New perspectives on archaeological landscapes in the south-western German alpine foreland — first results of the BeLaVi Westallgäu project

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Introduction

Annually laminated lake sediments contain an amazing wealth of evidence on activities of prehistoric communities. If it is possible to link their palaeoenvironmental, palaeoeconomic, and palaeoclimatic information precisely to waterlogged archaeological evidence, prehistoric human presence can be detected in a resolution and on a spatial scale far beyond conventional lake dwelling research. The successful methodological combination of on-site and off-site approaches in the same microregion was one of the core outcomes of a research project carried out between 2008 and 2010, which focused on Degersee, a small lake in southwest Germany, in the hinterland of Lake Constance (Mainberger et al. 2015b)*. In the same years it became evident that small lakes in the Swiss Plateau provided comparable datasets of high-resolution data covering several thousand years of postglacial human-environmental interaction (Tinner et al. 2006). Based upon those studies, the trinational project 'Beyond Lake Settlements: Studying Neolithic environmental changes and human impact at small lakes in Switzerland, Germany and Austria' (BeLaVi) aims to develop a bigger and at the same time more detailed picture of the northern pre-alpine prehistoric landscapes and their transformation by humans†.

Off-site observations from palynology like changes in vegetation cover and composition indicate both natural phenomena such as climate changes and anthropogenic influences such as woodland clearing and subsequent forest successions (Kleinmann et al. 2015). Distinguishing natural from human impact and quantifying and qualifying the importance and intensity of human activity on observed landscape changes has been one of the central methodological challenges of wetland archaeology and palaeoenvironmental research for a number of decades (cf. Azuara et al. 2015; Martinelli et al. 2017; Schwörer et al. 2014; Ye et al. 2013). Within the BeLaVi project, the correlation of anthropogenic indicators from off-site data with archaeological evidence and on-site environmental data in the immediate vicinity, combined with high resolution absolute dating will allow a better understanding of how to distinguish between natural and human impacts in different regions. We expect that agricultural systems and techniques like fire management of woodland

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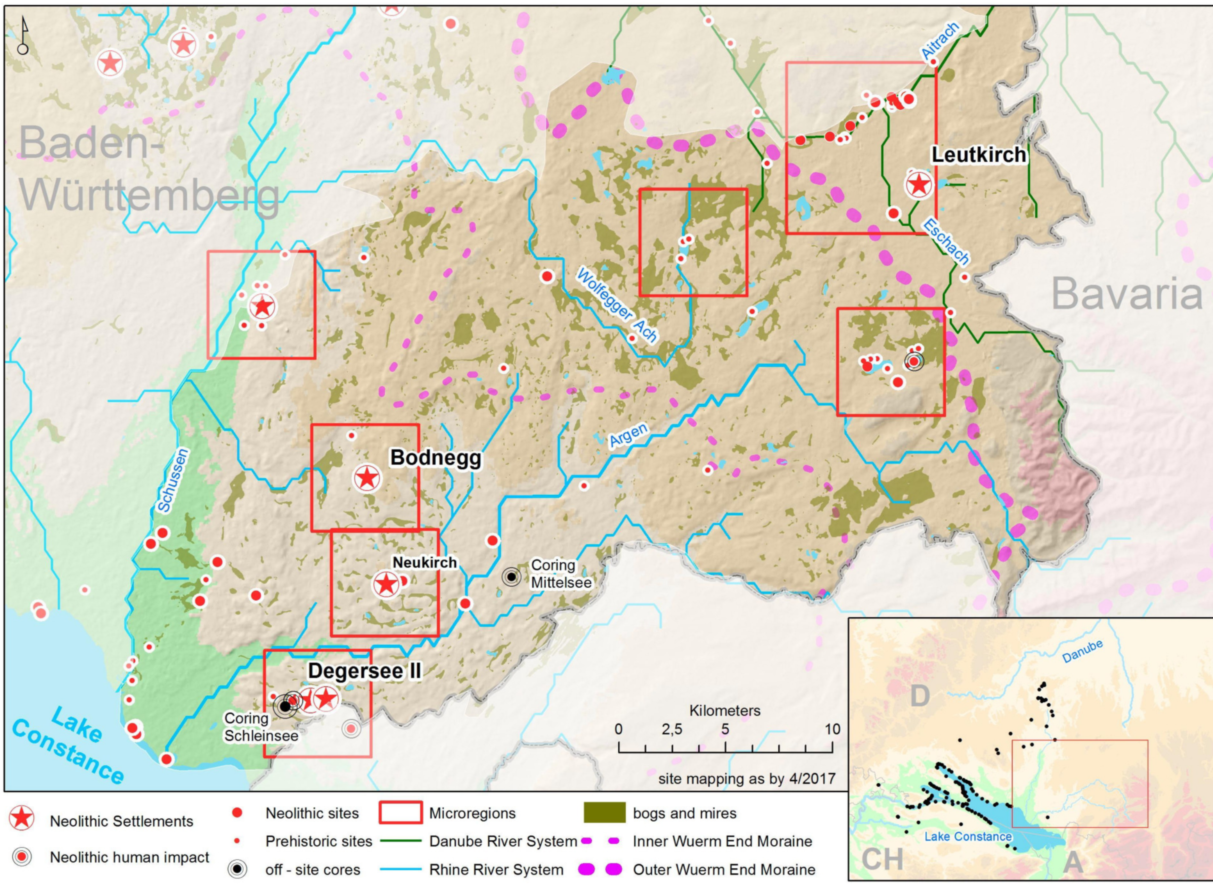

Figure 1: Study area with sites and microregions in SW Germany north of Lake Constance. The overview map shows the state of research as of 2011.

as well as questions of demography and population density will be better understood on this larger geographic scale.

Three areas are in the focus: (1) the Swiss Plateau with Burgäschisee, a small lake, at its center, (2) the Westallgäu between Lake Constance and the western tributaries of the river Iller (Figure 1), and (3) the Salzkammergut in Austria with the lakes Attersee and Mondsee. We expect that the comparison of these three study areas, each with its respective specific natural environments and cultural traditions, will result in a variety of possible scenarios of how Neolithic communities adapted to changing environmental conditions. Due to its significant oscillations of climate and distinct changes in material cultures (cf. Daim et al. 2011; Schlichtherle 2011), the 4th millennium BC is of special interest.

The following paper[‡] presents first results and discussions from the Westallgäu part of the project.

‡ This paper is a result of two presentations held at the workshop TH6-11 "Settling waterscapes in Europe: the archaeology of Neolithic and Bronze Age pile-dwellings" at Vilnius during the 22nd EAA meeting. We would like to thank J. McIntosh, Freiburg i. Br., for editing works on the English text.

The study area: physical conditions, taphonomic issues, and outer boundaries

The physical landscape of the Westallgäu is dominated by three main elements: the last glacial (Würm) outer and inner terminal moraines and the river Argen (Figure 1). The outer terminal moraine indicates the extent of the Rhine glacier at the time of the last glacial maximum. It forms a large crescent that encloses a hilly landscape dominated by glacial, periglacial, and fluvial landforms such as drumlins, moraines, river valleys, and terraces. The topography ascends from the basin of Lake Constance and the Schussen valley northward to the outer terminal moraine and eastward and southward to the Alps. The inner terminal moraine marks a stagnation in the retreat of the Alpine ice shield. The river Argen, with its Lower Argen (*Untere Argen*) arm, cuts through this moraine belt and forms the main hydrological axis of the Westallgäu, subdividing the study area into northern and southern sections. While the Argen flows into Lake Constance and is part of the Rhine catchment area, the small rivers beyond the outer terminal moraine flow northward and are tributaries of the Iller and Danube catchments. The European continental water divide that separates the North Sea drainage system from the Black Sea drainage system follows the terminal moraines. Due to the poorly developed postglacial hydrological system (headwater erosion has not yet reached large portions of the region), the formerly glaciated area in general and the terminal moraines in particular are marked by a multitude of wetlands and waterscapes. Peat growth and siltation filled most topographic depressions during the Holocene. Only recently, in the 19th and 20th centuries, rural engineering measures have changed many of these wetlands to arable land.

