Archaeological and palaeoecological investigations at Burgäschisee (Swiss Plateau): new interdisciplinary insights in Neolithic settlement, land use and vegetation dynamics

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Albert Hafner[1,2], *Fabian Rey*[2,3,4], *Marco Hostettler*[1,2], *Julian Laabs*[1,2], *Matthias Bolliger*[5], *Christoph Brombacher*[6], *John Francuz*[1], *Erika Gobet*[2,3], *Simone Häberle*[6], *Philippe Rentzel*[6], *Marguerita Schäfer*[6], *Jörg Schibler*[6], *Othmar Wey*[1,2], *Willy Tinner*[2,3]

1 – Institute of Archaeological Sciences, University of Bern, Switzerland
2 – Oeschger Centre for Climate Change Research, University of Bern, Switzerland
3 – Institute of Plant Sciences, University of Bern, Switzerland
4 – Geoecology, Department of Environmental Sciences, University of Basel, Switzerland
5 – Archaeological Service of the Canton of Bern, Underwater Archaeology and Dendrochronology, Sutz-Lattrigen, Switzerland
6 – Institute for Integrative Prehistory and Archaeological Science, University of Basel, Switzerland

Introduction

The prehistoric lake dwellings of Switzerland, Germany, and Austria have been known for more than 150 years. Of these, 111 were awarded UNESCO World Cultural Heritage status in 2011. Mainly dating from the Neolithic (including the Chalcolithic or Copper Age) and the Bronze Age, lacustrine settlements represent an early phase of sedentarisation in the northern foothills of the Alps. Despite much significant research on the material culture, settlement dynamics, economy, and ecology, the focus has hitherto almost exclusively been on the classic sites situated on the larger northern pre-Alpine lakes in the so-called Three Lakes region of western Switzerland and on the Lakes of Geneva, Zurich, and Constance. The international and interdisciplinary research project 'Beyond lake villages: studying Neolithic environmental changes and human impact on small lakes in Switzerland, Germany and Austria' was launched in 2015

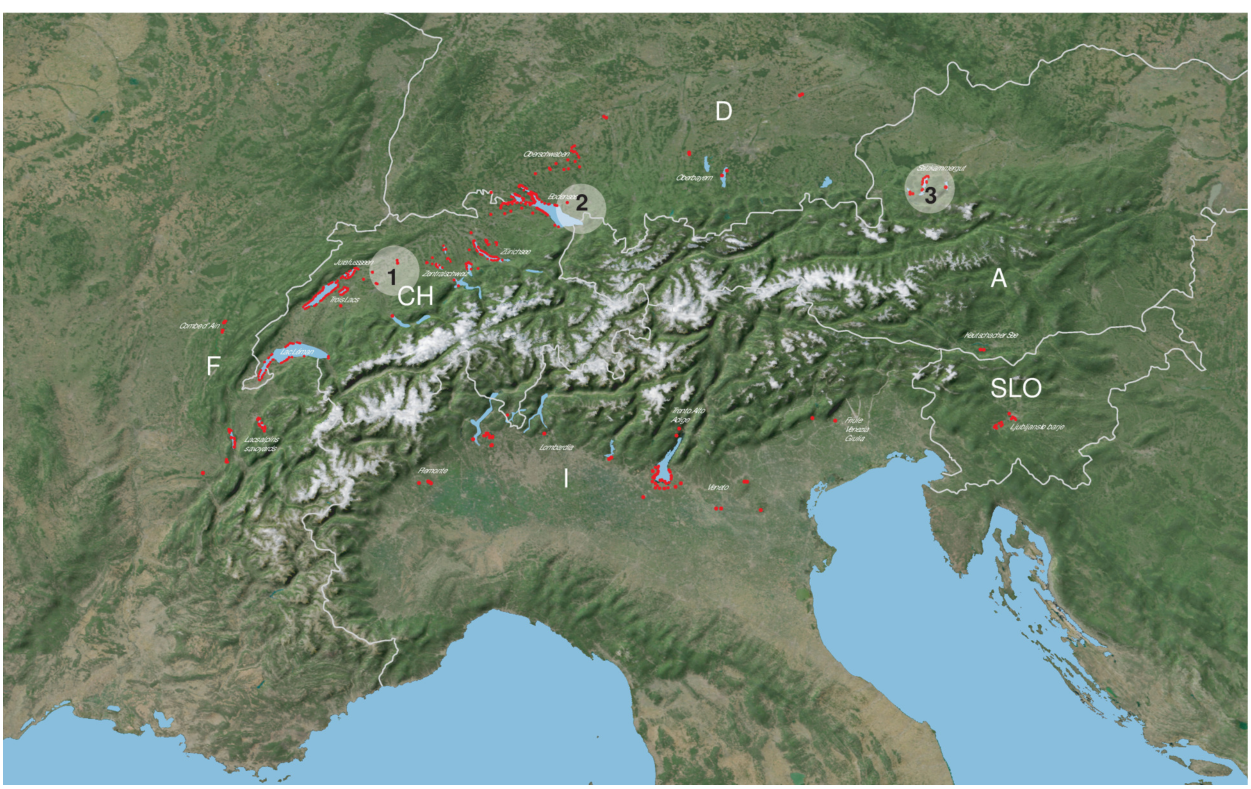

Figure 1: Areas examined as part of the interdisciplinary project entitled 'Beyond lake villages' in the Alpine region. 1 Burgäschisee, central Switzerland, 2 Westallgäu, southern Germany, 3 Salzkammergut, Austria.

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and is jointly funded by the Swiss (SNF), German (DFG), and Austrian (FWF) National Science Foundations. Research teams in prehistoric archaeology and palaeoecology from the universities of Bern, Basel, Vienna, and Innsbruck as well as the cultural heritage management authorities of the German State of Baden-Württemberg and the Swiss Cantons of Bern and Solothurn are concentrating their efforts on three Neolithic settlement areas on the Swiss Plateau, the German Westallgäu, and the Austrian Salzkammergut (Figure 1). Research is focused on small, deep lakes and their immediate surroundings, with the aim of obtaining new high-resolution data on the natural environment and human impact on the landscape. Our ongoing palaeoecological investigations have confirmed that small, deep lakes such as Burgäschisee and Moossee in Switzerland preserve laminated annual sediments that have enormous potential for generating high-resolution, diachronic data on vegetation, palaeoclimate, and human impact. Through the integration of wetland archaeology and palaeoecology, we hope to generate new data and models that will help to understand the variability of human impact on landscapes, especially the environmental interactions of Neolithic societies in the circum-Alpine region. The overall aim of the project is to gain a better understanding of large-scale processes of adaptation and anthropogenic impact over time. The 'Beyond lake villages' project began by setting the following goals:

- to significantly enhance the archaeological database of Holocene human activity in three research areas and to precisely analyse chronologically-resolved sedimentary records (e.g. pollen, spores, macrofossils) of annually laminated sediments, and to cross-correlate them with phases of occupation as dated by dendrochronology and AMS-radiocarbon chronology in periods of significant palaeoclimatic oscillations.
- to expand research into the 'hinterland' of large pre-Alpine lakes to examine an extended range of human land use activities employing a combination of archaeological and palaeoecological methods so as to identify and understand the nature of agricultural systems, fire management regimes, wildfires, and woodland cycles.
- to gauge population mobility and to establish patterns of demographic change.
- to identify agents of economic and cultural processes in relation to physical-geographical conditions and human economic adaptions at a time of significant climatic/environmental change and to model possible scenarios across three similar cultural and natural environments in the northern pre-Alpine zone.

Geographical data and earlier research

Burgäschisee is a small eutrophic lake on the Swiss Plateau (47°10'8.5"N, 7°40'5.9"E) located at 465 m a.s.l. (Figure 2, Figure 3). The surface area is 21 ha, the maximum water depth is 31 m and the hydrological catchment area is 3.2 km^2 (Guthruf et al. 1999). Ca. 18,500 years ago, after the end of the Last Glacial Maximum (LGM), its surface area was about six times larger than it is today (von Burg et al. 2011). During the Holocene, the shallow areas of the Pleistocene lake transformed into large peat bogs. The lake level was artificially lowered by 2 m in 1943 to drain the wetlands

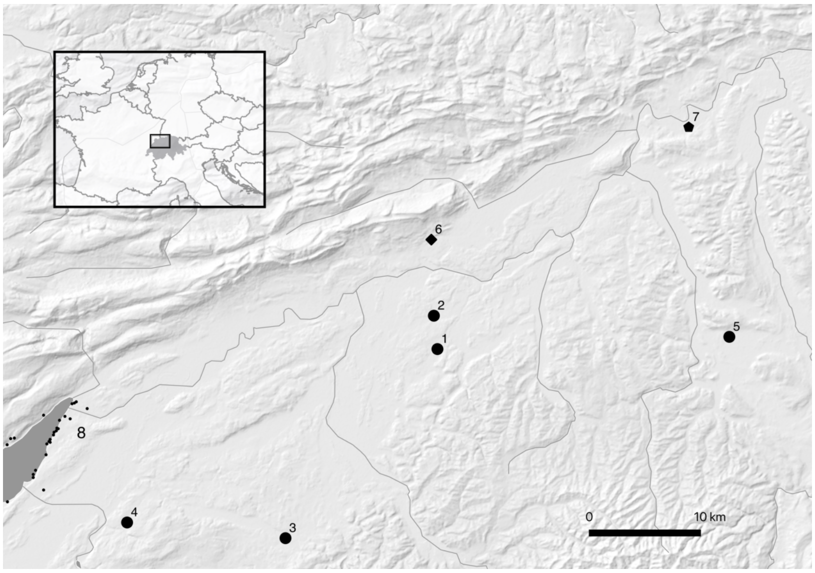

Figure 2: The Burgäschisee research area in central Switzerland and associated Neolithic sites. 1 Burgäschisee, lake dwellings, 2 Inkwilersee, lake dwellings, 3 Moossee, lake dwellings, 4 Lobsigensee, lake dwellings, 5 Egolzwil, lake dwellings, 6 Oberbipp, Steingasse, collective dolmen burial site, 7 Däniken, Studenweid, stone cist burial site, 8 Lake of Biel, lake dwellings.

