replaced by the modern alpine dairies *(malghe)* still in use nowadays – nonetheless, the residual use of the enclosures until the mid-20th century is also documented. The transformation of the 15th-16th centuries was thus followed by a period of relative stability and by another ‘tipping point’, corresponding to the intensification and ‘industrialisation’ of dairying production during the 19th century. Different phases of abrupt transformation left specific traces in the uplands, creating today’s palimpsestic landscape; similar discontinuities in landscape history have been detected in other high-altitude areas of the Alpine arc related to pastoral economy *(Andres, 2015; Orland, 2004; Remacle, 2001; Salvador & Avanzini, 2014)*.

The data from Val Molinac and Val Poré reveal that the evolution of upland landscapes does not mirror the gradual development of Alpine society and economy, despite being influenced by it. It can be argued that discontinuous landscape evolution in the study area depends on the carrying capacity of upland environments. Resilient human communities can gradually adapt their strategies to changing socio-economic and ecological conditions *(Gómez-Baggethun et al., 2012)*, but when the limit of sustainability is reached, radical transformations are sometimes necessary. These transformation phases (see Figure 7) cannot be explained with an accelerated pace of incremental landscape change in the 15th-16th and 19th centuries *(see Antrop 2000)*. Instead, the evolution of the investigated upland landscape can be more appropriately described as a “punctuated equilibrium”.

The “Punctuated equilibrium paradigm” was developed in the field of evolutionary biology and has been widely applied to the study of complex social systems, organizational evolution, psychology and philosophy of science *(Eldredge & Gould, 1972; Gersick, 1991; Kuhn, 1970)*. It is also used by evolutionary archaeologists and behavioural ecologists to interpret rates and trajectories of culture change *(Rosenberg, 1994; Spencer, 1997)*. The pioneering and revolutionary work of Ester Boserup about the gradual intensification of rural economy under population pressure *(Boserup, 1965)* can also be attributed to the same theoretical and philosophical framework. Punctuated equilibrium theory states that systems evolution alternate periods of equilibrium, in which incremental change is permitted, and periods of punctuated alteration that affects their deep structure. Systems maintain the choices of their deep structure, making some adjustment to preserve the inertia and protect the equilibrium. Revolutionary periods, caused by internal or external changes, tear the old deep structure and enable the formation of a new one. The evolution of the investigated landscapes seems to match this trend. The progressive and continuous intensification of pastoral strategies (in turn enhanced by demographic growth and socio-economic development) led to a radical reconfiguration of upland management and landscape structure at the end of the Middle Ages. In other words, local communities around the 15th century AD reorganized the pasturelands according to the changing economic role of pastoralism. The most evident signs of this reorganization are the large enclosures discussed above. Similar processes occurred during the early 19th century, when the construction of modern pastoral sites *(malghe)* with milk-processing areas and barns for stabling dairying animals was encouraged by the growing importance of cattle and cheese-making in alpine economy. The ephemeral use of the dry-stone enclosures during the 19th and early 20th centuries suggests that some features of the earlier landscape organisation were incorporated in the new system, often with a distinct function.
The case-study reported in this paper shows that historic landscape character is not determined by the superimposition of unrelated features cumulatively added over time, but is the result of phases of rapid (often radical) landscape reconfigurations, anticipated and followed by more stable periods. In this perspective, palimpsests seem to originate from the interaction of features belonging to different landscape reconfiguration phases (i.e. different ‘deep structures’ of the landscape).

3.2. Final remarks

Current upland landscapes are palimpsests of footprints left by past human activities. A general overview of these palimpsests might suggest that upland landscape character has changed gradually over time, as a cumulative result of intentional and unintentional human strategies of niche-construction (Laland & O’Brien, 2011). However, the case-studies presented above show that the evolution of anthropogenic upland landscapes can be discontinuous, with long periods of stability punctuated by phases of rapid change (Figure 7). As pointed out before, the model that best approximates the observed historical trajectory seems to be the “punctuated equilibrium paradigm”, widely applied in biological and social sciences.

Punctuated evolution fits the data from different upland sectors of the Alps, and it can also be assumed for other mountainous ranges (Rendu, 2003). It can be disputed, though, whether this theory applies only to highlands and pastoral landscapes, or might be a useful guide for approaching and interpreting any historical rural landscape. The extensive and seasonal exploitation of high-altitudes – which in turn constrains the type and range of activities to be fulfilled – certainly facilitates the identification of phases of stability and change. These are expected to be complex to assess in the much more intensively occupied lowlands, where various activities are often spatially aggregated and different sectors of the landscape embed multiple functions and values (Turner, 2006; Turner & Crow, 2010). Nevertheless, evidence of discontinuity in the landscape evolution has been highlighted in some agricultural areas (see for example: Pluciennik et al., 2004; Rippon et al., 2006), suggesting that these processes can be pinpointed even in permanently inhabited lowlands.

The use of punctuated equilibrium theory to interpret the aforementioned discontinuity as a change in the deep structure of the landscape might lead to a more accurate understanding of landscape history and landscape-change driving forces (Bürgi et al., 2004).