The Westallgäu is part of the central European oceanic temperate climate zone (Cfb; after Köppen 1936) with moderately warm summers, mild winters, and prevailing westerly winds. Most rain falls during the summer months. Climatic differences within the study area are mainly due to the ascent of the relief towards the east. Mountains like the *Pfänder Massiv* and the *Adelegg* in the east of the study area are submontane sections of the Allgäu Alps. As a result, precipitation rises from about 1000 mm in the west (Ravensburg) to 1600 mm in the east (Isny). Mean annual temperatures decrease accordingly; the difference between Ravensburg (8.8°C) and Isny is 1.6°C. A climatic peculiarity of the landscape is the *Föhn*, a warm, downslope wind from the Alps.

In a strong contrast to the well-researched landscapes of Upper Swabia and western Lake Constance, which are adjacent to the west of the study area, the Westallgäu was archaeologically *terra incognita* until recently (Figure 1; Hagmann et al. 2011, p. 6). The blank space on the distribution maps was explained by palaeoenvironmental and climatic factors (Krahe 1958, p. 37; Schlichtherle 1985, p. 18).

However, in the light of the discoveries of the Degersee project, taphonomy seems to be the main reason behind the empty map up to now. While Upper Swabia is traditionally characterised by agriculture, the Allgäu nowadays has its economic bprofundal zoneackground in cattle breeding and dairy farming.

This is a result of a turbulent shift in economy in the 19th century, when Allgäu agriculturalists changed their farming strategies to a dairy produce economy. As a consequence, formerly ploughed farmland was changed into meadows and pastures. This fact had an important influence on the chances of survival or even discovery of an archaeological object or site. In comparison to the open farmland in Upper Swabia and Linzgau the green hills and forested hilltops of the Allgäu were — and still are — much less accessible to archaeologists and local volunteers, who played a major role in the history of archaeological research going back to the 1930s (Reinerth 1956). Furthermore, building and infrastructure activities are less intense than the growing agglomerations around Lake Constance or more industrialised parts of Upper Swabia.

The outer boundaries of the investigation area Westallgäu are defined by a combination of natural and administrative borders. Lake Constance and the river Schussen mark two distinct natural borders to the south and west. The eastern border is defined by the administrative boundary between the federal states of Baden-Württemberg and Bavaria. The northern border is limited by geographical elements as defined by Dongus (1991). It is self-evident that a perimeter defined by such a mixture of different parameters reflects an area of interest rather than any border that was valid in prehistory.

Approaches, concepts, methods

'Beyond Lake Villages' conceptually implies expanding the area of interest to the hinterland of the intensively researched large pre-alpine lakes and therefore to the landscape rather than to individual sites. Consequently, off-site investigations, against the background of the results of the Degersee project (Kleinmann et al. 2015), constitute a central strategic pillar within the project. The methodological approach used is based on several decades of research experience (Clark et al. 1989) and has been refined in the Degersee project (Kleinmann et al. 2015).

The strategy developed during the Degersee project was to combine off-site and on-site studies in the same lake. Off-site sediments from long cores in the profundal zone of the lakes provide highly resolved sections without hiatuses. They reflect microregional influences from the catchment and are often annually laminated. Densely sampled radiocarbon AMS data provide a reliable chronostratigraphical framework which allows the chronological interconnection with archaeological and scientific on-site data revealing local signals. Off-site studies, in particular, aim at disentangeling human impact from the forces of nature. A novel strategy to achieve this aim is comparing relevant data from a lake close to prehistoric sites such as Degersee with lakes some distance away and potentially less influenced by human impact such as Schleinsee and Mittelsee (reference lakes) (Figure 1).

Off-site field methods and analysis of the respective samples applied state-of-the-art techniques. Sediments of undisturbed long cores (Merkt and Streif 1970) were densely and continuously sampled and prepared for pollen analysis (Moore et al. 1991; Stockmarr 1971), loss-on-ignition (Kleinmann et al. 2015) and microfabric analysis (thin-sections, Merkt 1971). Terrestrial macroremains were cleansed with 200 or 300 μm mesh sieves for AMS dating. XRF-Scans were executed in 200 μm steps on fresh surfaces of cores for geochemical composition.

The counterpart to off-site-investigations are archaeological and scientific on-site studies. Based on a long tradition of settlement archaeological concepts (Jankuhn 1977), which have successfully been adopted to the Swiss and the German northern Alpine foreland from the 1980s on (Schlichtherle 1991, 2009), they include observations on spatial scales much larger than single settlements and their vicinity. However, the specific character of the investigation area demands an approach slightly different from comparable investigations in the loess regions, where landscape archaeological concepts were initially developed (for details on the history of research see Zimmermann, 2014). The short hydrological history of the area has shaped an immature drainage system with waterscapes rather than landscapes. In the vicinity of Degersee, for instance, dry, arable land was restricted to drumlin hills that emerged like islands from an entanglement of reeds, mires, and open water (Mainberger 2009, fig. 3; Mainberger et al. 2015a, p. 523). It has been suggested to conceptualise landscapes so deeply influenced by the presence of aquatic elements and their use by prehistoric communities as 'limnic cultural landscapes' (*limnische Kulturlandschaften*) (Bleile 2010). The concept was originally developed in the field of nautical archaeology by C. Westerdahl. Basically, Westerdahl's concept was to observe archaeological phenomena linked to water from two perspectives – from the land (agricultural) point of view, but also from the perspective 'on board a vessel closing in with the shore' (Crumlin-Pedersen 1978; Westerdahl 2011). Elements of the 'maritime' or 'limnic' cultural landscapes are not only all kinds of sources directly related to water — like settlements, fisheries installations, weirs, watermills, waterfront constructions — but also hilltop forts or natural landmarks (Westerdahl 1998, 40 fig. 3). BeLaVi Westallgäu adopts this complementary approach, leading up to a work discussing the potential role of Upper Swabian watercourses and lakes in the regional traffic systems (Mainberger 2017).

The results presented in this paper relate to three spatial scales (Figure 1): the first level encompasses settlement sites and their direct vicinity (*Siedlungsumfeld)* (Maier 2015; Maier and Vogt 2000; Vogt 2015). The second level describes microregions (*Kleinlandschaften*) that may include several neighbouring sites; the map marks these units as rectangles of up to 7 by 8 km side length. The third, regional level (study area; *Untersuchungsgebiet)* expands from Lake Constance in the southwest to the tributaries of the river Iller in the northeast and is today known as Eastern Upper Swabia or Westallgäu (Benz 2013, 4 for the history and on-going discourse to the term).

The technical principles and standards of southwest German wetland and underwater archaeology have been described often and from different points of view (Dieckmann et al. 2006, pp. 19–45; Mainberger and Hohl 2013; Mainberger 2015, pp. 17–18). The methodology developed by a circle of scientists and technicians at the Wetland Department of the State Office for Cultural Heritage Baden-Württemberg has continuously been adapted to the challenges of new scientific questions, tasks, and technical possibilities. BeLaVi Westallgäu profited much from this expertise. The starting point of archaeological fieldwork was in many cases information provided by locals — we owe most new discoveries and reports relating to unpublished observations to these enthusiasts, with their thorough knowledge of the landscape, oral and written traditions[§]. Remote sensing technologies (satellite imagery analysis, aerial photography), as well as the systematic use of LIDAR data and historical maps proved to be important tools in preparing fieldwork and identifying areas of interest on a microregional level. Archaeological field methods included one-day site visits, several single day systematic surveys, and excavations lasting from a few days to several weeks. Excavation trenches were generally restricted to very small 'keyholes' due to the multitude of sites and tasks and this allowed for stratigraphic observations and sampling for scientific analyses. Archaeological investigations were carried out on mineral soils, wetlands, and in mires as well as in open water.

Geophysical techniques included ground-penetrating radar (GPR) and single beam echo sounder (SBES) technologies. 2500 transects with an interval of 5 m were investigated by GPR. 44 sediment cores were taken to visually identify the structures displayed on the radar.