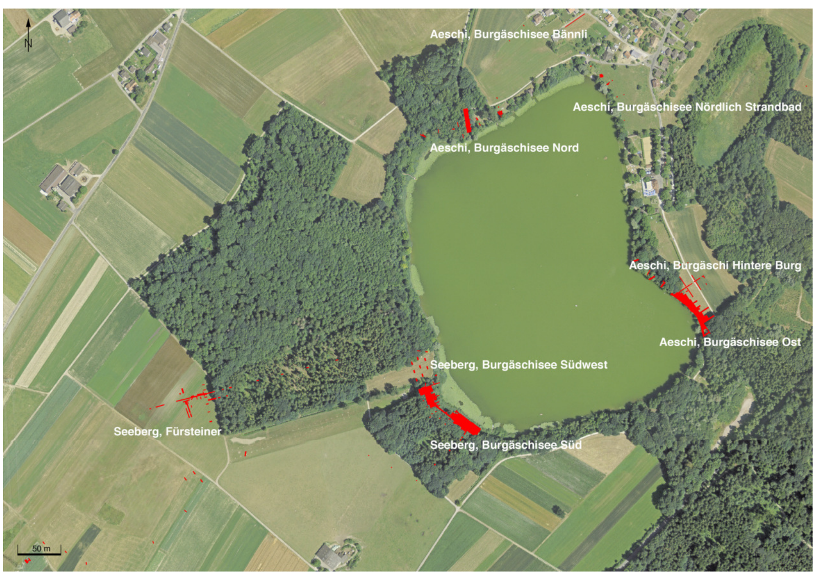

Figure 3: Aeschi SO and Seeberg BE. Burgäschisee. Archaeological investigations.

in the area and to create farmland (Arn 1945). The local climate is oceanic with a mean annual temperature of 9.1 °C and an annual rainfall average of 1088 mm (data: MeteoSwiss).

The first archaeological finds came to light in the mid-19th century. Surface concentrations of flint artefacts along the Pleistocene/Early Holocene shorelines point to the presence of hunter-gatherer camps which can be attributed to the Magdalenian and Late Palaeolithic and to the Mesolithic (von Burg et al. 2011; Wyss 1952, 1953). Excavations at Neolithic settlement sites began in 1877/1902 and were followed by several major excavation campaigns in 1944–1946, 1951–1952, and 1957–1958 (Anliker et al. 2009, 2010; Bandi et al. 1973; Bleuer et al. 1988; Brunnacker 1967; Müller-Beck and Schweingruber 1965; Müller-Beck and Wey 2008; Wey 1999, 2001, 2012). Before the 2015–2017 investigations, four Neolithic settlements from the 4th millennium BC had been known and individual finds had also indicated human presence during the 5th and 3rd millennia BC. Several inhumations, probably Neolithic cist graves, were found in the early 20th century in bogs immediately west of Burgäschisee. Similar cists dating from around 4300–4000 BC were found in 1946 and 1970 at Däniken, Studenweid, approximately 10–20 km away (Dubuis and Osterwalder 1972; Schweizer 1947). A collective burial in a megalithic dolmen dating from 3300–3000 BC was discovered in 2012 at Oberbipp, Steingasse (Ramstein et al. 2013). Bronze Age finds indicating 2nd millennium BC settlements were detected in nearby Lake Inkwilersee (3 km from Burgäschisee) during underwater archaeological surveys carried out in 2007 (Hafner and Harb 2008; Hafner et al. 2008), altogether suggesting that the area was permanently settled since more than 6000 years.

The Burgäschisee area is situated between the important Neolithic settlement concentrations in the Three Lakes region (Seeland) in the west and Lake Zurich in the east. Because the excavations at Burgäschisee took place early in the history of archaeological research, only a small number of dendrochronological dates were available from one of the sites until now. A predominance of Cortaillod-style pottery suggests contact between Burgäschisee and western Switzerland on one hand and 4th millennium sites in the Three Lakes region and beyond (Néolithique Moyen Bourguignon pottery styles in eastern France) on the other. Copper artefacts and crucibles found at Burgäschisee also indicate intensive long-distance contact with areas in eastern Switzerland and southern Germany (Anliker et al. 2010; Dzbyński 2014; Lefranc et al. 2012; Nielsen 2012; Ottaway and Strahm 1975; Wey 2012) whilst unique animal clay figures of Neolithic age suggest cultural links with regions even further to the east (eastern Austria, Moravia, and Bohemia).

Pioneering palynologist Max Welten examined lakeshore sediments and an on-site palynological transect through one of the prehistoric settlements from the 1940s onwards. In this way he was able to reconstruct the vegetation for a period of over 15,000 years; an extraordinary feat for the time (Welten 1947, 1955, 1967). From 2009 to 2014, exploratory studies initiated by the Palaeoecology Group at the Institute of Plant Sciences and the Oeschger Centre for Climate Change Research at the University of Bern, in collaboration with the Climate Geology Group at the Swiss Federal Institute of Technology ETH in Zurich, made it possible to identify the Burgäschisee region as a new archive of annually laminated sediments. The area has a very limited catchment and no relevant slopes, resulting in negligible erosional input (van Raden et al. 2013). In the autumn of 2009 and spring of 2014, a total of four parallel sediment cores (up to 15 m long) were retrieved from the deepest point using an UWITEC piston corer. Radiocarbon dates and palaeoecological data showed that the lake sediments cover a period of at least 18,700 years (Rey et al. 2017). These overall investigations suggested similar vegetation and land use dynamics for the Burgäschisee region as those identified at other (partially annually laminated) sites on the Swiss Plateau (e.g. Soppensee, Lotter 1999), where the vegetation dynamics (e.g. vegetation composition, openings of forests) were mainly controlled by land use measures including the use of fire since the beginning of the Neolithic around 5400 BC (Tinner et al. 2005a, 2003). They also suggested that thanks to the annual laminations from the mid and late Holocene, Burgäschisee could be one of only a few lakes on the Swiss Plateau that is suitable for high-precision and high-resolution palaeoecological studies (Rey et al. 2017).

Archaeological investigations: new data from Neolithic settlement sites

The last large-scale excavations carried out on Burgäschisee from 1952 to 1958 were run by the Historisches Museum Bern and the Institute ('Seminar') of Prehistory at the University of Bern (predecessor of today's Institute of Archaeological Sciences, both of which were managed by Hans-Georg Bandi at the time). Following ground-breaking early interdisciplinary research, Burgäschisee fell into a deep slumber for over 50 years and no synthesis of the prehistoric occupation of this small settlement area, which was one of the most important settings for pile-dwelling research for more than 150 years, was ever compiled. From the point of view of archaeological research, the lack of dates obtained by modern methods made it impossible to compile an overview of the well-known sites and the settlement history of the Burgäschisee region. Because the locality also bore a high palaeoecological potential for varve formation, the Institute of Plant Sciences at the University of Bern independently carried out sediment coring at Burgäschisee in 2009 and again in 2014. The combination of all these aspects led to a situation that appeared to be suitable for a joint archaeological and palaeoecological research project, and initial archaeological preparation work began in 2012. In the summer of 2013, various archaeologically promising areas were surveyed by means of an intensive coring programme. All areas with wetland preservation near the shoreline of Burgäschisee and in the adjacent wetland areas of Aeschimoos and Chlöpfibeerimoos were examined using hand augers. This led to the discovery of a number of previously unknown Neolithic settlements and helped to define more precisely the boundaries of known settlement sites. On the other hand, the almost 200 cores also showed that there were no prehistoric settlement layers in the peatlands of Chlöpfibeerimoos or Aeschimoos areas. Additional surveys were undertaken further away from the lakeshore on slightly elevated areas without wetland preservation at Aeschi SO, Burgäschi, Hintere Burg, and Bännli and at Niederönz SO, Seeacher, and Seeberg BE, Seematt, and these were combined with data obtained from 2015 to 2016. Only Burgäschi, Hintere Burg was revealed to be an area of archaeological interest, the other examinations produced negative results.

Whilst hydrographic investigations carried out in December 2014 in the shallow water zone of Burgäschisee using a single-beam echo sounder had indicated archaeologically promising areas, a coring survey to test these areas produced no positive results. The entire shallow-water area of Burgäschisee was examined in March 2016 by members of the diving team of the Archaeological Service of Canton Bern, but no evidence of submerged settlements, such as piles or pottery, were discovered on the lakebed. The underwater archaeological surveys were hampered by difficult conditions in the lake, where a high concentration of suspended matter generally restricted the divers' visibility to less than 1 m. The reed beds in the shallow-water areas on the northern and southern shores as well as dense macrophyte cover along the western shore further impeded surveying of the lakebed.

Between 2015 and 2017, numerous test excavations were carried out at the lakeshore sites of Seeberg BE, Burgäschisee Süd and Südwest, and Aeschi SO, Burgäschisee, Nord, Nördlich Strandbad, Ost and Hintere Burg and were extended to areas of up to 30 m^2 if the test trenches had yielded

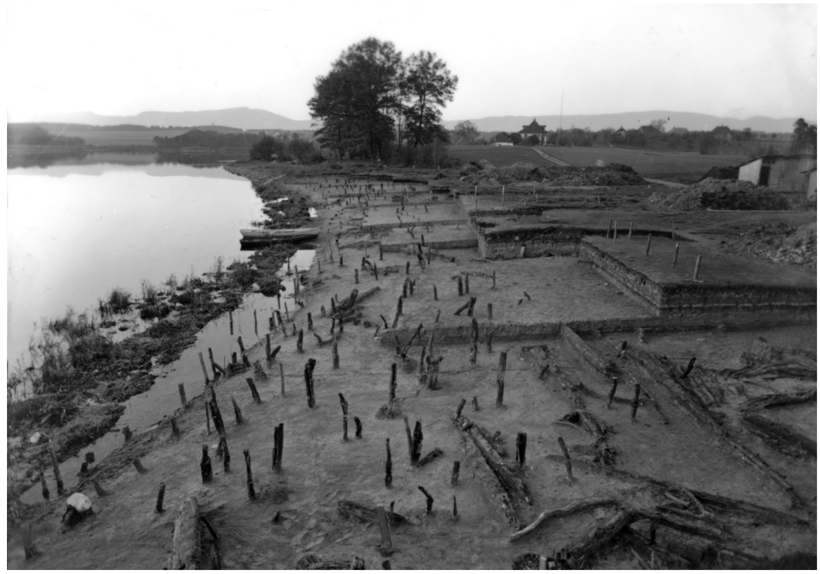

Figure 4: Aeschi SO, Burgäschisee Ost. Overview of the Neolithic pilefield uncovered by the 1944 excavations.

