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RECONSTRUCTING THE NEOLITHIC LANDSCAPE AT WESTERN LAKE CONSTANCE, GERMANY

By Ursula Maier and Richard Vogt

Investigations in the Neolithic lake-side settlement of Hornstaad Hörnle IA, Lake Constance, Germany (dendrochronologically dated to 3917-3905 BC) have answered many questions concerning Neolithic life. The reconstruction of landscape development, agricultural activities and land use have been the main subjects for pedological and archaeobotanical research. The settlement was built in the seme-terrestric zone of the lake. Beech-lime-oak-forests occurred on the soils (luvisols) that lie beyond the site, mostly developed on glacial and young Holocene sediments. It was there that the first agricultural occupation took place. The high quality of the cultivated soils meant manuring was not necessary. The location of the Neolithic fields has been reconstructed by soil mapping, and huge carbonized cereal stores made it possible to reconstruct the extent of the arable land. As most of the wild plant remains in the stores were from annual field weeds, it was concluded that the arable land has been cultivated continously, probably for the whole duration of the settlement. In contrast to the Bronze Age, only a few signs of soil erosion and accumulation processes could be observed during the Neolithic. All investigations took place within a long-term project involving interdisciplinary research financed by the 'Deutsche Forschungsgemeinschaft'.

Introduction

Hornstaad Hörnle IA is a Neolithic pile settlement located on the western part of Lake Constance (Bodensee) at the tip of the Höri peninsula (Figure 1). The site was systematically excavated from 1983 to 1993 by the 'Landesdenkmalamt Baden-Württemberg' and the project was financially supported by the German research fund (Deutsche Forschungsgemeinschaft). The main aims of the project were the reconstruction of the Neolithic village, soils and landscape, along with the agricultural activities and landuse of the settlers and their influence on the natural environment. Founded as an interdisciplinary project, there was close co-operation between archaeology and the other disciplines concerned during both the 10 year excavation and the following interpretation phase (Dieckmann 1985, 1991; Hoffstadt 1999; Schlichtherle 1990). Archaeobotany (Maier 1991), archaeozoology (Kokabi 1991), dendrochronology (Billamboz 1985) and sedimentology (Ostendorp 1991) had their working fields inside the settlement area. Pollen analysis was carried out on material from the excavation (Liese-Kleiber 1985) as well as from bogs in the surroundings (Rösch 1985). Pedological investigations were carried out in the wider environment of the site (Vogt 1991).

Lake Constance or Bodensee is one of the largest lakes in the northern foreland of the Alps, covering an area of 540 km² and bordering Switzerland, Austria and Germany. The region is climatically favoured with average annual temperatures of 8.5-8.9°C. The winters are mild with only few frosty days, little snow and January averages of about 0°C. The average temperatures in July are 17.5-18.1°C. The annual precipitation in Constance is 775 mm with a rain maximum in June and July. The region is in the transition from a maritime to a continental climate (Lang 1990).

The Höri peninsula is the eastern part of the Schiener Berg mountain, situated between two parts of western Lake Constance, the Zellersee and the Seerhein. It stretches from the east to the west rising from 395 m above sea level at the lake shore to an altitude of more than 700 m on the Schiener Berg ridge (Figure 1). The water level of Lake Constance is mainly influenced by the River Rhine with its large catchment area in the Alps. During winter time precipitation is retained as snow, causing low water levels from October to March. In summer large amounts of melting water raise the water level about 1.5 m or more (Gasser 1957).