Dendrochronological, archaeobotanical, palynological, archaeo-osteological, and pedological investigations have long since become standard tools in the scientific assessment of prehistoric settlement sites. The methods deployed and techniques used in Baden-Württemberg have been described on different occasions (see for methodological details Billamboz 2014; Maier 2001, 2016; Vogt 2001, 2014). Generally, samples for botanical, palynological, and anthracological analyses originate from trench profiles; according to specific questions, a number of samples were also taken in excavated areas and from drill cores. High-resolution on-site analyses of pollen, microcharcoal, and non-pollen palynomorphs (NPP) were performed in close cooperation with the archaeobotanical and pedological work. The profile columns recovered for archaeobotanical studies were continuously subsampled for pollen. Additionally, on-site sediment corings were investigated in order to discover traces of local human activities and to estimate the extension of cultural layers as well as their state of preservation. The preparation of the pollen samples with a volume of 1 cm^3 followed standard methods using HF 40 percent and acetolysis (Moore et al. 1991). *Lycopodium* tablets were added for the estimation of pollen and charcoal concentrations (Stockmarr 1971). Dendrochronological analyses were carried out for the dating of timber and were supplemented by AMS single and AMS 'wiggle matching' radiocarbon dating (Bronk Ramsey et al. 2001; Bronk Ramsey et al. 2010; Galimberti et al. 2004; Reimer et al. 2013), given as 2σ calibration ranges. Wood charcoal samples were taxonomically analysed according to their anatomical characteristics (Schweingruber 1990a,b). Charcoals were analysed on freshly broken surfaces with a stereo-lens with 5–100x magnification and an episcopic light microscope with 100–500x magnification and additionally their diameter was measured (Nelle 2002). Sediment cores up to several meters in length were taken in mires and depressions to answer geomorphological and pedological questions.

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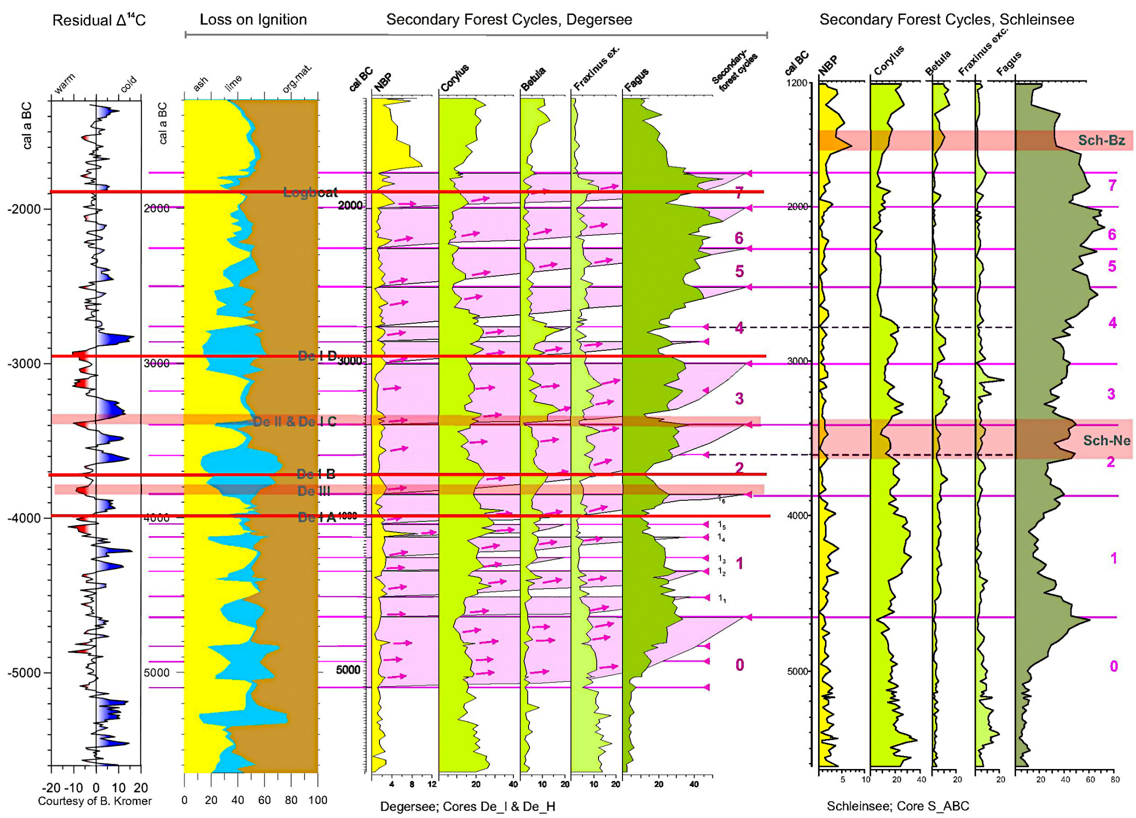

Figure 2: Synoptical diagram: Solar activity, loss-on-ignition, Neolithic occupations (DeI A–D, De II, De III and Sch-Ne) and Bronze Age evidence from Degersee and Schleinsee (red lines/bars). Comparison of pollen diagrams of the Neolithic Secondary Forest Cycles (magenta) in the sediments of Degersee and Schleinsee (Kleinmann, et al 2015, Abb. 29, modified).

First results

Off-site studies

Off-site studies were carried out at Schleinsee and Mittelsee. Both lakes are of glacial origin. Schleinsee is situated at 474 m asl close to the Degersee sites I to III. Recently a prehistoric site has been discovered in Schleinsee itself (Figure 1, 2). Mittelsee is located some 12 km to the northeast at 542 m asl and about 6 km away from the nearest known prehistoric site.

Cyclical oscillations of the climax beech (*Fagus*) forest were found in the Neolithic sediments of the three lakes studied (Kleinmann et al. 2015; H. Müller 1962, 1973). Müller 1973 interpreted these oscillations as 'secondary forest cycles' resulting from human activity. A secondary forest cycle starts with a decrease in *Fagus*, at the same time non-arboreal pollen (NAP) increase slightly. This phase is followed by an increase in light-demanding species such as hazel (*Corylus*) and birch (*Betula*) and succeeded by ash (*Fraxinus*). At the end of the cycle beech culminates again in a climax forest. Seven main secondary forest cycles could be identified. These secondary forest cycles are sometimes subdivided into subcycles, when the growth-cycle was interrupted by further clearing events (Fig. 2).

Schleinsee

Much data about this lake has already been accumulated but reliable AMS dating had not been available until now. Pollen analysis, loss-on-ignition, and thin section studies of the new core S_Y have been completed, AMS dating of this core is in progress. A few wooden piles retrieved by archaeological divers are dated to Neolithic and Bronze Age periods and prove the activities of settlers from 3625–3373 cal BC (Sch - Ne) and 1622–1510 cal BC (Sch - Bz; Fig. 2). When comparing the pollen peaks of beech from the so far undated Schleinsee core S_ABC with the corresponding peaks from the Degersee there is a perfect matching pattern when tentatively adjusted to the AMS ages of their partner peaks in Degersee (Fig. 2).

During the Degersee project, at the DeI site (Figure 3), five lakeshore occupations could be verified and dated. They all coincide with sediment portions characterised by the beginning of beech forest depressions, low lake levels, the accumulation of laminated calcareous mud and high solar activity as seen in the curve of residual delta ^{14}C (Figure 2). Peaks of the recovering beech forest, in contrast, coincide with high lake levels, 'weak sun', less charcoal, and massive diatomaceous non-calcareous mud (Figure 2) (Kleinmann et al. 2015). This coherent concert of processes and proxies implies an independent regional agent such as climate influencing environment and related human activity (Mainberger et al. 2015a, pp. 532–533).

Mittelsee

Mittelsee, situated about 12 km northeast of Schleinsee, resembles Schleinsee in size and morphology. No prehistoric settlements have been found on its shores or in the vicinity up to now. It has neither surficial inlet nor outlet, but is fed by groundwater from the surrounding gravel beds. Consequently, it is most appropriate as a reference lake for our on-going study. The lake is about 4 m shallower than Schleinsee and more exposed to the wind due to poor morphological shelter.

Preliminary testing/analyses and XRF scans in 200 μm steps showed that despite exposure to the wind the deposition during the Neolithic is characterised by sections of perfect and stable calcareous laminations, only interrupted by abrupt but short-span phases with a total lack of calcite, prevailing organic matter, and diatom silica. At the onset of the Bronze Age the sedimentary system changes within a few years: olive-coloured, sticky and massive mud completely devoid of calcite is dominated by diatoms and organic matter indicating an intense change in the economic system in the catchment of the lake, corroborated by elevated and fluctuating concentrations of titanium. There are virtually no terrestrial macroremains left in this upper core section that could be cleansed for AMS dating.