Figure 5: Aeschi SO, Burgäschisee Ost. Working situation 1944 excavations.

any positive results (local excavation director: Othmar Wey). Test trenches were dug both at known sites and in areas that had not yet yielded any archaeological evidence but which appeared promising. Because the known sites were all excavated between 1877 and 1958 and the excavation records had either been partially or completely lost, leaving considerable gaps in the available information, the test excavations mainly aimed to obtain evidence with regard to the stratigraphical sequence and to retrieve piles and horizontal timbers for dendrochronological dating. A total of six settlement sites, some multi-phased and considerable in size, are now known to have existed at Burgäschisee during the Neolithic period.

Figure 6: Aeschi SO, Burgäschisee Ost. Reconstruction of house locations based on a plan from the 1944 excavations.

Aeschi SO, Burgäschisee Ost

The site of Burgäschisee Ost was excavated in detail in 1944–1945 after the lake level had been artificially lowered (Figure 4, Figure 5). The excavation revealed a large but rather sparse pilefield and a thin layer, most probably disturbed, containing archaeological finds. Ceramic vessels of the classical Cortaillod style allowed us to date the site to around 3800 BC (Anliker et al. 2009, 2010). The closest parallels were the pottery assemblages from Twann BE, Bahnhof, US layer (Lake Bienne, 40 km west of Burgäschisee, dendrochronologically dated to 3838–3768 BC; Stöckli 1981, 2009), Egolzwil 2, layer III, and Egolzwil 4 (both at the Wauwil bog, 30 km east of Burgäschisee; Wey, 2001). Two piles recovered from the area were dendrochronologically dated in 1985 (Anliker et al. 2009). The waney edge dates were estimated to have covered the period between 3835–3830 BC. The dates were based on a short mean curve of only 35 tree rings and the original readings and samples have since been lost. It is not possible, for the time being, to confirm these dates, although they do correspond with the typological dating of the site. Several ceramic finds typical of the Egolzwil style, the most important sites being Egolzwil LU, Egolzwil 3, dendrochronologically dated to 4280 – 4250 BC (De Capitani and Seifert 2013), and Zürich, Kleiner Hafner, layer 5, (Suter 1987), suggest settlement activity in the late 5th millennium BC. A single fragment of a typical Corded Ware pot with a wavy cordon indicates that people were present in the area in the early 3rd millennium BC (c. 2800–2600 BC) but remains difficult to interpret since no other material from the period was found. A few flint artefacts from layers beneath the Neolithic horizon of Burgäschisee Ost may date to the Magdalenian period (c. 14’000–13’000 BP) or the Late Mousterian period (c. 35’000 BP Anliker et al. 2009). Two new trenches measuring 30 m^2 and 35 m^2 were examined within the area that had been excavated in 1944. Unfortunately, most of the wooden piles had not survived because the water table had been quite low over an extended period of time. Therefore, only two piles, one from each trench, could be sampled. A thorough analysis of the existing plans using a GIS and separating oak from non-oak timbers allowed us to newly interpret and reconstruct the ground-plans of the houses (Figure 6). Ten buildings with three rows of posts and dimensions of up to 9 m in length and 4–5 m in width were reliably reconstructed. The settlement layout consisting of parallel houses set at right angles to the lakeshore has also been identified at several other settlements dating from the first half of the 4th millennium in the Wauwil area (Egolzwil 4 and 5) and in the Three Lakes region (Lake Bienne: Sutz-Lattrigen, Hauptstation Innen, Lake Neuchâtel: Hauterive, Champréveyres).

Aeschi SO, Burgäschisee Nord

The site of Burgäschisee Nord was first excavated in 1877, and then in 1902 and again in 1943 and 1945 (Figure 7). In contrast, to the excavations at Burgäschisee Ost in 1944–1945 the Burgäschisee Nord activities were not well documented, and their precise location is unknown. Ceramic finds from these early archaeological activities point to the existence of human settlements in the early and mid-4th millennium (classical and late Cortaillod Style, dating from around 3900 to 3600 BC) and in the early 3rd millennium BC (Corded Ware pottery; Wey 1999/2001). The excavations in 2015–2016 (Figure 8) at Burgäschisee mainly concentrated on gaining new stratigraphical and dendrochronological data from the site at Burgäschisee Nord, where the majority of the project’s trenches were located. Ceramic finds of classical Cortaillod Style recovered from layer 5.3 in trench 1 confirmed the results obtained from previous, 20th century excavations. The discovery of a large quantity of so-called scratched or incised pottery (Figure 9) (layer 3, trenches 4, 6, and 10) in western Switzerland was both novel and surprising. This type of Neolithic pottery is not completely unknown but is not usually found outside of the areas with typical Pfyn Style ceramics of eastern Switzerland (e.g. Lake Zurich and Lake Constance, Figure 10–Figure 11) as shown in Figure 12. West of these areas, only a few scratched or incised sherds have been found at Meisterschwanden, Erlenhölzli (Lake Hallwil in central Switzerland), and a single vessel came to light at Burgäschisee, Süd (Bleuer et al. 1988, Fig. 7), though this attracted very little attention at the time. The discovery of such a large assemblage of scratched or incised pottery

Figure 7: Aeschi SO, Burgäschisee Nord. Impressions from the 1902 excavation.

sheds new light on cultural influences from the eastern part of the Swiss Plateau towards the west. Further research on this topic will be required to explain the presence of typical Pfyn style pottery in an area which was previously known only for its western, Cortaillod pottery styles. An initial literature overview suggests that the scratched or incised pottery from Burgäschisee, Nord dates from approximately 3750–3600 BC. Comparable, firmly dated finds are known from Canton Thurgau, south of Lake Constance, at Thayngen, Weier, dated to 3800–3750 BC, (Stöckli 2009, Pl. 58.2), Pfyn, Breitenloo, dendrochronologically dated to 3706–3704 BC (Leuzinger and Haas 2007, Fig. 76 and Pl. 187.3–4), and Ürschhausen TG, Nussbaumersee, Inseli, lower layer, dendrochronologically dated to 3732–3704 BC, (Stöckli 2009, Pl. 63.7-10). The site of Zürich, Mozartstrasse, layer 4u, dendrochronologically dated to 3612–3601 BC, must also be mentioned in this context (Gross et al. 1992).

The 2015–2017 investigations at Burgäschisee produced some 500 samples of wooden piles (dendrochronological analysis: Matthias Bol-

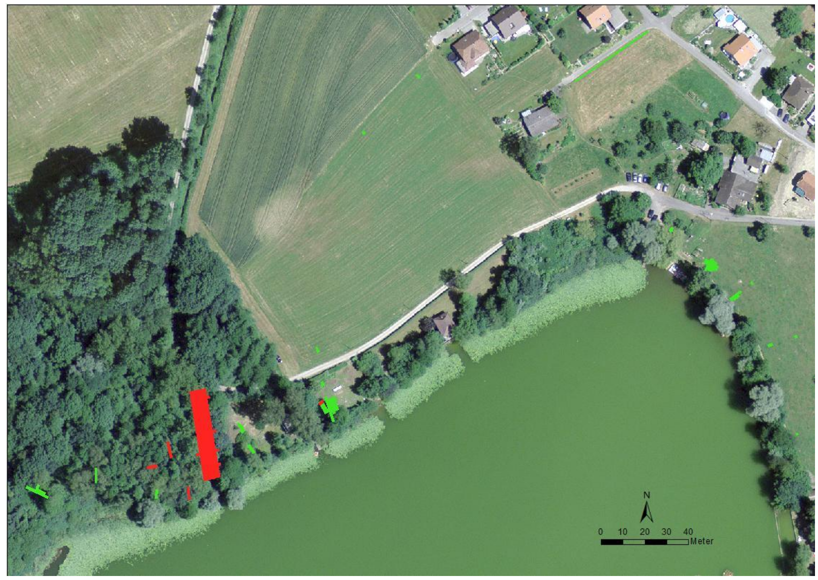

Figure 8: Aeschi SO, Burgäschisee Nord (below) and Nördlich Strandbad (above). Excavated areas. In red: 1944–1945 excavations, in green: 2015–2017 investigations.

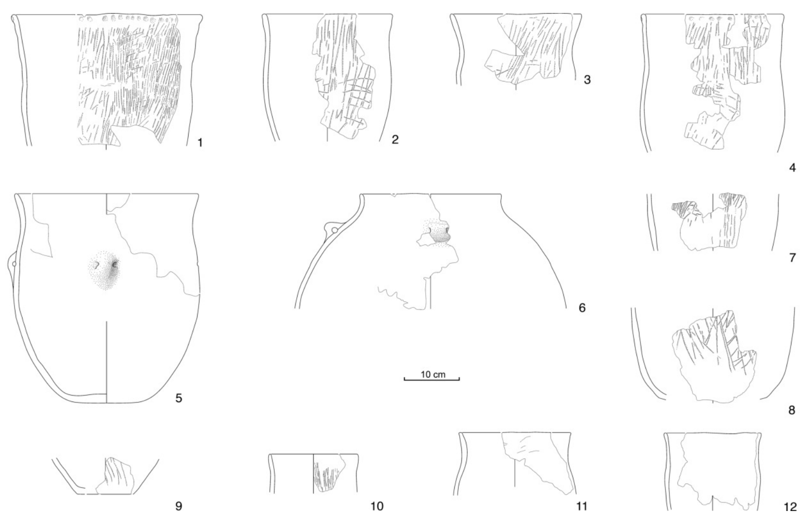

Figure 9: Aeschi SO, Burgäschisee Nord. Scratched or incised pottery (Pfyn style) from layer 3 in trenches 4, 6, and 10.

liger). Unfortunately, most were samples of species not suitable for dendrochronological dating or oak samples with less than 30 tree rings. Previous research had resulted in a local curve for the period between 3976 and 3748 BC (MK 60333 Burgäschisee based on 16 samples from Burgäschisee, Süd and Südwest, established by Bruno Huber in 1967 and tested by John Francuz in 2012). Two samples from Burgäschisee Nord, nos. 48794 and 48772, match the new mean curve, MK 6, with an end date of 3920 BC (heart wood) which could have been associated with, or at least provide a terminus post quem for the earliest settlement phase (Figure 13). A new mean curve, MK 5, was obtained from three samples and covers a settlement phase dating from around 3835–3830 BC (nos. 48773, 48770 and 48768; sapwood). One sample, no. 48771 (waney edge) is dated to 3781 BC and points to a next settlement phase. These preliminary results indicate the possibility of contemporary settlement phases on Burgäschisee in the areas Nord and Ost and Süd and Südwest, respectively.