In prehistoric times the shore of Lake Constance was a most important settlement area, and

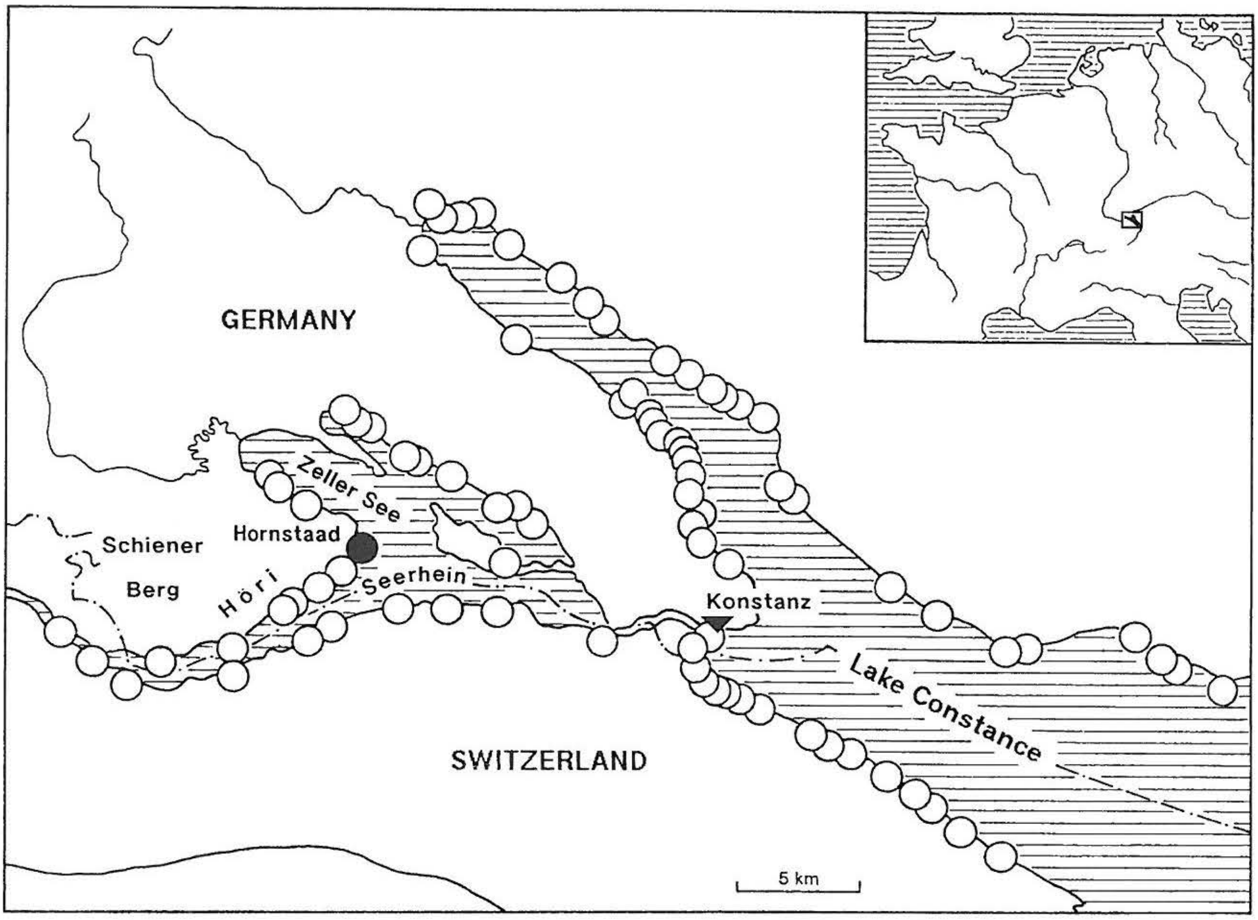

Figure 1: Map showing Western Lake Constance (Bodensee) with its prehistoric lake shore settlements (O) and the location of the Neolithic site Hornstaad Hörnle IA.

more than 200 archaeological sites belonging to the Neolithic and Bronze Age have been discovered (Schlichtherle 1989, 1991). At the shore of western Lake Constance several Neolithic sites have been found at the Höri peninsula, dated by dendrochronology (Figure 1). All these sites belong to the Young and the Late Neolithic from about 4000 to 2500 BC (in this paper the chronological classification of south Germany is used: see Figure 6). The settlement presented in this paper is the oldest site in that region: Hornstaad Hörnle IA, dendrochronologically dated to 3917-3905 BC.