The palynological study is in progress. As expected, the secondary forest cycles begin to appear. Compared to the cores from Schleinsee and Degersee, the general frequency and density of a beech-dominated woodland seems to be higher with less distinct fluctuations and lower amplitudes in the characteristic cycles.

On-site studies

In the context of the BeLaVi project three so far unknown sites (Neukirch, Bodnegg, Leutkirch) have been confirmed as Neolithic sites with one or several occupations each. A considerable number of additional sites have delivered Neolithic materials or datings but hitherto no detailed evidence of their character (Figure 1). For many sites the only knowledge we have so far is that they are of prehistoric origin. Analyses and some fieldwork are still on-going. The following reports are therefore to be understood as tentative, with some examples highlighted, some general observations and lines of interpretation summed up in the discussion.

The lakeshore settlement at Degersee II

Degersee II (De II) is situated on the northern shore of Degersee, a small lake basin of glacial origin between Lake Constance in the south and the river Argen to the north (Figure 3). The lake is situated at 478 m asl, the terrain being about 80 m higher than Lake Constance. From 2008 to 2010 it was surveyed as part of the Degersee research project (Maier et al. 2010; Mainberger et al. 2015b). At present we know of three Neolithic sites on the lakeshore (Degersee I, II, III). With a Neolithic and a Bronze Age site at Schleinsee and colluvial deposits of the same periods at different sites in the vicinity, the Degersee-Schleinsee microregion (Figure 1) is one of the hotspots of the BeLaVi project.

The southern part of the De II site is today situated below the water table at a depth of about 1.5–2.5 m. Further to the northwest, piles and cultural layers are embedded in a peat moor that expands from the water line to the edge of the moraine hills. Drilling activities and excavation works were carried out in open water (trench 2, Figure 3), in the lacustrine and telmatic deposits of the mire (trench 4) and also on the mineral soils of the moraine, combining wetland archaeological and diving archaeological methods with investigations on dry land. In total, todays´

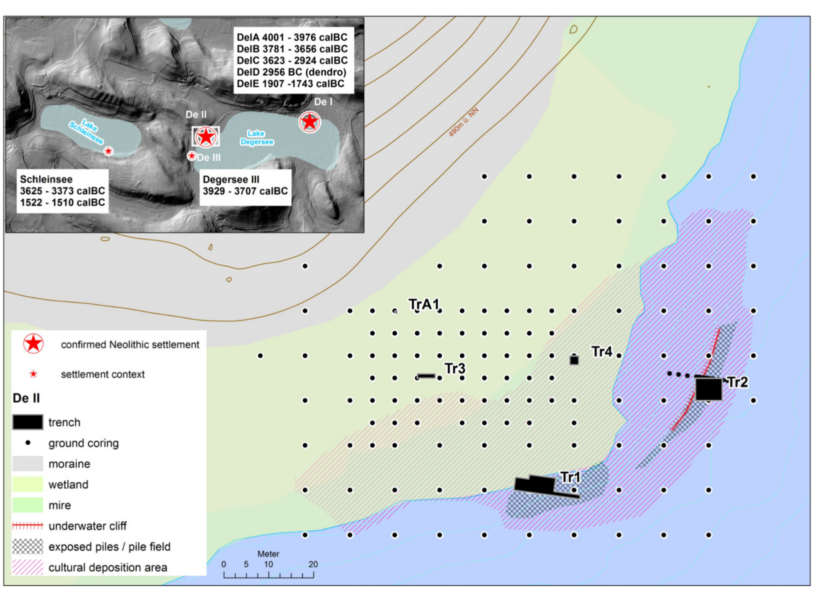

Figure 3: De II: General plan. Overview map: sites and datings in the Schleinsee/Degersee region (exclusive of De II). AMS radiocarbon dates are given in 2σ calibration ranges.

Figure 4: De II: Profile at the submerged shelf at trench 2. Photograph courtesy M. Mainberger / LAD.

knowledge of the site is based on 76 m^2 investigated by surface analysis, 13 m^2 excavated completely and 168 drillings.

Cultural layers are generally situated directly on top of the biogenic chalk of the Holocene lake. Sloping slightly down in southerly directions, they are covered by peat in the moor environment and by lake marl towards the lake. The southern, lakeside outer border of the site is marked by a geomorphological peculiarity. Anthropogenic remains stop in a sharp line formed by a submerged shelf, which rises about half a meter from the lake bottom, exposing culture layers in an almost vertical profile (Figure 4). Very few piles appear beyond this line. There are strong indications that the formation of this geomorphological anomaly is not a mere product of recent erosion processes but has its origin in the occupation period or soon after (Kleinmann et al. 2015, pp. 428–429). According to the results of drill cores, a similar geomorphological step occurs at the opposite side of the site, directly below the flanks of the adjacent moraines. Consistent results of plant remains analysis and on-site pollen investigations show that the cultural layer and natural deposits were intermittently influenced by high water tables.

Figure 5: De II: implements for textile production. Foreground: spinning whorls (trench 4); background: loom weights (trench 2). Photograph courtesy M. Erne / LAD.

This evidence, along with the stratigraphic position of the cultural layer directly on top of lacustrine sediments and also the total lack of any coherent constructions suggest that the houses on the site were not founded directly on dry ground but rather a bit elevated above the wet, soft, and at least periodically submerged conditions of a reed belt. Lake level fluctuations in combination with accumulation of lake sediments — as indicated in the pollen record — may have been the cause for the destruction and subsequent conservation of the site.

Cultural layers consist mainly of organic detritus, charcoal, charred and waterlogged timbers, pebbles, and clay. The artefact inventory contains ceramics, fired clay, stone and flint artefacts, and also the whole spectrum of waterlogged materials like wooden objects, seeds or animal bones.

Figure 6: De II: linseed (Linum usitatissimum). These seeds from the small-seeded flax types are only 2.7–3.0 mm long. Photograph courtesy U. Maier / LAD.

Table 1: Degersee II: Remains of crop plants.

	rest types	number	
common flax	seeds, capsule segments	28713	*Linum usitatissimum*
common flax	seed-, capsulefragments	++++	*Linum usitatissimum*
common flax	stem fragments	++	*Linum usitatissimum*
durum-wheat	chaff, grains	998	*Triticum durum*
barley	chaff, grains	102	*Hordeum vulgare*
emmer	chaff, grains	54	*Triticum dicoccon*
einkorn	chaff, grains	24	*Triticum monococcum*
wheat species	different remains	88	*Triticum sp.*
cereal species	different remains	1055	*Cerealia*
opium poppy	seeds	7041	*Papaver somniferum*
garden pea	pod fragment	1	*Pisum sativum*

Most prominent are finds connected to textile production, among them loom–weights (trench 2) and spinning whorls (trench 4; Figure 5). The loom–weights – a concentration of at least 7 objects of two different types – were embedded in a concentration of flax stalks, indicating an activity zone connected to textile production. Typological features of ceramics are best compared to sites dating about 3300 BC (Mainberger 2015, pp. 106–107). This matches with the absolute dates. Radiocarbon dates from construction timbers and from seeds cover the period between the end of 34th century until the 31th century BC (3339–3031 cal BC; 3331–2936 cal BC; 3348–3098 cal BC; 3338–3029 cal BC, 2σ). Dendrochronological dating has not been successful so far. Remarkably, radiocarbon dates of the neighbouring site Degersee I (De I) phase C indicate settlement activities at the same time period (Million and Billamboz 2015).

Agriculture, according to archaeological observations, seems to have been mainly based on common flax (*Linum usitatissimum*). Of the analysed plant remains this crop is absolutely dominant with nearly 30,000 remains, mainly uncharred seeds and capsule segments, an innumerable amount of very small fragments and a lot of stem parts (Figure 6; Table 1). It is a flax variety with small seeds with an average length of 2.9 mm (range: 2.6–3.1 mm), which only occurs from 3400 cal BC onwards. All flax seeds from older lakeshore settlements are distinctly bigger. It is assumed that the big-seeded flax was mainly used for its oil-rich seeds, while the small-seeded variety provided better fibres for textile production (Herbig and Maier 2011).