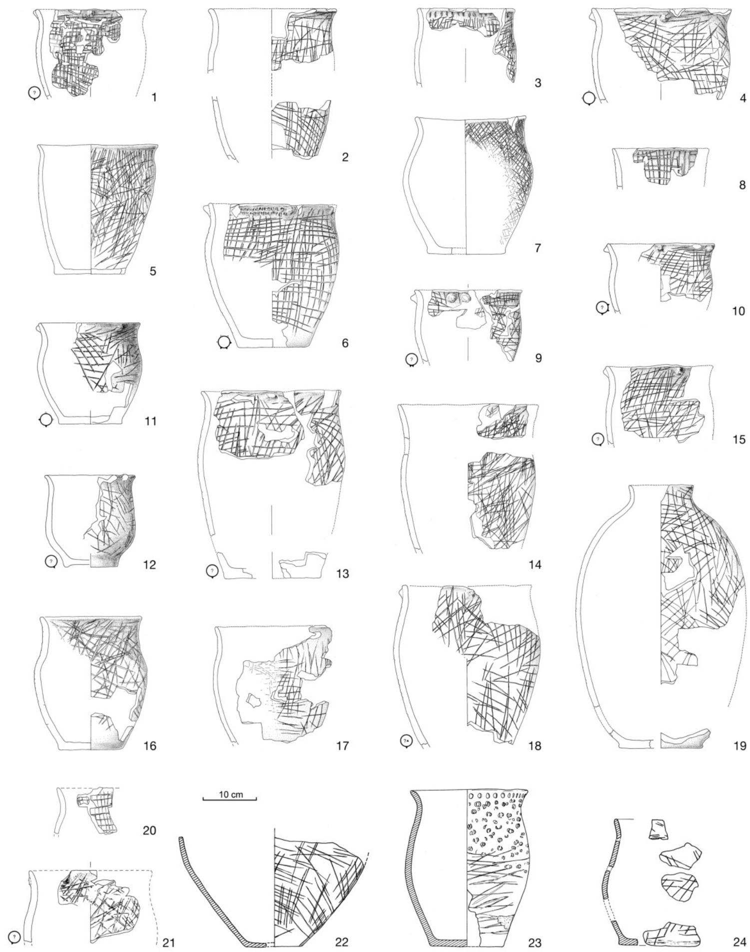

Figure 10: Scratched or incised pottery (Pfyn style) from sites in the Lake Zurich area.

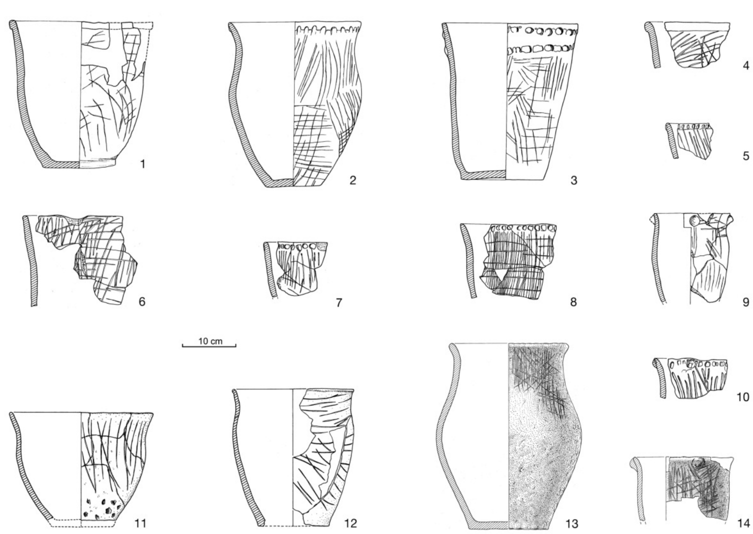

Figure 11: Scratched or incised pottery (Pfyn style) from sites in the Lake Constance area.

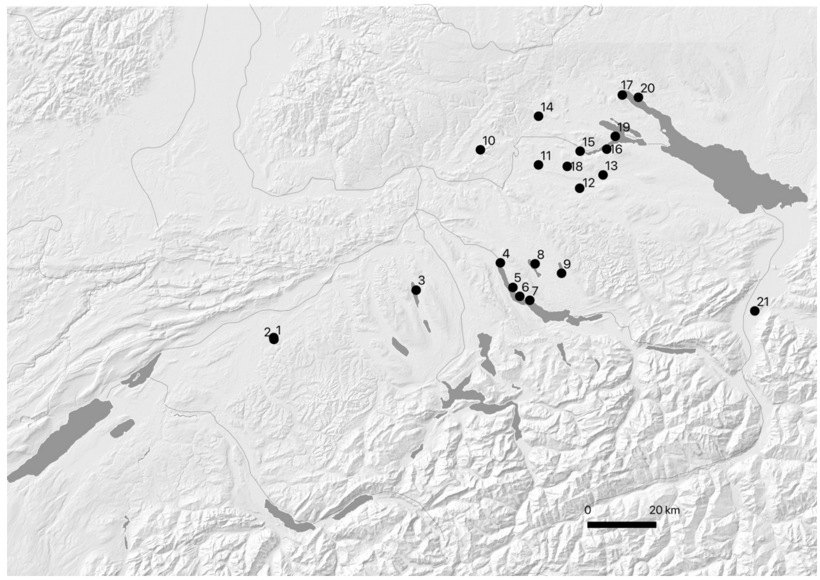

Figure 12: Neolithic lake-dwelling sites with scratched or incised pottery (Pfyn style) in Switzerland and southern Germany dating from 3800–3600 BC.1 Seeberg, 2 Aeschi, 3 Meisterschwanden, 4 Zürich, 5 Erlenbach, 6 Feldmeilen, 7 Obermeilen, 8 Greifensee, 9 Wetzikon, 10 Wilchingen, 11 Ossingen, 12 Niederwil, 13 Pfyn, 14 Thayingen, 15 Eschenz, 16 Steckborn, 17 Bodman, 18 Uerschhausen, 19 Hornstaad, 20 Sipplingen, 21 Gamprin.

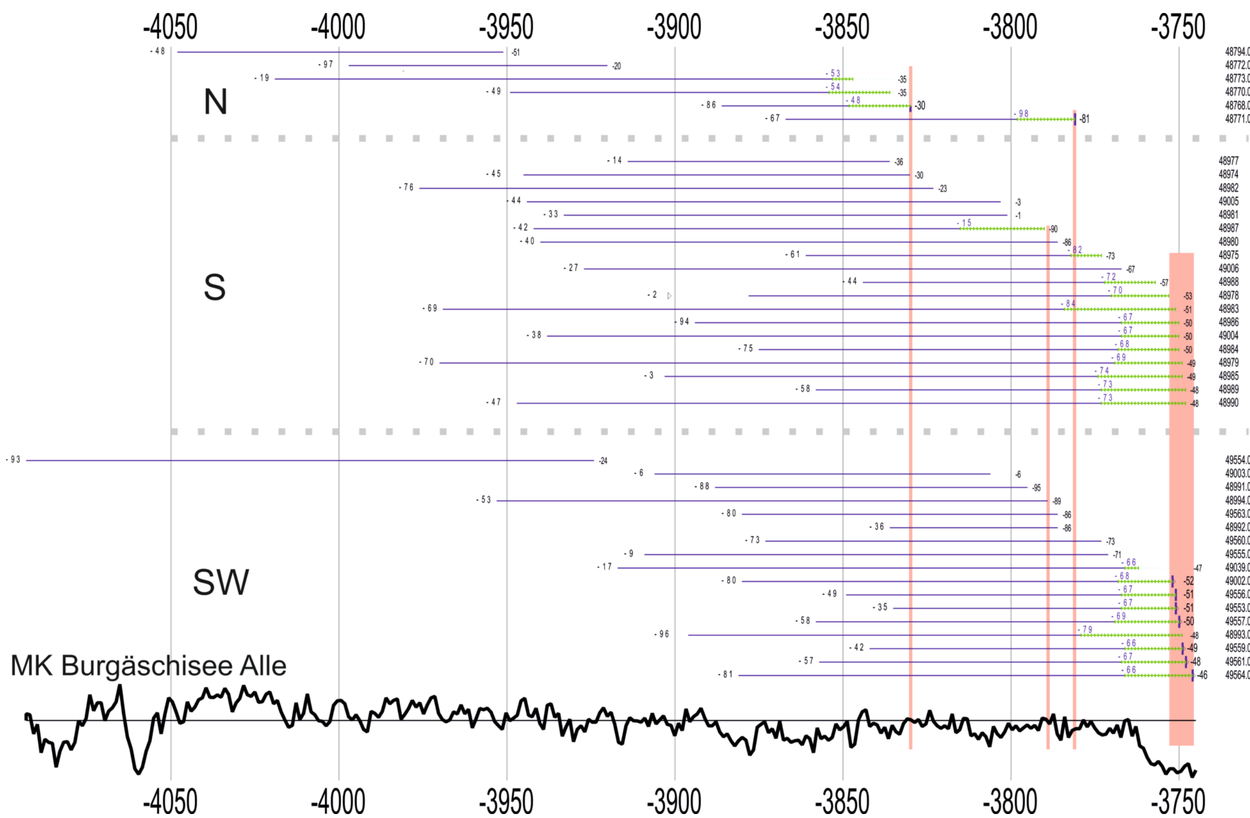

Figure 13: Aeschi SO, Burgäschisee, Nord. Dendrochronologically dated oaks. Green dotted lines: sapwood. Vertical red lines: settlement phases.

