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Climate change; human impact; Silvretta Massif; human adaption; Alpine Space.

Introduction

The Silvretta Massif is a mountain range on the Swiss-Austrian border. Apart from a few well known Bronze and Iron Age sites[1] in the Lower Engadin valley, the Silvretta has been more or less a kind of 'archaeological terra incognita', especially in the (high) alpine zones. Hence a multidisciplinary study named "Rückwege" was initiated by the Department of Prehistory at the University of Zurich (Th. Reitmaier) in 2007. The project's main goal is to explore alpine dairy farming, in particular its beginnings.[2]

Alpine regions like the Silvretta Massif are highly sensitive to climatic variations that affect alpine land-use and economy. Therefore at the end of 2010 another research program, entitled "CCA—Climatic Change in the Alps: 10,000 years of climatic and human impact in the Sivretta Massif between the Paznaun Valley (Austria) and the Lower Engadin (Switzerland)", was initiated. This project, which consists of an archaeological (K. Lambers, University of Bamberg) and a palaeoecological part (J.N. Haas, University of Innsbruck), is focusing on the reconstruction of the environmental and the settlement history of the Silvretta from the end of the last ice age until the 20th century, with particular regard to human-climate interactions. To understand these processes a well-founded, wide data base is indispensable. In 2011 a complementary field survey was therefore undertaken between Val Lavinuoz and Val Sinestra in the Swiss part of the research area, and Montafon valley and Fimber valley in the Austrian part. We recorded around 200 hitherto unknown sites covering the whole Holocene (Fig. 1).

The climatic influence on human activity and its impact on settlement behaviour within the study area shall here be discussed using the examples of the Bronze Age, the Roman period and the late Middle Ages or Modern Period.

Bronze Age

In the middle of the fifth millennium BC the central alpine region increasingly became an area of permanent settlement.[3] This development, with a short term decline between 3700 and 3000 BC[4] culminates in the Bronze Age. From around 2200 BC onwards an increase in settlement activities within the alpine belt can be noted.[5] This demographic development is not restricted to the main alpine valleys, also smaller (side) valleys like

1 Rageth 1997; Zürcher 1982.
2 Reitmaier 2010.
3 Oeggl and Nicolussi 2009, 81.
4 Oeggl and Nicolussi 2009, 81.
5 Primas 1999; Curdy 2007.