Compared to flax, cereals, with only about 2,300 remains (mainly uncharred chaff) seem to be of less importance. Most of the cereals are durum wheat (*Triticum durum*-type), a smaller proportion consists of barley (*Hordeum vulgare*), emmer (*Triticum dicoccum*), and einkorn (*Triticum monococcum*). The combination of a small-seeded flax variety and durum wheat as the dominant cereal is typical for the last quarter of the 4th millennium BC. The same evidence has been observed at approximately contemporary sites like Arbon Bleiche 3 (Hosch and Jacomet 2004), Bad Buchau Torwiesen II (Maier 2011), and Sipplingen-Osthafen layer 11 (Maier n.d.). More than 7,000 uncharred seeds of opium poppy (*Papaver somniferum*) prove the importance of this crop plant in the site. It might have been used as a medicinal plant or a drug, but the seeds can also be used for food.

In definite contrast to both the archaeobotanical observations and the archaeological record, flax cultivation is not well represented in the pollen data: five pollen samples taken from cultural sediments rich in flax macroremains contain only 0.1 – 2.0 percent *Linum* pollen. The anthers of *Linum usitatissimum* drop off during the ripening of the capsule. This, combined with the rather low pollen production, may be the reason for the poor reflection of flax processing in the pollen record. The same applies to the poppy, which is represented only by some single pollen grains of the *Papaver rhoeas* type that includes *P. somniferum* and the weed *P. rhoeas*. The pollen spectra of the cultural layers in the two profiles analysed from De II are characterised by high percentages of cereal pollen and indicators for gathering wild plants (rose hip, berries etc.).

Charcoal spectra from De II are dominated by alder (*Alnus*), ash (*Fraxinus*), and hazel (*Corylus*). Beech (*Fagus*) plays a significant role. Six other taxa are present, notably fir (*Abies*), which was also found once in the waterlogged branch wood spectra of De I (Million and Billamboz 2015, p. 300) and also in the timbers of De II. Waterlogged timber is clearly dominated by alder, followed by ash and beech. Overall, wood and charcoal show relative similarities, which indicates that the selection of construction timber was not thorough and did not exclude taxa which appear in the fuel wood spectra. The virtual absence of oak (*Quercus*) in the waterlogged samples of De II is striking and forms a strong contrast to pollen data (Kleinmann et al. 2015). It seems that either oak trees were virtually lacking in the close vicinity of the settlement or were not used for unknown reasons. Lime (*Tilia*) is present in charcoals, but rare in construction timber. Being a soft wood, it was probably predominantly used as fuel wood or for making wooden artefacts (which might have been burnt in the fireplaces once broken or no longer used).

Alder, ash, and beech pile wood samples with more than 20 tree rings were measured. They show an average of around 30 rings (alder, ash) and 40 rings (beech). So far, it was not possible to date them absolutely by dendrochronology due to the small number of rings and the problems of dating these wood species. However, some of the dendro curves match dendrotypologically (methods see Billamboz 2014) and form dendro-groups in the respective species of alder and ash. Most of the alder trees were cut in the same year; this can be said also for most of the ash trees. But the cross-dating of the two species was not possible yet, which means that there are no hints of the usage of alder and ash trees at the same time. Thus, it remains unclear whether there were one or two cutting phases at this site.

During the excavations at De II from 2015 to 2016 a total of 589 animal remains were recovered in trench 4. Together with the 522 bone objects excavated in 2009 in trench 1 (Stephan 2015) the archaeozoological sample now encompasses more than 1,100 bone fragments. Unfortunately, due to very high fragmentation and the substantial amount of very small fragments, only 8.5 percent of the bone finds could be determined to species level (number of identified specimens NISP = 94). In weight this identifiable percentage is equal to about 91.5 percent of the assemblage. Cattle and red deer finds predominate with approximately 25 percent and 40 percent of the identified specimens (40 percent and 30 percent by weight). Sheep or goat, pig, and dog as well as roe deer, wild boar, and red fox are represented by only few or single finds. According to this evidence, cattle breeding and hunting of red deer might have been important aspects of subsistence. Livestock breeding is also indicated by spores of coprophilous fungi and plants known to be used as winter fodder such as ivy (*Hedera helix*) and mistletoe (*Viscum album*). This taxonomic composition resembles the compositions of the faunal assemblages from contemporaneous sites such as Arbon Bleiche 3 (Deschler-Erb and Marti-Grädel 2004) and Sipplingen-Osthafen layer 11 (Steppan 2004, n.d.) but the number of identified specimens from De II is too low to make any reliable statements.

Taking all available information into account, De II represents a type of site we know from many shores and shallow water zones at pre-alpine lakes. Similar to the conditions in De I, it was built directly on the waterfront with houses slightly elevated from the wet surface. According to archaeological and absolute data the site dates to about 3300 BC or shortly after. Similar to other sites of that time, the cultivation of flax and textile production played a dominant role, with cereal and poppy cultivation, animal husbandry, hunting, fishing, and gathering being other important parts of economic subsistence.

The moor site of Bodnegg

The site at Bodnegg-Breites Ried is located some 20 km north of Degersee at 574 m asl. (Figure 7). A post-glacial backwater valley subdivides the Bodnegg microregion from drumlin formations north of the river Argen with the newly discovered site of Neukirch in its center. The heights of the inner terminal moraine are nearby to the north (Figure 1). The site was discovered in 2014 when waterlogged timbers, charred seeds, and artefacts were observed close to recently cleaned drainage ditches (Mainberger et al. 2016, p. 41). The subsequent archaeological surveys in 2015 and 2016 included establishing a coring grid consisting of 119 drillings, a georadar investigation and excavation of two small trenches.

Geomorphological and stratigraphical evidence result mainly from sediment coring. The profiles demonstrate that today´s meadows, pastures,

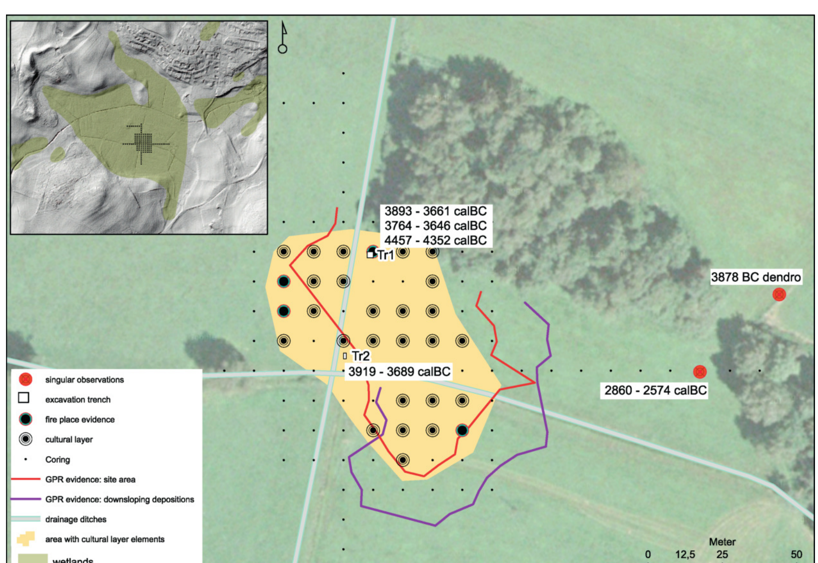

Figure 7: Bodnegg: General plan. AMS radiocarbon dates are given in 2σ calibration ranges. The given dendro-date refers to the last measured ring.

Figure 8: Bodnegg: fireplace in trench 1. Photograph courtesy H. Nagler.

and wetlands originate, like Degersee, in a glacial lake basin. The detected archaeological site is situated on top of peat layers in the centre of the mire. Glacial deposits and Holocene lake sediments are sloping down in away from the site all directions, forming an elevated plateau with cultural layers on top. Whether the peat mound was surrounded by open water at the time of human occupation, remains unresolved so far. However, the existence of organic lacustrine sediments on the periphery of the site indicates that its outskirts were strongly influenced by water.