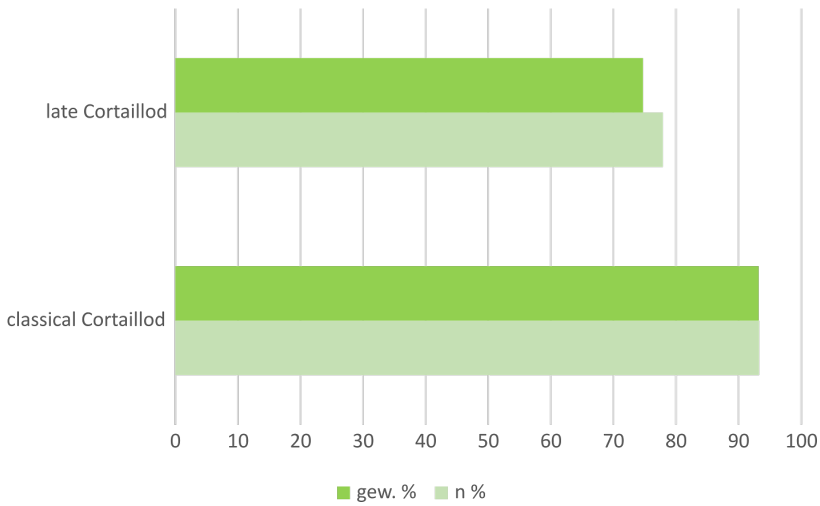

Figure 14: Burgäschisee Nord. Proportions of animals hunted in the classical Cortaillod Culture (wild animals n = 2153, weight = 34.1 kg, total identified bones n = 2308, weight = 36.6 kg) and in the late Cortaillod Culture (wild animals n = 321, weight = 0.6 kg, total identified bones n = 412, weight = 0.8 kg).

A total of 5,994 hand-retrieved animal bones were analysed (archaeozoological analysis: Marguerita Schäfer, Jörg Schibler). Of these, 2,720 could be identified to species level. The animal bones came from two different chronological periods, with the earlier period dating from the 39th and 38th centuries BC whilst the latter period was dated to around 3600 BC. Wild mammal bones dominated in both periods, making up about 90 percent in fragment numbers and bone weight (Figure 14). This means that hunting provided around 90 percent (classical Cortaillod) or around 80 percent (late Cortaillod) of the mammal meat consumed at the sites and animal husbandry played a minor role. Similar results have already been published for the site at Burgäschisee-Süd dated to the 38th century BC (Figure 15). Judging by the ratios of wild animal species, hunting was highly selective. Red deer (*Cervus elaphus*), aurochs (*Bos primigenius*), wild boar (*Sus scrofa*), and roe deer (*Capreolus capreolus*) were most frequently hunted. These four wild mammal species provided more than 80 percent of the consumed mammal meat. Such a preference for the biggest and heaviest wild mammal species clearly shows an intention to obtain as much meat as possible. Similar examples are known especially from Neolithic settlements of the lake Zurich region, where such selective hunting took place during economic resp. food crisis (Schibler 2017; Schibler and Jacomet 2010). Other, less intensively hunted wild mammal species like badger (*Meles meles*) and beaver (*Castor fiber*) act as an environmental marker for a densely-forested environment with small lakes and streams. They also provide proof of the specific use of fur and other by-products (fat and secretions). Approximately 10 percent of the bones identified belonged to domestic animals, with cattle bones being the most numerous. Domestic small ruminants and pigs were clearly of minor importance and only contributed 1 or 1.5 percent of the meat consumed. Only 11 bones could be identified as dog bones. This result opens up the debate about the use of dogs in the Neolithic. Were they, in fact, used for hunting? A comparison between the chronological periods shows a slight increase in the keeping and slaughtering of domestic animals. This was seen mainly in the larger proportion of cattle bones and decreasing numbers of red deer bones in the later Cortaillod Culture features. Was this the first sign of the impact caused by intense red deer hunting?

As well as hand-retrieved animal bones, small bones from sediment samples were also analysed. Fish, bird, small mammal, amphibian, and reptilian remains are usually invisible to the naked eye. As a consequence, they are often absent from hand-retrieved bone material but can be found in processed archaeobiological sediment samples. Samples were taken at Burgäschisee Nord (trench 1, layers 5.1 and 5.3) and Burgäschisee Südwest and analysed for plant and small animal remains (analysis of small animal remains: Simone Häberle). A total of 30.5 litres of sediment were processed using the wash-over method (Hosch and Zibulski 2003). Processing of small animal remains and species identification was carried out using the equipment and modern animal reference collection of the Institute for Integrative Prehistory and Archaeological Science at the University of Basel. While the analysis of the material from Burgäschisee Südwest is still underway, the analysis of the material from Burgäschisee Nord has been completed and has provided some interesting preliminary results. So far, 4750 small animal remains have been collected from sieves with mesh sizes of 4 and 1 mm respectively. A preliminary analysis has shown that fish, songbirds, small mammals, amphibians, reptiles, and molluscs are represented, with fish (65 percent) and amphibians (33 percent) clearly dominating. Cyprinids such as rudd (*Scardinius erythrophthalmus*) and tench (*Tinca tinca*) as well as perch (*Perca fluviatilis*) and pike (*Esox lucius*) are species typical of the fish stocks in small and nutrient-rich lakes like Burgäschisee and still occur today. Barbel (*Barbus barbus*)

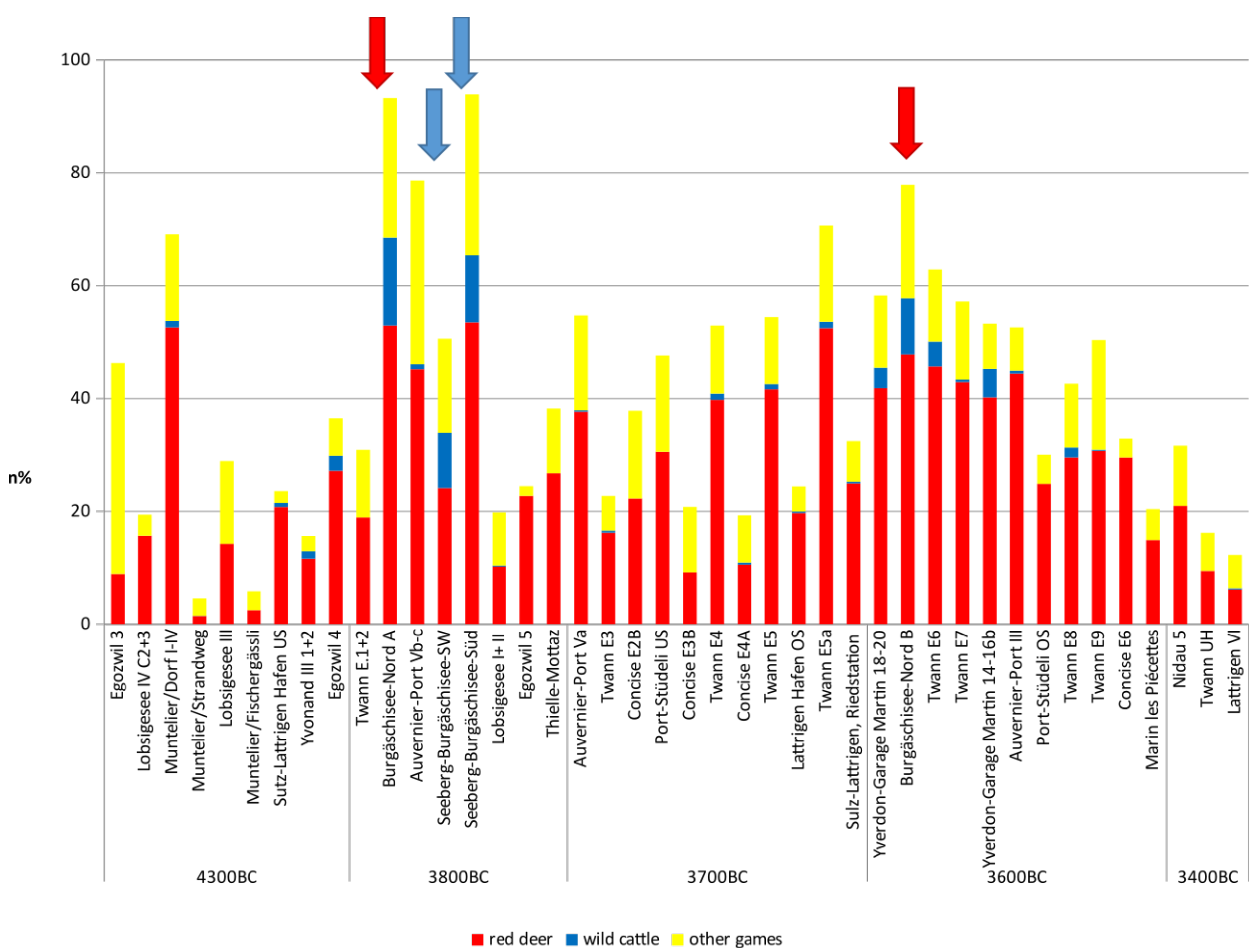

Figure 15: Proportions of hunted animals calculated on the basis of the numbers of identified bone fragments from Neolithic wetland sites in the western part of the Swiss Alpine Foreland (wetland sites see table 1).