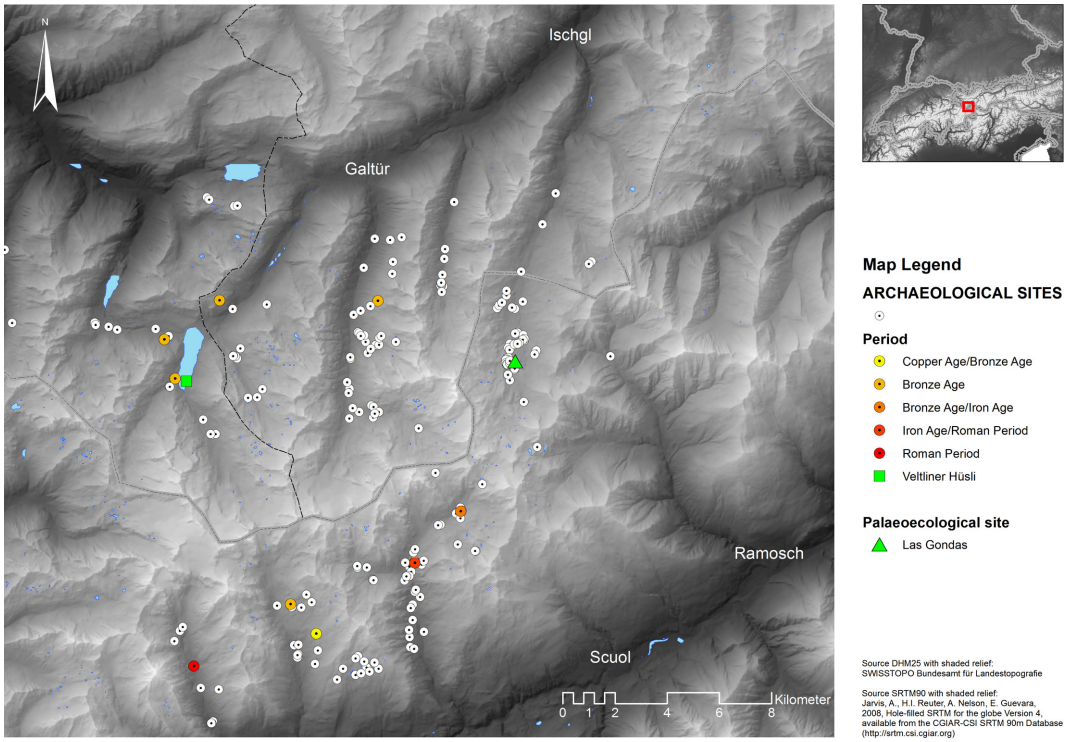

Fig. 1 | Map of the study area with the archaeological and palaeoecological sites. Those sites mentioned in the text are highlighted in colour: yellow to red dots = Bronze and Roman Age sites, green square = 'Veltliner Hüsli,' green triangle = 'Las Gondas' (Map source: DHM25 with shaded relief: ©SWISSTOPO Bundesamt für Landestopografie. Inland waters and administrative boundaries: http://diva-gis.org/gdata - April 3rd 2012).

the Montafon[6] or the lower Engadin valley[7] became more densely colonized. The increasing settlement in the valleys was accompanied by intensified exploitation of the high altitude zones. This phenomenon, starting in the Neolithic, is reflected in a variety of pollen diagrams depicting the situation throughout the Alps[8] and showing a retreat of the timberline and a significant increase of pastoral indicators, indicating extended summer farming. In the Silvretta region the situation is comparable. For the Bronze Age, based on radiocarbon dating from hearths and locally defined charcoal deposits, we were able to detect eight sites in altitudes between 2050 and 2350m asl (Fig. 2). Due to the lack of economically recoverable raw material in the study area, these sites are likely to be related to pastoral or hunter/gatherer activities. If we now compare climatic developments during this period to archaeological sites and palaeoecological data, it is remarkable that the majority of these findings can be parallelized with a climatically unfavourable phase reported for the Austrian and Swiss Alps between 1800–1300 BC,[9] which is called "Löbben", or "Tiefengletscher"and corresponds with the cold phase CE-7.[10] In the Silvretta this tendency can be confirmed by a clear accumulation of sites in the 18th–13th century cal. BC (2σ).

6 Krause 2009.
7 e.g., Stauffer-Isenring 1983; Caduff 2007.
8 Gobet, Vescovi, and Tinner 2010; Bortenschlager 2000.
9 3500–3100 BP Patzelt and Bortenschlager 1973, 62.
10 Pindur, Schäfer, and Luzian 2007, 191; Haas et al. 1998, 305.

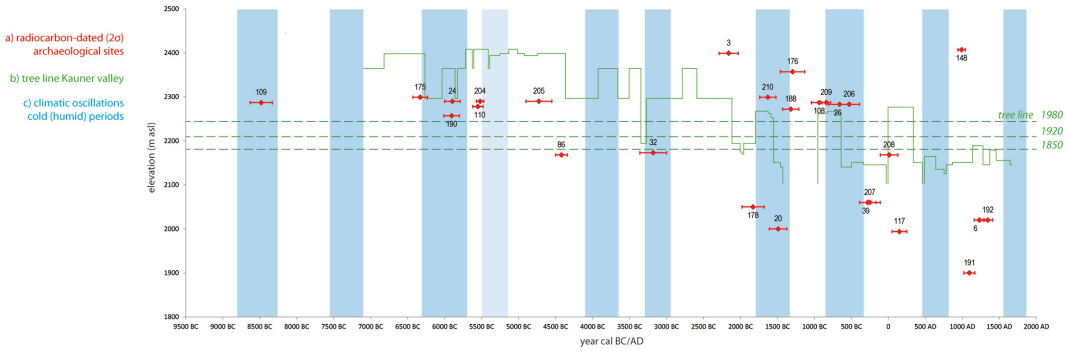

Fig. 2 | Time-altitude distribution of the radiocarbon dated archaeological sites (state: spring 2012). The 2σ range of the calibrated ^{14}C ages is given with the median value. b) Tree line in the inner Kauner valley/Tyrol based on dendrochronologically dated mega fossils (modified after Nicolussi 2009a Fig. 6). c) Holocene climatic oscillations, cold (humid) periods CE-1 to CE-8, Göschenen II and Little Ice Age modified after Haas et al. 1998; Büntgen et al. 2011; Veit 2002; Siegmund 2011.