The site

The Neolithic site of Hornstaad Hörnle IA is situated near the modern village of Hornstaad. It lies in the shallow water zone, with the cultural layers embedded in lake marl. At their base there are uncarbonized waste deposits of the first settlement phase, dated between 3917 and 3910 BC (Billamboz 1998). They are covered by a 150 mm thick charred layer representing the remains of a conflagration that had destroyed almost the whole village in 3910 or 3909 BC. In addition to the remains of burnt houses this fire zone also contains charred stores of naked wheat, einkorn, emmer and barley (Maier 1996). After the fire, the village was reconstructed in 3909 BC. The second settlement phase consisted of house loams, uncarbonized waste material and faeces (Dieckmann 1991). The final dendrochronological date shows that the last house was built in 3905 BC, and the village was probably abandoned about ten years later (Billamboz 1998).

Because of the considerable annual fluctuations in the level of Lake Constance the houses of Hornstaad-Hörnle IA were constructed as pile dwellings on lake marl in the semi-terrestrial zone of the shore (Dieckmann *et al.* 1997). The locations of the houses were reconstructed on the basis of burnt house loams in the charred layer. At its greatest extent the village had 40 houses and probably 150 to 200 inhabitants (Dieckmann *et al.* in press).

Landscape reconstruction

The reconstruction of the Neolithic landscape in the surrounding of Hornstaad Hörnle IA is mainly based on the archaeobotanical and pedological results, along with pollen analysis and dendrochronology.