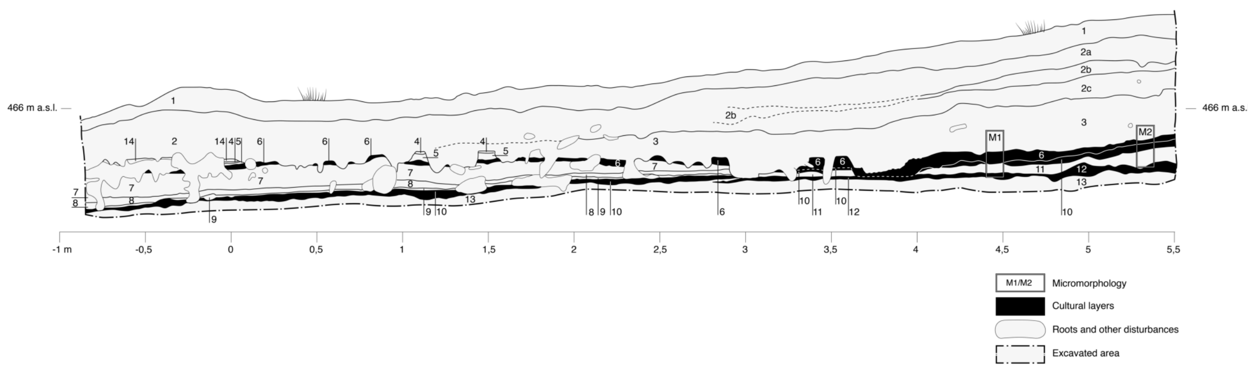

Figure 16: Aeschi SO, Nördlich Strandbad. Trench 4 and location of samples M1 and M2 for geoarchaeological studies.

as well as salmonids like the grayling (*Thymallus thymallus*) indicate that fishing took place not only in the lake itself but also in nearby streams. Some of the amphibian remains were identified as grass/common frog (*Rana temporaria*). This philopatric species spawns in shallow waters that are heated by the sun and are rich in vegetation. Several fish and amphibian remains showed signs of charring and digestion, and can thus be identified as a source of food for the inhabitants of the lakeside dwellings (Hüster Plogmann 2004, 2006; Hüster Plogmann and Häberle 2017).

Charred plant remains have regularly been found at both Burgäschisee Nord and Burgäschisee Südwest (ongoing archaeobotanical analysis: Christoph Brombacher). These mainly include cultivated plants such as barley (*Hordeum vulgare*) and naked wheat (*Triticum durum/T. aestivum/T. turgidum*) and also peas (*Pisum sativum*). Linseed (*Linum usitatissimum*), emmer (*Triticum dicoccon*), and einkorn (*Triticum monococcum*) are also present. The uncharred, subfossil remains, on the other hand, have suffered much due to recent drying out and only a small number of more resistant seeds and fruits, such as hazelnuts, blackberries, raspberries, and elderberries, and a few opium poppy seeds, have survived. The state of preservation appears to have deteriorated since the 1940s and 1950s, at which time it was described as good, and this is illustrated particularly by the low number of taxa and the small quantities of subfossil remains.

Aeschi SO, Nördlich Strandbad

Burgäschisee is delimited to the north and east by moraine ridges from the last phase of glaciation. Excavation trenches located near the actual beach at the foot of the hill at the northern end of the lake were geoarchaeologically studied (analysis: Philippe Rentzel). Profiles were documented in the field and two monolith samples (profile columns in plastic boxes) were taken for micromorphological and geochemical analysis (Figure 16–Figure 17: trench 4, profile P1). In the laboratory, the monoliths were subsampled for geochemistry, then impregnated with synthetic resin and cut into 1 cm thick sections using a diamond saw. Ten petrographic thin sections were prepared for micromorphological analysis and described following the principles set out in Bullock et al. (1985) and Stoops (2003). Geochemical analysis included calcium carbonate content, pH (pH meter in a KCl solution), organic matter content (loss on ignition), humus content (colorimetric method using sodium fluoride as a

Layer	CaCO3	Loss on ignition	Phosphate	Humus	pH
	%	%	(FW)	(FW)	(KCl)
10	0	7.5	2.2	2.6	6.5
11	0	6.5	2.2	1.7	6.1
12	0	8	2.5	1.9	6.2

Figure 17: Aeschi SO, Nördlich Strandbad. Trench 4. Polished section of sample M1 and results of geochemical analysis.

reagent) and phosphate concentration (Braillard et al. 2004). The following paragraphs present the preliminary results based on field studies, micromorphological observations (polished section of sample M1), and geochemical data.

The archaeologically sterile layer 13 at the base of the stratigraphy consisted of a decalcified sandy gravel comprising weathered crystalline components of glacigenic origin. Horizontal bedding and sorting of the gravel pointed to morainic material that had been redeposited in the littoral zone of Burgäschisee. Layer 12 yielded Neolithic artefacts (Cortaillod-style pottery) and was characterised by horizontally oriented fragments of wood and bark as well as compact lumps of loam. The latter, originating from a terrestrial soil horizon (luvisol) was associated with construction work. Degraded organic remains, low organic content, modern roots, and the predominance of resistant elements such as bark at the topmost level pointed to processes of erosion and weathering affecting the cultural layer. A 5 cm thick layer of laminated sand (layer 11) with finer sequences at the top covered the archaeological deposit sealing it off. The decalcified fine to medium sand of the Alpine petrographic spectrum contained some clay, microcharcoal and horizontal bands of degraded organic material, including leaves. Composition and sedimentological traits point to hill-washed glacigenic material, overprinted by limnic processes in a shallow-water depositional environment. As a working hypothesis, erosional phenomena could have been triggered by intensive land use (e.g. agricultural activities on the luvisols) in the immediate surroundings of the prehistoric lakeshore settlements.

The gravel-dominated layer 10 comprises weathered Alpine components of a Bt-horizon, which also derived from a luvisol. This coarse gravel sheet probably accumulated in the wake of intense erosional events affecting the adjacent moraine hills of the hinterland. The ongoing study will focus on questions of potential human impact in connection with the formation of gravel layer 10. Up to 30 cm thick, the sand deposits in layers 6 and 3 again correspond to a sedimentary facies from a shallow water regime, where hill-washed deposits were accumulated. Brownish parts represent phases with a higher input of fine-grained organic detritus, whereas isolated charcoal fragments (up to 1 cm) indicate human presence. Layer 1 corresponds to the actual humus horizon, developed on an artificial dump (layer 2).

In summary, the sedimentary sequence of the Burgäschisee, Nördlich Strandbad outcrop points to a basal archaeological layer (10/12) dating from around 5000 BC (based on four radiocarbon dates and ceramics) which was overprinted by erosional processes and weathering phenomena. In comparison to well-preserved archaeological lakeshore deposits, its significance regarding geoarchaeological interpretations is rather limited (Ismail-Meyer and Rentzel 2017; Ismail-Meyer et al. 2013). However, the overlying hill-washed deposits are an interesting archive and provide important insight into erosional processes dominated by recurrent events (prehistoric land use), which influenced the local landscape evolution.

Seeberg BE, Burgäschisee Süd and Südwest

The neighbouring sites of Burgäschisee Süd and Südwest were examined intensively in the 1940s and 1950s. Excavations were carried out at Burgäschisee Südwest in 1945–1946 and again in 1951–1952, followed by large-scale excavations at Burgäschisee Süd in 1952 and 1957–1958 (Wey 2012). Unfortunately, some of the documentation of the Burgäschisee Südwest site has since been lost. The excavations at Burgäschisee Süd, on the other hand, were carried out using documentation methods similar to what would be regarded as standard today. The Burgäschisee Süd project in particular allowed for modern methods such as radiocarbon dating and dendrochronology to be used. In 1958, the Radiocarbon Dating Laboratory of the Physics Department at the University of Bern published the first radiocarbon dates from the Burgäschisee Süd excavation (Oeschger et al. 1959). In 1963 Huber and Merz found synchronous tree-ring patterns from wooden piles unearthed at Thayngen, Weier, Burgäschisee, Süd and Südwest confirming contemporaneity of the Neolithic sites from around Lake Constance and western Switzerland (Huber and Merz 1963). In 1966 Ferguson, Huber and Suess compared the radiocarbon content of a series of samples of dendrochronologically dated bristlecone pine wood with a floating tree-ring chronology from Burgäschisee and Thayngen, Weier and determined that these sites had existed in the period between 3700 and 3600 BC (Ferguson et al. 1966). The results of the Burgäschisee Süd project were published in a series of eight monographs whose scientific presentation is still very convincing (Bandi et al. 1973; Bleuer et al. 1988; Boessneck et al. 1963a; Brunnacker 1967; Müller-Beck and Flükiger 2005; Müller-Beck and Schweingruber 1965; Müller-Beck and Wey 2008; Wey 2012).

Much like Burgäschisee Ost, Burgäschisee Süd/Südwest also yielded an older phase with Egolzwil pottery dating from 4300–4200 BC. Dendrochronological analysis confirmed the existence of a phase dating from around 3750 BC at Burgäschisee Süd, whilst radiocarbon dates from the 1950s yielded more recent dates in the second half of the 4th millennium BC. The 2016–2017 campaigns at Burgäschisee Süd and Südwest were limited by dense vegetation and by changes in the shoreline since the 1950s excavation. Four trenches (46 m^2 in total) were dug within the area of Burgäschisee Süd that had been excavated in 1957–1958, primarily for the gathering of additional dendrochronological samples. Two trenches at Burgäschisee Südwest each yielded a settlement horizon containing loam layers, which can most probably be interpreted as the remains of floors. A total of 150 samples taken in 2016–2017 from piles in the area excavated in 1945 now offered an opportunity to obtain new dendrochronological dates around 3750 BC (Figure 13).