In trench 1, a massive structure made of pebbles and clay was found below the sods of the surface (Figure 8). In the profiles the stratigraphy displays the detail. We know such structures from Neolithic and Bronze Age houses; there is no doubt that the trench cuts through a fireplace laid out on an earthen house floor. Due to poor organic conservation no wood has been conserved below this construction. Horizontal timbers in trench 2, however, suggest that floors made of timbers and clay were laid out directly on the peat surface. According to waterlogged wood analysis, oak and ash were used for the pile foundations of the houses.

Results from georadar allow us to distinguish mineral (clay) bodies and larger single stones from organic layers and help to indicate the outer borders of the site. The respective mapping correlates well with the drill core evidence. According to this evidence, houses were built in a total area of about 4000 m^2. Observations of down-sloping strata suggest a possible peninsular situation. A direct stratigraphical connection of this evidence to the detected clay floors has yet to be confirmed.

Due to short tree ring sequences of woods in the culture layer dendrochronological dating has not been successful so far. Radiocarbon samples taken from the fireplace in trench 1 date the detected culture layer to the 38^{th} or 37^{th} century BC. This dating well matches the excavated archaeological materials, which show close similarities to neighbouring cultural formations labelled ‘Pfyn-Altheimer Gruppe Oberschwabens’ or ‘Pfyner Kultur’. There are, however, distinct differences to these archaeological cultures as well. In trench 1 a representative archaeobotanical sample (57 x 20 x 12 cm) was taken. Within the cultural layer, a lot of cereal chaff and one flax seed (*Linum usitatissimum*) have been found among the

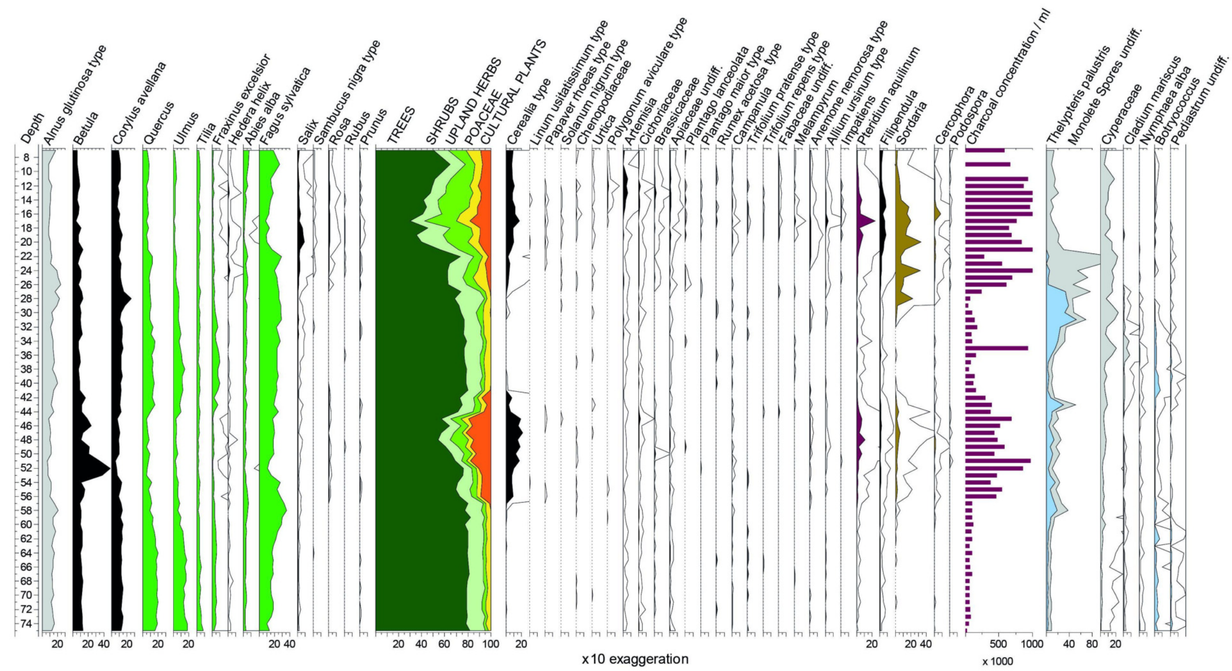

Figure 9: Bodnegg: on-site pollen diagram (trench 2) showing two Neolithic cultural layers separated by aquatic-telmatic sediments. Percentage values of major taxa and non-pollen palynomorphs (NPP); *Alnus*, aquatic plants and NPPs are excluded from the reference sum.

carbonised materials. 50 percent of the chaff was from einkorn (*Triticum monococcum*), nearly 30 percent from naked wheat (*Triticum durum-type*), and more than 20 percent from barley (*Hordeum vulgare*). This assemblage is different from those of comparable Pfyn-Altheim sites; in Reute-Schorrenried (Hafner 1998) and Ödenahlen (Maier 1995) durum-wheat was the prevailing cereal. The same sample was used for analysis of pollen and non-pollen palynomorphs. No pollen is preserved in the top 20 cm below surface as a consequence of the peat mire drainage. In the better preserved lower parts of the sample high percentages of cerealia pollen and sporadic finds of flax (*Linum usitatissimum* type) and poppy (*Papaver rhoeas* type) occur as well. Livestock breeding is represented by grazing indicators and spores of coprophilous fungi.

Charcoal spectra of the upper cultural layer in trench 2 are clearly dominated by beech, followed by oak, alder, ash, and hazel. This is in line with the assumption that the lake was small during Neolithic times and the woodlands on wet soils on its periphery were smaller or even non-existent compared to De II. The data suggests that Neolithic settlers collected their firewood further away, eg. on the surrounding minerotrophic soils.

There are strong indications that the 38th/37th century occupation represents not the only presence of farming communities at the site. The most distinct hint for an occupation dating about one century earlier was detected in pollen evidence originating from the lower part of the profile in trench 2; pollen and microcharcoal records reveal clear signs of nearby or on-site human impact (Figure 9). An oak timber sampled in the peat-gyttja deposition, which also contained some larger pebbles, dates to the 40th century BC (AMS radiocarbon). Additional evidence from the 38th/37th century was detected on the periphery of the cultural deposits. A radially split oak timber found in a trench gave a heart wood date around 3858 ± 10 BC (*terminus post quem*), and an alder wood from a coring was dated to 2860–2574 cal BC.

A palynological observation found some centimetres below the fireplace sequence of trench 1, where up to 2 percent cerealia pollen and a conspicuous increase in microscopic charcoal coincide with declines in pollen percentages of elm and ash was most surprising. A combination of several indicators like this leaves no doubt that there was human occupation in the near vicinity. According to a radiocarbon date of terrestrial plant remains in the peat formation this presence dates to the middle of the fifth millennium BC (4457–4352 cal BC) and is older than the earliest wetland settlements known in the Lake Constance region. This evidence was not observed in the stratigraphy of trench 2, which raises questions about the formation history of the respective sediment sequences. The pollen stratigraphy of trench 2 (Figure 9) reveals the great importance of animal husbandry by high amounts of spores of coprophilous fungi (*Sordaria*, *Cercophora*, *Podospora*) as well as the use of wild fruits/berries and herbs, such as *Filipendula* (meadowsweet) and *Pteridium aquilinum* (bracken).

Summing up, it can be tentatively stated that Bodnegg represents a moor site (*Moorsiedlung*), a settlement type we know from different periods of the north alpine Neolithic and Bronze Age.

Archaeological, geostratigraphical, and botanical observations suggest that we are dealing with a village that was erected on a peat mound in a wetland environment; whether it was surrounded by water at times or even permanently remains unresolved. The dimensions and numbers of houses are still unknown. Absolute dates and archaeobiological evidence indicate that the 38th century site had precedents in the centuries before and followers in the subsequent millennium; further investigations are necessary to precisely date and localise these occupations.

The hilltop site at Leutkirch-Wilhelmshöhe

Wilhelmshöhe is a hill above the town of Leutkirch. It is located at 707 m asl and rises from the banks of the river Eschach, a tributary of Iller and Danube (Figure 1). The site was discovered in 2014 during maintenance works at the public fairground (Mainberger et al. 2015b, p. 41). The elevation model (Figure 10) indicates that the hilltop, today perfectly flat, has been shaped by modern levelling works.