Roman Period

Multi-proxy analyses show that the Iron Age was an era of rather unfavourable climatic conditions until the second century BC.[11] From then onwards until the middle of the third century AD warm and wet summers occurred, also known as the Roman climate optimum.[12] Some researchers proclaim an intensification of mountain pasture for this time, which can be seen, inter alia, in pollen diagrams.[13] Even historical records like those of the historian and geographer Strabon (64/63 BC–24/25 AD) describe wool and cheese trading between alpine societies and the plains and, therefore, high altitude grazing can be assumed.[14] But there is one major issue about this theory: the low number of upland archaeological sites in the Alps.[15] This might be just a lack of research but studies in the Parc National des Ecrins by Kevin Walsh and Florence Mocci confirm "a reduction in the level of activity" in high altitude zones.[16] Until now, only two camp sites underneath rock shelters in the Silvretta Massif—in Val Urschai (110 cal. BC–130 cal. AD, 2σ) and in Val Lavinuoz (50–250 cal. AD, 2σ)—could be dated in this climatically advantageous period (Fig. 2). This does not necessarily imply an abandonment of alpine pasture in the high altitude zones of the Silvretta, even though the number of known sites from the Roman period in the study area is low compared to the Bronze and Iron Ages. Other studies in the adjacent Montafon (Austria) and St. Antönien valley (Switzerland) have proven that there was human activity linked with pastoralism.[17] Local societies in the Silvretta and in the neighbouring valleys in Vorarlberg and Grisons seem to have used the high mountain regions, but probably not as intensively as in prehistoric times.[18] These results, combined with what we know from the Western Alps, lead to a question that has to be discussed further: Why does there seem to be a waning of human activity in these zones despite favourable climate conditions compared to preceding periods? One possible explanation could rather be the "cultural processes that have influenced people's decisions to move

11 Nicolussi 2009b, 120; Büntgen et al. 2011, 578.
12 Veit 2002, 259.
13 Schmidt, Kamenik, and Roth 2009, 92; Gleirscher 2010, 58.
14 Gleirscher 2010, 58.
15 Carrer 2012, 106; Gleirscher 2010, 58.
16 Walsh, Mocci, and Palet-Martinez 2007, 9.
17 Krause 2011, 17; Röpke et al. 2011, 495.
18 Kathrein 2010, 79–81.

into and work the alpine zone",[19] such as "peoples' attraction to the developing complex urban centres" which may have put "a new emphasis on valley-based communication and a reduction of activity at higher altitudes".[20]

Modern Period

As a last example the results of the studies of a (late) medieval-early modern tollhouse and tavern, the so called Veltliner Hüsli, are to be discussed.[21] The ruins of the building, now submerged under the waters of a reservoir lake ('Silvretta-See'), were archaeologically examined during two short excavation campaigns in 2010 and 2011 while the lake was drained for renovating the dam. The stone building was once located at the entrance of the Ochsental along a trans-regional trading route leading from the Paznaun and Montafon valley via the glaciated Vermunt pass (2717m asl) to the Valtellina valley in Italy. Historical sources report that the tavern was already a ruin at the end of the 18th century AD.[22] Besides political and historical unrest during the early modern age and the shift of trading to different routes, the main reason for the abandonment of the 'Veltliner Hüsli' was the changing climatic conditions. Historic documents confirm this presumption.[23] During the Little Ice Age alpine glaciers began to grow. These glacier advances involved enlarging crevasses. Hence travelling this track became more and more unsafe and the 'Veltliner Hüsli' lost its importance.

Discussion and Outlook

One of the main issues regarding a parallelization of climatic and archaeological data is the inaccuracy of dating.[24] When we are talking about climatic impact on human activity and cultural development another important factor is the scale being used.[25] These two factors have to be taken into account, especially for prehistoric times. For example, during the Bronze Age or the Roman period, seen from a larger perspective, climate does not have such a big influence on society and settlement dynamics. On the other hand, climate change can have massive singular effects, as we found out for the 'Veltliner Hüsli.' This means that climate and culture must not be correlated linearly.[26]

19 Walsh, Mocci, and Palet-Martinez 2007, 17.
20 Walsh, Mocci, and Palet-Martinez 2007, 20.
21 Reitmaier and Walser 2011.
22 Der Sammler 1781, 52; Steub 1996, 84.
23 Jäger 2008, 29.
24 Maise 1998, 201–202.
25 Oeggl and Nicolussi 2009, 83.
26 Bleicher 2011; Oeggl and Nicolussi 2009; Berglund 2003.

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