Palaeoecological investigations: vegetation and fire dynamics between 12,500 and 800 BC

Palaeoecological analyses on sediment cores retrieved in 2009 were carried out as part of the Marie-Heim-Vögtlin SNSF project 'Societal responses to prehistoric climate changes in Central and Southern Europe: combining palaeoclimatic, palaeoecologic, and archaeologic evidence.' (applicant: Erika Gobet). Subsequently, new cores were obtained in 2014

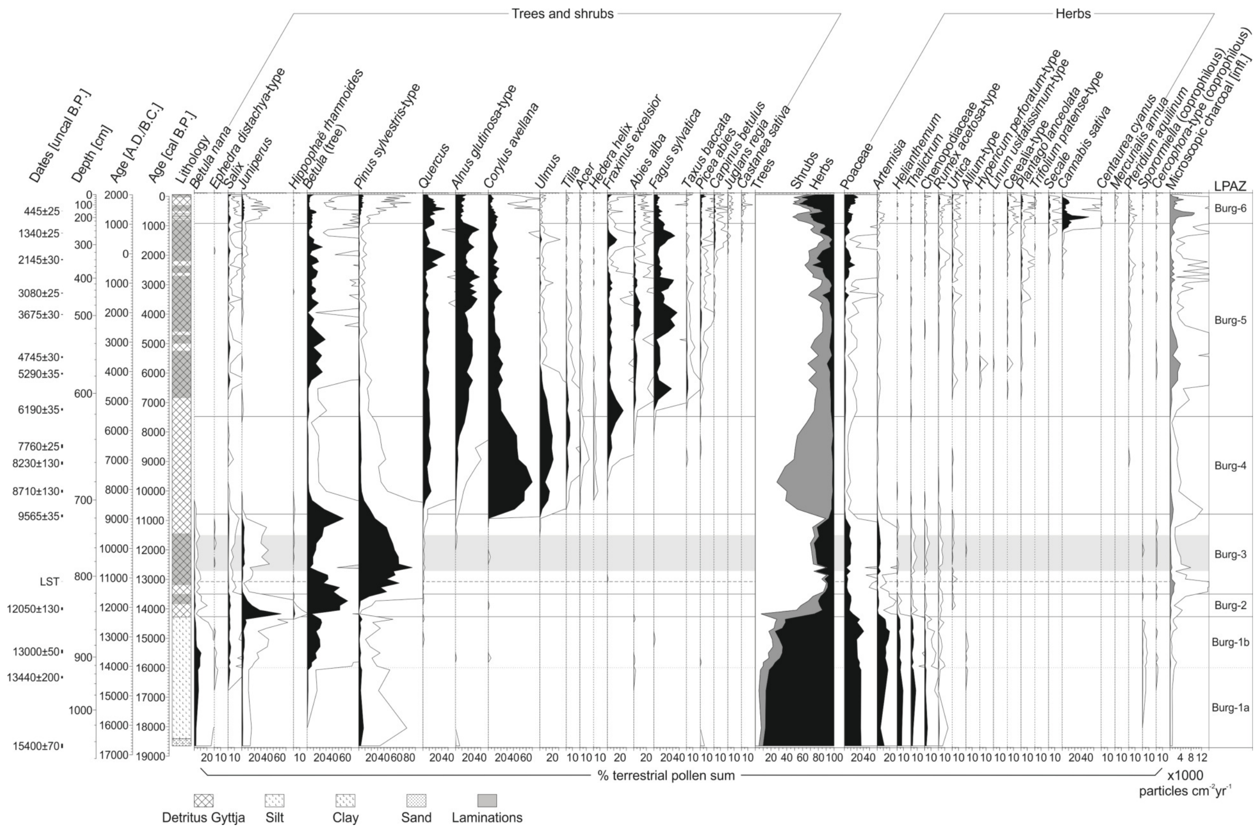

Figure 18: Burgäschisee. Pollen diagram (Rey et al. 2017).

during the SNSF project (applicant: Willy Tinner) entitled 'Exploring eight millennia of climatic, vegetational and agricultural dynamics on the Swiss Plateau using annually layered sedimentary time series' (Figure 18; Rey et al. 2017). After deglaciation, the first steppe tundra communities established during the Late Glacial, at the onset of the Oldest Dryas, c. 17,000 cal BC. As observed in many lowland records, initial afforestation in the Burgäschisee region also began with a mass expansion of *Juniperus* shrubs which invaded the steppic tundra of the Oldest Dryas. This vegetational shift preceded the establishment of *Betula* woodlands at the onset of the Bølling period c. 12,550 cal BC. Mixed *Pinus sylvestris* and *Betula* forests formed during the subsequent Allerød period (11,950–10,950 cal BC). This late glacial vegetation succession is typical of the entire Swiss Plateau (e.g. Wick 2000; Lotter 1999) and other Central European regions (e.g. A. Becker et al. 2006; Kleinmann et al. 2015). Fairly closed forests in combination with stable and warm summer temperatures (Heiri et al. 2015) may have led to an increase in regional fires as represented by a rise in charcoal influx values. During the Younger Dryas cooling (10,950–9550 cal BC), the steppic tundra vegetation (e.g. *Artemisia, Poaceae*), typical of the Oldest Dryas (before 12,550 cal BC), partially expanded and forests opened up; *Betula* declined and *Pinus sylvestris* began to dominate. Forest composition changed at the onset of the Holocene around 9700 cal BC as a result of rapid warming (Heiri et al. 2015), and boreal forests were gradually replaced by temperate forests with deciduous *Tilia, Ulmus, Quercus*, and *Corylus avellana*. These trees and shrubs dominated Central European forests for over 4,000 years during the Early Holocene (e.g. Ammann 1988; Clark et al. 1989; Hadorn 1992; Lotter 1999). Vegetation only changed significantly from c. 6550–6050 cal BC when *Alnus* and *Fraxinus*, together with mesophilous trees such as *Abies alba* and *Fagus sylvatica* established, most likely in response to the more humid summer conditions in the mid Holocene (Tinner and Lotter 2006).

The onset of noticeable agricultural activities in the pollen record from the Burgäschisee region has been dated to c. 4550 cal BC (first occurrence of Cerealia-type and *Plantago lanceolata* pollen, see Figure 18). This finding coincides with individual archaeological Neolithic finds dating from the period after 4300 cal BC and with the existence of local settlements after c. 3850 cal BC. The expansion of arable and pastoral farming as indicated by pollen from crops and weeds (e.g. Cerealia-type, *Plantago lanceolata*, *Linum usitatissimum*-type) and the re-expansion of disturbance-adapted shrubs (*Corylus avellana*) and pioneer trees (*Betula*) is typical for the Central European lowlands. These land use disturbances generated marked vegetation shifts and successional cycles (e.g. Clark et al. 1989; Kleinmann et al. 2015; Rösch and Lechterbeck 2016; Rey et al. 2019; Tinner et al. 2005a). Fire activity increased, suggesting that fire was used intensively to create open land, most likely by means of slash-and-burn activities. Forest fires set for agricultural purposes significantly reduced fire-sensitive species (e.g. *Tilia, Ulmus, Fraxinus, Abies alba*, see also Tinner et al. (2003)). Subsequently, land use intensified during the Middle Bronze Age (around 1550 cal BC) and many disturbance-sensitive trees such as *Tilia* and *Abies alba* disappeared locally (Rey et al. 2017). The comparison of the paleoecological record of Burgäschisee with the vegetational pattern observed at other sites suggests that land use and deforestation phases were synchronous and thus likely linked to climate change (Rey et al. 2019). Earlier explanations developed for the Metal, Roman, and Early Middle Ages assume that warm-dry climatic conditions triggered increases of cereal yields and thus higher carrying capacities that resulted in further deforestation and slash and burning pulses (Tinner 2012; Tinner et al. 2005b, 2003) and subsequent land use intensification. When climate became cooler and moister, cereal-based carrying capacities declined, leading to land abandonment in marginal areas and subsequent spontaneous afforestation successions. Our new palaeoecological investigations suggest that this explanatory model can be adopted for the Neolithic period. The synchronisms in land use pulses extend to southern Europe, across different cultures north and south of the Alps, making societal triggers very unlikely (Rey et al. 2019).

Modelling population density and land use in Western and Central Switzerland

The increased interest in the subject of complexity in archaeology have created and pushed a research agenda for model-based archaeology focused on investigating and gaining a better understanding of coupled human and natural systems, complex adaptive systems, human/societal resilience to environmental, and social deterioration, the emergence of inequality, and many more topics (e.g. Barton 2014; Kohler and van der Leeuw 2007; Lake 2014; McGlade 2014; Wurzer et al. 2015). Therefore, within the scope of the project ’Beyond lake villages: Studying Neolithic environmental changes and human impact at small lakes in Switzerland, Germany, and Austria', special emphasis was put on the creation of well-informed simulation models for small lake communities and larger geographical regions to estimate land use and population densities during the Neolithic. The models require elaborate hypotheses with regard to past human-environmental relationships originating from the archaeological and paleoecological evidence and theoretical models of (past) human behaviour in space and time.

The investigated communities' size, subsistence strategy, and the occupation time of a site must be known to estimate their land use. These set of variables are enigmatically represented by the archaeological record. The land surface area used by a community for its subsistence is relative to its size. However, depending on the characteristics of the mode of production, e.g. the composition of livestock and cultivated plants, labour organisation, technological standards, exploitable resource conditions, etc., land use patterns will differ from community to community and change over time (Boserup 1996; Gregg 1988; Hughes et al. 2018). A dynamic, agent-based land use simulation of wetland settlements (WELASSIMO) in southern Germany and on Lake Zurich was recently presented by Baum (Baum 2014, 2016). As an archaeologically well-informed land use simulator WELASSIMO includes specific components of subsistence economy such as crop cultivation and cattle husbandry systems for the excavated sites under investigation. Simulations of different crop cultivation scenarios led to the conclusion that permanent crop cultivation was the more likely system to have been employed than shifting cultivation (Baum et al. 2016; Jacomet et al. 2016).

In order to go on the task of simulating the land use on a mesoregional scale the archaeological database is insufficient for such a task as in many cases the documented sites do represent only a fraction of former numbers and additionally often they cannot provide us with an estimate of its number of inhabitants or its total duration. However, the wealth of information gained from Neolithic wetland sites over several decades of archaeological research and paleoecological studies enables us to formulate reasonable hypotheses about the subsistence strategies of past communities, including foraging, farming and animal husbandry (e.g. Doppler et al. 2017; Jacomet 2008; Schibler 2008), their social organisation and settlement dynamics (e.g. Ebersbach 2010; Hafner and Suter 2003; Hofmann et al. 2016; Röder et al. 2013), their impact on vegetation through land use (e.g. Rey et al. 2017; Tinner et al. 2005b; see former section) and their ways of coping with environmental change or instability (e.g. Arbogast et al. 2006; Magny 2004). The Swiss part of the «Beyond Lake Villages» project tries to use computational simulation models that already exist and combine them to a functional simulation model suited to test the empirical models and data-driven hypotheses about the western and central Swiss Neolithic generated by archaeological research and paleoecological land use reconstructions.