The Leutkirch area, in contrast to the microregions to the west, is a landscape characterised by fluvial waters rather than by bogs and mires. It has been subject to archaeological surveys since the 1930s, when Count Christoph von Vojkffy, an amateur archaeologist, detected a number of Mesolithic sites. Today we know that the respective inventories also contain a wide variety of Neolithic materials, some of them dating back to the Early Neolithic (Gehlen and Schön 2011).

Archaeological observations on Wilhelmshöhe were restricted to a few hours only and carried out by a volunteer. In the profiles and at the bottom of about 1 m deep ditches dark discolorations were found which proved to contain charcoal, charred seeds, stone and flint artefacts, ceramics, and burnt clay.

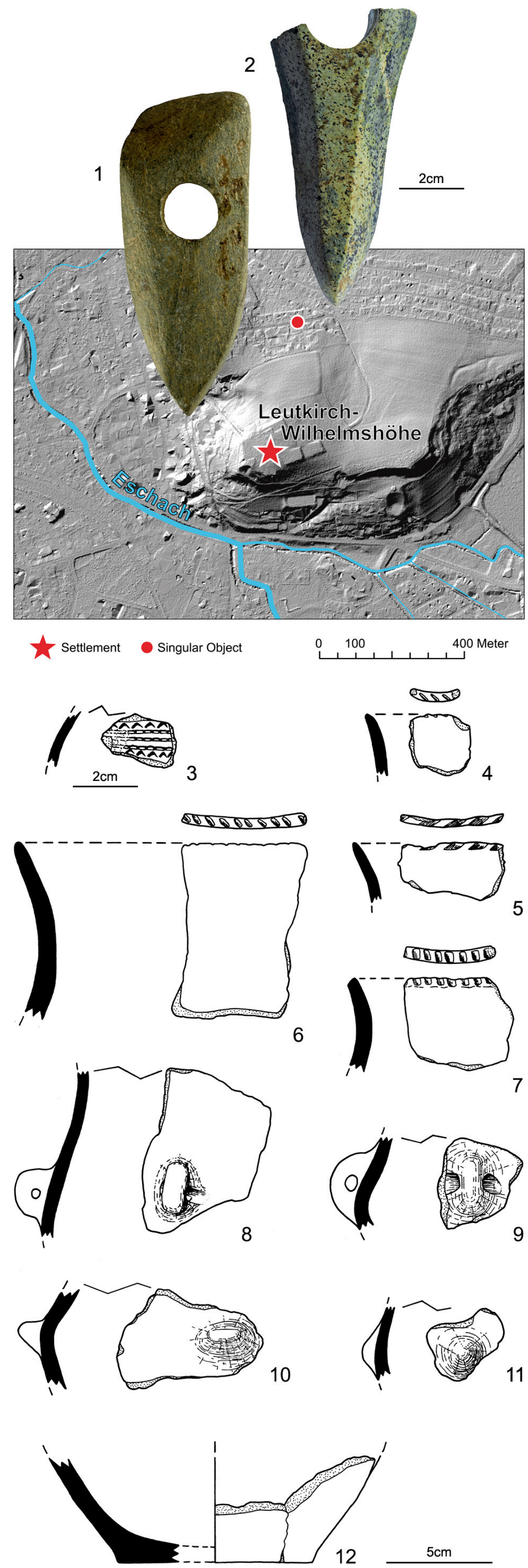

Figure 10: Leutkirch – Wilhelmshöhe: objects and elevation model. LIDAR data courtesy Landesamt für Geoinformation und Landentwicklung Baden-Württemberg; Photograph courtesy M. Erne / LAD; Drawings Ph. Gleich / LAD.

From the dimension and shapes of the evidence, it becomes clear that we are dealing with pits, indicating a permanent occupation. The archaeological finds can well be compared to the period of the earliest wetland sites from around 4300 cal BC onwards. The best affinity is to materials from Aichbühl (K. Müller 2000; Strobel 2000, pp. 223–224) and Schulterbandgruppen (SBK) (Zeeb 1998). A radiocarbon date derived from charred seed (4345–4251 cal BC) confirms this archaeological and chronological context. Aichbühl, with its eponymous site in the Federsee basin, marks the beginning of the lake dwelling tradition in southwest Germany (Strobel 2000, p. 438). Hitherto the eponymous site was the southernmost settlement in the Aichbühl Culture, which has its main distribution area along the Danube and its tributaries (see Mainberger 2015, pp. 97–98). The Leutkirch site, with its location at the western sources of the Danube hydrological system well matches this archaeological background.

Up to now 35 litres of sediment have been analysed botanically. Most of the 630 charred plant remains determined were cereals and field weeds. It revealed that einkorn (*Triticum monococcum*) was the prevailing crop with about 73 percent of the total inventory followed by emmer (*Triticum dicoccum*) with 20 percent. Naked wheat (*Triticum durum*-type) and barley (*Hordeum vulgare*) only played minor roles. The predominance of einkorn is typical for this time span. It can be found in several synchronous sites attributed to the Schussenried culture of the Middle Neckar region (Maier 2004) as well as in the Degersee IA and Degersee IB sites (Figure 3) and at contemporaneous Federsee and Lake Constance sites (Billamboz et al. 2010; Maier 2015; Maier and Vogt 2004). Apart of the cereals, nearly 200 weed seeds were identified derived from at least 9 weed species. Most of them are from graminaceous plants (grasses) which imply the existence of fallows. Remains of non-cultivated plants were extremely rare in comparison to Degersee II and Bodnegg. Only hazelnut (*Corylus avellana*) has been identified with 8 shell fragments. However, as Leutkirch-Wilhelmshöhe is a mineral soil site, this may well be due to taphonomic reasons.

The lack of beech (*Fagus*) in the Leutkirch charcoal spectrum is striking. Reasons for it are difficult to discuss in the absence of additional samples. However, the species assemblage matches the radiocarbon date very well with a significant presence of elm (*Ulmus*) well before the elm decline.

Leutkirch–Wilhelmshöhe is geographically furthest advanced to the flanks of the Allgäu Alps and has the highest elevation of the Westallgäu sites presented here. In strong contrast to the Degersee and Bodnegg sites it is situated in a hilltop position and conserved under mineral soils. Nevertheless, it has distinct connections to water and the hydrological network: Wilhelmshöhe has a close spatial relationship to the confluence of the Eschach and Wurzacher Ach rivers and therefore a potential junction of routes between the Rhine river system, the inner Alps and the Iller/Danube catchment.

Archaeobotanical evidence and archaeological materials support the idea that the cultural connections of the site are oriented to the landscapes to the north. Due to the restrictions of a rescue activity carried out by a hobby archaeologist, many questions about this important site remain unresolved so far.

Preliminary conclusion and perspectives

Degersee II, Bodnegg, and Leutkirch represent a mere fraction of the more than 20 sites that have been surveyed or investigated so far. The lakeshore, moor, and hilltop sites indicate that the Westallgäu region offers a similar multitude and diversity of archaeological sources as their western neighbours, the well-researched archaeological landscapes of Upper Swabia and the Lake Constance/Hegau region. The origins and subsequence of cultural development follow more or less the same order and logic, with an initial episode around 4300 BC (Leutkirch) that is followed by occupations in the 40^{th} century BC (Degersee I) and the 39^{th} to 37^{th} century BC (Degersee I, Degersee III, Bodnegg, Neukirch). A later occupation dating to the 36^{th} or 35^{th} century occurs in Schleinsee.

Degersee II, with dates at about 3300 BC, starts another well-represented period around the turn of the 4^{th} to the 3^{rd} millennium. Degersee I D, with dendrochronological dates at 2956 BC (Million and Billamboz 2015, p. 287), concludes this sequence. Hints on slightly later occupations (Bodnegg) match our knowledge of sites in the Schussen valley (Ravensburg-Veitsberg) and Upper Swabia. According to this data, during the Neolithic the Westallgäu region was closely connected to the cultural development in the landscapes to the west and southwest. The archaeological data is supported also by scientific evidence. Farming and woodland economy, which is complemented by hunting and gathering subsistence strategies, follow the same models we know from the archaeological landscape further to the west. Slightly deviating scientific evidence from Leutkirch, the easternmost, most elevated and hydrographically different site, implies variants of the respective patterns. However, this may also result from different taphonomic conditions of the archaeological evidence.