In recent decades, landscape has been a privileged arena of confrontation among distinct theoretical archaeological approaches (e.g. Fleming, 2006; Fleming, 2007; Johnson, 2007; Tilley, 1994), but evolutionary theory has featured in this debate little if at all. One of the goals of this study has been to explore the potentials of “punctuated equilibrium paradigm” for landscape archaeology, through its application to the pastoral landscapes detected in the Alpine valleys of Val Molinac and Val Poré. The inferences proposed above are preliminary and the theory needs to be applied to a wider range of landscapes to be fully evaluated; but this study will hopefully pave the way to future developments in this direction.
References


URL: http://mc.manuscriptcentral.com/clar  Email: journal@landscaperesearch.org


Alps (Switzerland/Austria) as evidenced by archaeological, palaeoecological and pedological proxies. 
Zeitschrift für Geomorphologie, 59 (2), 177-198.


### Tables

**Table 1.** Shape and size of the large and compound enclosures of Val Molinac and Val Poré.

<table>
<thead>
<tr>
<th>Valley</th>
<th>Enclosure</th>
<th>Structural Element</th>
<th>Shape</th>
<th>Size (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Val Molinac</td>
<td>MZ037S</td>
<td>-</td>
<td>Rectangular</td>
<td>650</td>
</tr>
<tr>
<td></td>
<td>MZ001S</td>
<td>N</td>
<td>Irregular</td>
<td>750</td>
</tr>
<tr>
<td></td>
<td>MZ001S</td>
<td>SW</td>
<td>Rectangular</td>
<td>600</td>
</tr>
<tr>
<td></td>
<td>MZ001S</td>
<td>SE</td>
<td>Rectangular</td>
<td>450</td>
</tr>
<tr>
<td></td>
<td>MZ002S</td>
<td>E</td>
<td>Irregular</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>MZ002S</td>
<td>W</td>
<td>Rectangular</td>
<td>630</td>
</tr>
<tr>
<td>Val Poré</td>
<td>MZ005S</td>
<td>ES1/6</td>
<td>Rectangular</td>
<td>402</td>
</tr>
<tr>
<td></td>
<td>MZ005S</td>
<td>ES3</td>
<td>Rectangular</td>
<td>256</td>
</tr>
<tr>
<td></td>
<td>MZ004S</td>
<td>W</td>
<td>Irregular</td>
<td>565</td>
</tr>
<tr>
<td></td>
<td>MZ004S</td>
<td>E</td>
<td>Irregular</td>
<td>N/A</td>
</tr>
<tr>
<td></td>
<td>MZ003S</td>
<td>-</td>
<td>Rectangular</td>
<td>200</td>
</tr>
</tbody>
</table>
Figure captions

Figure 1. The location of Trentino (top, left) and Val di Sole (right, left) in the Alpine arc, and the study-area with the surveyed dry-stone structures (bottom) – modified after Angelucci & Carrer, 2015, fig. 1.

Figure 2. Panoramic view of the Val Molinac from the South.

Figure 3. Two of the large compound enclosures of Val Molinac: MZ001S (top) and MZ002S (bottom).

Figure 4. Two of the large compound enclosures of Val Poré: MZ005S (top) and MZ003S (bottom).

Figure 5. GIS-simulated least-cost paths from Ortisé and Menas towards respectively the head of Val Molinac and Val Poré.

Figure 6. The early-modern Venetian bronze coin (top – diameter 16 mm) and the glass bead (bottom, length 6 mm) from the MZ005S excavation.

Figure 7. Synoptic chart on the chronology of historical and archaeological evidence from Val Molinac, Val Poré and surroundings. Line "documentary sources": age of documentary sources mentioning the villages of Ortisé and Menas or the surrounding uplands (documents younger than 1754 are not taken into account). Lines "Val Molinac" and "Val Poré": grey bars – approximate age of archaeological finds recovered in the sites of the valley (labels refer to the site ID); black bars – radiocarbon dates available from the sites of the valley (labels refer to the sample ID; ages are represented as 2σ intervals between minimum and maximum calendar years). Vertical grey columns indicate approximate periods of abrupt changes suggested in the text (data after Angelucci & Carrer, 2015 and Dell’Amore, 2014/2015).
Figure 1. The location of Trentino (top, left) and Val di Sole (right, left) in the Alpine arc, and the study-area with the surveyed dry-stone structures (bottom)

247x288mm (150 x 150 DPI)
Figure 2. Panoramic view of the Val Molinac from the South.

245x164mm (300 x 300 DPI)
Figure 3. Two of the large compound enclosures of Val Molinac: MZ001S (top) and MZ002S (bottom).

254x342mm (150 x 150 DPI)
Figure 4. Two of the large compound enclosures of Val Poré: MZ005S (top) and MZ003S (bottom).

249x274mm (150 x 150 DPI)
Figure 5. GIS-simulated least-cost paths from Ortisé and Menas towards respectively the head of Val Molinac and Val Poré.

209x296mm (150 x 150 DPI)
Figure 6. The early-modern Venetian bronze coin (top – diameter 16 mm) and the glass bead (bottom, length 6 mm) from the MZ005S excavation.

199x232mm (150 x 150 DPI)
Figure 7. Synoptic chart on the chronology of historical and archaeological evidence from Val Molinac, Val Poré and surroundings. Line "documentary sources": age of documentary sources mentioning the villages of Ortisé and Menas or the surrounding uplands (documents younger than 1754 are not taken into account). Lines "Val Molinac" and "Val Poré": grey bars – approximate age of archaeological finds recovered in the sites of the valley (labels refer to the site ID); black bars – radiocarbon dates available from the sites of the valley (labels refer to the sample ID; ages are represented as 2σ intervals between minimum and maximum calendar years). Vertical grey columns indicate approximate periods of abrupt changes suggested in the text.