To achieve this goal, a scaled down, regional version of the 'Global Land Use and technological Evolution Simulator' (GLUES) is being employed. The mathematical simulation model GLUES describes coupled human-environmental systems and has previously been used to simulate the Neolithic transition (Lemmen et al. 2011; Lemmen and Wirtz 2014; Wirtz and Lemmen 2003) and to estimate pre- and protohistoric carbon releases caused by deforestation on a global scale (Lemmen 2009). GLUES is a spatially explicit and dynamic numerical model that simulates the population density and three dimensionless socio-cultural traits of societies (agents) inhabiting a relatively large biogeographical region. The adaptive dynamics of GLUES are defined by the four variables of population density, technological efficiency, subsistence economy, and economic diversity, which coevolve in the context of the changing availability of natural resources as defined by vegetation productivity and climatic constraints. Technological efficiency includes not only the available physical means such as the workforce and tools but also the organisational structures that influence the efficiency of food production. Subsistence economy or farmers' share is the proportion of effort put into an agropastoral farming economy, where 0 stands for a lifestyle based solely on foraging. This variable is used as a threshold for defining a society as Neolithic. Economic diversity describes the number or diversity of economic strategies a society practises in the sector of food production. The population dynamics (growth and decline) of an agent are directly coupled with the development of three socio-cultural traits and the environment's resource utility. In turn the traits follow the direction of increase or decrease of its associated agent (Wirtz and Lemmen 2003).

An agent in GLUES is defined as the population of a relatively large biogeographical region. For the «Beyond Lake Villages» project simulation model LUTES (Land Use and Technological Evolution Simulator), on the other hand, the agent represents a social entity that is organised in several groups forming a settlement. The rescaling of the spatial reference area including the natural resources each agent utilises to satisfy its needs is already applied. Different environmental variables (e.g. slope, soil, temperature, precipitation) have an impact on the suitability of a given location for various socio-economic purposes. The number of neighbours in the agent's social network is defined by the variable of spatial distance, which also describes the strength of interaction between them. At the current stage of our work we are further integrating and enhancing existing agents behaviours including their choice of settlement location, interaction, mobility, and their economic strategies. We are also refining the rough foraging-farming dichotomy of GLUES. The possibility to feed GLUES with data from other simulation models and vice versa (Lemmen 2009) has prompted the linkage to WELASSIMO (Baum 2016; Baum et al. 2016) to estimate land use in geographic space and feedback into sub-models of the «Beyond Lake Villages» project simulation model.

Discussion/Conclusion

As an intermediate result, we present here phases of Neolithic human impact from palaeoecology combined with archaeological data (typology, radiocarbon, dendrochronology) from different sites at Burgäschisee (Table 1). First human impact and the beginning of agriculture in Central Switzerland dates back to around 5000 BC. Despite some evidence for early farming attempts reaching back to the Late Mesolithic (Stöckli 2016; Tinner et al. 2007; Welten 1982), we assume that the period 4800–4500 BC is crucial for the development of sedentary farming societies in northern-alpine forelands: more and more indicators convince us to set the onset of fully established agricultural economies in this time slot of the early 5th millennium BC. Indicators are settlement activities in the Alpine

Table 1: Burgäschisee. Phases of human impact and/or settlement activity between 4600 and 2600 BC. [1] dendrochronology, precise waney edge data; [2] dendrochronology, estimated sapwood data.

Chrono-logy **Phases BC**	**Palaeo-ecology** **Phases of human impact**	**Archaeology** **chronological data (typology, radiocarbon, dendrochronology)** **Sites at Burgäschisee:**					
		Ost	**Hintere Burg**	**Nördlich Strandbad**	**Nord**	**Südwest**	**Süd**
2800 – 2600	•	ceramics Corded Ware type singular (old) finds	^{14}C		2840 – 2810 cal BC ^{14}C wiggle matching		^{14}C
3200 – 3000	•		^{14}C				^{14}C
3800 – 3600	•	3900 – 3780 cal BC wiggle matching		^{14}C Layer 3	3780 BC[1] 3835/3830 BC[2]	3752 – 3746 BC[2]	after 3750 BC[2] 3790 BC[2]
4300 – 4000	•	ceramics Egolzwil type singular (old) finds	^{14}C	^{14}C Layer 6			
5000 – 4700	•			^{14}C Layer 10–12			

Rhine Valley (Zizers), first use of alpine pastures in the Bernese Alps (Iffigsee/Schnidejoch) and an earliest phase of Neolithic stone cists graves in the Alpine Rhone Valley (Hafner 2015). A next phase of settlements at Burgäschisee starts in the late 5^{th} millennium BC. This phase is in agreement with settlements in other parts of Central Switzerland (Egolzwil). The following centuries of the early 4^{th} millennium BC form the best represented phase of Neolithic settlements and human impact. Comparable phases are well documented in Switzerland and Southern Germany (Three-Lakes Region, Lake Zurich, Lake Constance). The late 4^{th} millennium which is usually one of the most densely represented settlement phases in Switzerland is clearly underrepresented at Burgäschisee and remains below expectations. The Neolithic sequence ends in the moment with a settlement phase in the early 3^{rd} millennium BC. A time slot just before 2800 BC is clearly proven by a combination of dendrochronology and radiocarbon dating. This indication is more than five decennia before the assumed arrival of Corded Ware ceramics in Central Switzerland. This kind of typical ceramics has been found as a few singular sherds in former large-scale excavations and indicate settlement activities dating around 2700–2600 BC as well.

In Switzerland, in the years 2015–2017 research within the project 'Beyond lake villages: Studying Neolithic environmental changes and human impact at small lakes in Switzerland, Germany and Austria' focused on three spatial levels of investigation. First, archaeological investigations concentrated on different types of sites around Burgäschisee with a strong potential to prove prehistoric settlement activities of sedentary societies with agricultural economies. The aims were: (1) to investigate settlement areas on the lake shore and in a clear wetland context and, (2) to find settlements areas on mineral soils in the direct hinterland. Excavations in wetland context consisted of re-opening of formerly excavated trenches with the goal to get wood material for new dendrochronological dating. In order to get insight into the stratigraphy of undisturbed wetland settlement areas selected new trenches were opened as well. On mineral soils and off the lake shore selected trenches were investigated mainly in suspected slope areas. Here tiny prehistoric settlement traces were assumed under thick layers of accumulation. The second spatial level of investigation consists of palaeoecological research on vegetation, land use, and fire dynamics of the Holocene. Burgäschisee lake sediments are an exceptional archive in Central Switzerland covering more than 18,700 years of vegetation history including most of the archaeological settlement phases during the last c. 6,800 years. Laminated sediments of Burgäschisee store traces of human activities near the lake and in a distance of 5–10 km around the lake and deliver major information on agricultural activities like cereal production and livestock farming. With the onset of fully agriculture-based economies ca. 7000 years ago, vegetation changes became primarily controlled by human activities, including fire disturbance under relative stable climate conditions. Laminated sediments of Burgäschisee indicate cycles of deforestation and reforestation which reflects presence or decrease of human populations within the immediate vicinity of the lake. Increase or decrease of human populations could be triggered by wetter climatic conditions which made settlement areas near the lake shores uninhabitable due to rising water tables in already marshy areas surrounding Burgäschisee. More generally, wetter conditions may have substantially affected Neolithic crop production and thus carrying capacity as well as population density, as assumed for the subsequent prehistoric times for wide areas in and around the Alps (Gobet et al. 2003; Rey et al. 2017; Tinner et al. 2003). The focus of our third spatial level of investigation is extending beyond the Burgäschisee area and covers Western and Central Switzerland. Modelling of land use, anthropogenic land cover change and population densities during the Neolithic in an extended area contributes substantially to our understanding of past human-environment relationships. Bringing together the new data from all three levels of investigation will allow to describe in a substantial way evolutionary processes of landscapes and human populations (Table 1).

Acknowledgements

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Tables

Table 2: Table to Figure 15

Sites	Bibliography	Years BC
Egozwil 3	Stampfli 1992	4282–4275/4260
Lobsigesee IV C2+3	Ginella and Schibler n.d.	3900–3850
Muntelier-Dorf I–IV	Lopez 2003	3867–3826
Muntelier-Strandweg	Reynaud 2005	3851–3837
Muntelier-Fischergässli	Morel 2000	3842–3819
Sutz-Lattrigen Hafen US	Kerdy n.d.	3834–3820
Yvonand III 1+2	Chaix 1976b	3800
Egozwil 4	Stampfli 1992	3860
Twann E.1+2	Stampfli 1980	3838–3768
Äschi-Burgäschisee-Nord A	Schäfer/Schibler in prep.	3840–3780
Auvernier-Port Vb–c	Chaix 1985	3791–3785
Seeberg-Burgäschisee-SW	Josien 1956, Stampfli 1964	3760–3748
Seeberg-Burgäschisee-Süd	Boessneck et al. 1963b	3760–3748
Lobsigesee I+ II	Ginella and Schibler n.d.	3750–3700
Egozwil 5	Stampfli 1976	3740
Thielle-Mottaz	Chaix 1979	3719–3699
Auvernier-Port Va	Chaix 1985	3728–3679
Twann E3	C. Becker and Johansson 1981	3702–3687
Concise E2B	Chiquet 2012	3692–3676
Port-Stüdeli US	Stampfli et al. 2003	3686–3638
Concise E3B	Chiquet 2012	3666–3656
Twann E4	C. Becker and Johansson 1981	3663–3658
Concise E4A	Chiquet 2012	3645–3636
Twann E5	C. Becker and Johansson 1981	3643–3631
Lattrigen Hafen OS	Kerdy n.d.	3641–3631
Twann E5a	C. Becker and Johansson 1981	3622–3607
Lattringen VII H innen	Kerdy n.d.	3613–3566
Yverdon-Garage Martin 18-20	Chaix 1976a	3600

Table 2: Table to Figure 15 (*continued*)

Sites	**Bibliography**	**Years BC**
Äschi-Burgäschisee-Nord B	Schäfer/Schibler inprep.	3600
Twann E6	C. Becker and Johansson 1981	3596–3573
Twann E7	C. Becker and Johansson 1981	3596–3573
Yverdon-Garage Martin 14–16b	Chaix 1976b	3588–3581
Auvernier-Port III	Chaix 1985	3627–3621/3560–3550
Port-Stüdeli OS	Stampfli et al. 2003	3560
Twann E8	C. Becker and Johansson 1981	3563–3532
Twann E9	C. Becker and Johansson 1981	3563–353
Concise E6	Chiquet 2012	3533–3516
Marin les Piécettes	Chiquet 2006	3504–3483
Nidau 5	Glass and Schibler 2000	3406–3398
Twann UH	Stampfli 1980	3405–3391
Sulz-Lattringen, Riedstation	Glass and Schibler 2000	3393–3388

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