Neolithic Lake Constance and Upper Swabia have long been known as important melting pots for goods, ideas, and people. A distinct geographical axis (Alpine Rhine valley–Schussen valley–Federsee bog) connects huge areas to each other with the Alps and northern Italy to the south, the Rhine Valley to the west and the Danube to the north and east (Köninger and Schlichtherle 1999; Mottes et al. 2002). The archaeological prominence of the Federsee bog may well result from its position on top of the continental water divide, with riverine systems and traffic routes connecting to each other. The concentration of sites at the lower course of the Argen river and again at the upper courses of the Iller tributaries suggest now that the Westallgäu might have played a role in this system as well. The flanks of the Argen valley could have offered an alternative track and a direct route to the Iller. Such a connection and also direct routes along the northern foothills of the Alps or along the inner Alpine valleys have been long postulated (Kieselbach and Schlichtherle 1998, p. 181; Mainberger 2015, p. 114).

The new evidence raises questions on what happened further to the east. Although the gap between the newly discovered Westallgäu archaeological landscape and the contemporary sites in the Bavarian pre-alpine foreland (Pflederer et al. 2009, p. 132; Schönfeld 2001, p. 18) has become smaller, the large area east of the BeLaVi study area still has archaeologically blank spaces at least during the Neolithic. Whether this gap is a mere product of current state of research or represents a prehistoric reality is still unresolved by the present state of research. The data presented here, albeit preliminary, confirm once more that empty spaces on Neolithic maps do not necessarily mirror any prehistoric reality. Furthermore, and other than postulated until recently (Schier 2009, pp. 19–20), relatively high annual rainfall and pre-alpine glacial landscapes have not been a barrier for the second wave of 'Neolithisation' from 4800 BC onwards. With a relatively low input in manpower and financial resources an impressive high output, not only of new sites but of evidence of a formerly completely unknown archaeological landscape, has been accumulated indicating that the area was as intensively occupied as the well-known regions and the UNESCO world heritage areas at the big lakes and large peatlands like the Federsee basin (Hagmann et al. 2011).

An important contribution to this success has been the combination of off-site and on-site data and the wide range of methods used, especially on-site palynology and macroremain studies linked to geomorphological analysis. High-resolution analyses of on-site pollen, microcharcoal, and non-pollen palynomorphs (NPPs) facilitated the detection and location of prehistoric occupations even where cultural layers could not be identified during excavation or in trench and drilling profiles. From an archaeological point of view, the most remarkable quality of the respective observations is their chronological age. Consistently the evidence of off-site pollen indicates Neolithic occupations long before the introduction of the lakeshore tradition into the pre-alpine foreland. Off-site palynological records expand this new knowledge to a landscape scale. We expect that the comparison of the Degersee and its known Neolithic sites with the evidence from nearby Schleinsee and Mittelsee will enable us to find arguments to distinguish human impact from natural processes.

The BeLaVi Westallgäu project will continue until 2018. The focus will be on the analyses of archaeological and scientific fieldwork and synthetic work with the results of the Swiss and Austrian research groups. After each region has precisely discussed off-site and on-site results on human activity and suggested wider patterns of landscape change, the next step will be comparing and connecting of the results of all three regions in order to separate local from supralocal patterns and discussing supralocal players like climate vs. human settlement and demographic rhythms.

Tables

Table 2: Leutkirch – Wilhelmshöhe: carbonised botanical macroremains.

sample number		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**total**
sample vol. (litres)		**10**	**10**	**10**	**10**	**5**	**5**	**5**	**5**	**5**	**5**	
einkorn												
Triticum monococcum	grains	3	3	3	1	2	2	2	1	2	4	23
Triticum monococcum	spikelet forks	10	27	8	11	10	11	6	3	13	-	99
Triticum monococcum	glumes	7	33	8	20	9	5	9	2	-	31	124
emmer												
Triticum dicoccum	grains	-	1	-	3	2	1	-	-	-	-	7
Triticum dicoccum	spikelet forks	2	4	1	5	2	1	-	2	3	-	20
Triticum dicoccum	glumes	-	9	3	10	5	3	1	2	-	3	36
naked wheat												
Triticum aestivum/durum	grains	2	4	2	-	-	2	3	2	-	1	16
Triticum aestivum/durum	internodes	1	-	1	-	2	-	1	-	-	5	10
barley												
Hordeum vulgare	grains	1	-	-	-	-	-	-	-	-	1	2
emmer/einkorn												
Triticum dicocc./monococc.	spikelet forks	-	-	1	-	1	-	1	-	-	3	6
Triticum dicocc./monococc.	glumes	-	4	-	13	8	3	3	-	2	2	35
wheat species												
Triticum sp.	grains	-	-	1	3	3	1	-	-	2	4	14
Triticum sp.	internodes	-	-	-	-	-	-	1	2	-	-	3
Triticum sp.	glumes	-	-	-	-	-	-	-	1	-	-	1
cereal species												
Cerealia	grain fragments	10	9	18	15	16	17	22	3	11	15	136
Cerealia	grains	3	2	4	-	-	2	3	6	2	2	24
Cerealia	embryo	-	-	-	-	-	-	-	-	1	1	2
weeds												
Bromus secalinus	seeds	-	1	-	-	-	-	-	-	-	-	1
Bromus sp.	seeds	2	2	-	-	-	1	-	-	-	-	5
Bromus sp.	seed fragments	-	-	-	2	-	-	-	1	-	-	3
Chenopodium album	seeds	-	-	-	3	-	-	1	-	-	1	5
Chenopodium album	seed fragments	1	1	4	2	-	-	-	-	-	-	8
Chenopodium polyspermum	seeds	1	-	-	-	-	-	-	-	-	-	1
Chenopodium sp.	seeds	-	-	1	-	1	-	-	-	-	-	2
Fallopia convolvulus	seeds	4	5	11	6	4	7	1	3	3	8	52
Fallopia convolvulus	seed fragments	4	31	-	4	-	-	5	1	-	-	45
Galium sp.	seeds	1	1	-	-	-	-	-	-	-	-	2
Lapsana communis	seeds	1	-	1	-	1	-	-	-	1	1	5
Poa annua/Phleum pratense	seeds	1	-	-	-	-	-	-	-	-	-	1
Poaceae, kleine	seeds	9	13	22	19	9	5	-	1	4	2	84
Silene vulgaris	seeds	-	1	-	-	-	-	-	-	-	-	1
Stellaria media	seeds	1	-	-	-	-	-	-	-	-	-	1
collected plants												
Corylus avellana	shell fragments	4	2	-	-	1	1	-	-	1	-	9
various												
Luzula sp.	seeds	-	-	-	-	-	1	-	-	-	-	1
Eupatorium cannabinum	seeds	-	-	-	-	-	1	-	-	-	-	1

Table 3: Percentage proportions of waterlogged wood and charred wood (char) at the sites at Degersee II (De II), Bodnegg (Bw) and Leutkirch-Wilhelmshöhe (LTKI). n = no. of analysed wood finds/charcoal fragments.

		DeII				**Bw**		**LTKI**
%			**charcoal**			**char**	**char**	**char**
	wood				**wood**			
	sum	**1.1**	**3.3.1**	**3.3.2**	**sum**	**2.1**	**3.1**	
Fraxinus (Ash)	31	16	20	19	28	5	13	27
Alnus (Alder)	44	13	22	17	17	24	4	.
Populus (Poplar)	.	6	11	6	.	.	.	.
Salix (Willow)	.	10	5	12	22	2	<1	.
Corylus (Hazel)	5	22	22	26	6	5	9	10
Acer (Maple)	3	10	1	3	.	15	5	15
Tilia (Lime)	1	17	6	3	.	2	3	.
Ulmus (Elm)	1	<1	.	1	.	.	.	4
Fagus (Beech)	13	4	13	14	17	22	44	.
Abies (Fir)	.	1	.	.	.	.	.	.
Quercus (Oak)	1	.	.	.	11	12	21	35
Betula (Birch)	.	.	.	.	.	5	2	.
Euonymus (Spindle tree)	.	.	.	.	.	7	.	.
Maloideae (Pomaceous fruit)	.	.	.	.	.	.	.	10
n	**149**	**300**	**116**	**200**	**18**	**41**	**200**	**52**

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