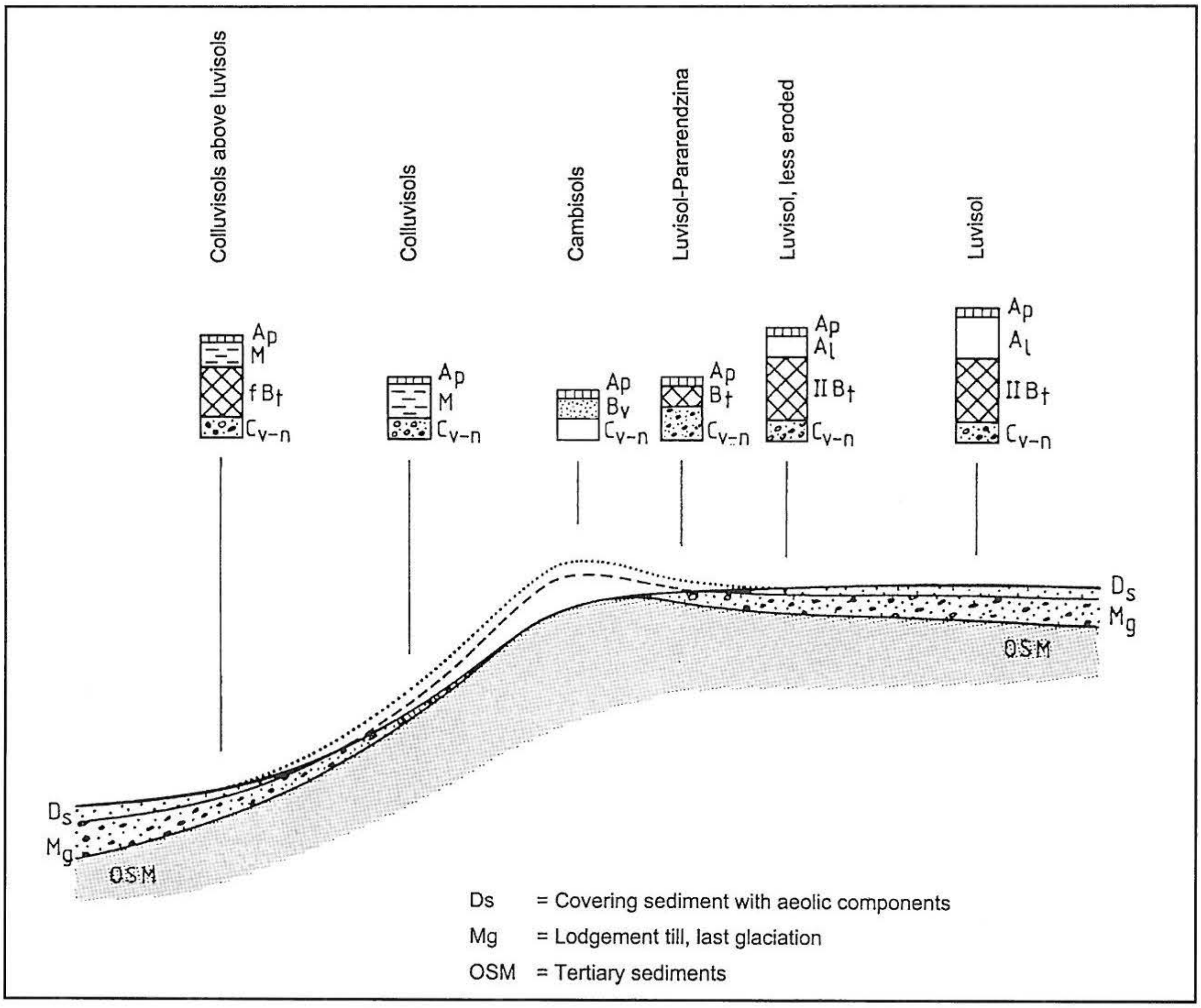

Figure 2: Simplified soil profile sequency of the Höri peninsula, Lake Constance.

As a first step a soil map was created, followed by nearly 900 drillings in a radius of 2.5 km around the site. The pedological map provided a base for various aspects of interpretation, including the development of landscape, the distribution of arable land in Neolithic times, models of agriculture, and mapping of the natural vegetation.

Geological and pedological premises and today's vegetation

The glacial deposits, in which soil development started during Holocene, are covering Tertiary sediments, mostly fine-grained sandstones. Above them a lodgement till of the Rhine glacier was deposited during the last glaciation (Figure 2). The upper parts of the lodgement till include components of aeolean origin, blown out of the moraines and sanders during the late glacial, and mixed by cryoturbation after deposition. During the Holocene the climax soil type luvisol has developed in these sediments. The luvisols are characterized by transfer processes of clay from upper (elluvial) to lower (illuvial) horizons in the soil profile. The elluvial (Al)- and the illuvial (Bt)-horizon play an important role in relation to archaeological questions because of their rather constant thickness in this region (*c.* 0.4 m for the elluvial- and 0.6 m for the illuvial horizon). This allows an estimation of the degree of erosion in the excavation areas (Vogt in press b).

Depending on the topographic situation, the original soil profiles have changed in area surrounding the settlements. By clearing the forest and using hills and other exposed positions for agriculture, the erosion of soils started. Indeed, the great variation of different soil types today is the result of human influence through agricultural activity during the last 6000 years. In some areas the profiles are shortened by erosion by more than 1 m. The eroded material is accumulated at lower parts of the slopes or in depression zones, where it leads to substantial colluvial deposits, characterized by the migration-horizon (M). These processes sometimes led to an equalization of the relief of some meters. Relatively flat areas, or those which are always covered by vegetation, are less influenced by erosion. In these areas the climax soils are preserved and they are important localities for comparative studies. An idealized section of landscape in Figure 2 shows the distribution of the different soil types in connection with topography: luvisols in stable areas, calcaric regosols or pararendzines in zones of erosion, and colluvial deposits in areas of accumulation (Vogt 1991).

As a result of the pedological survey a map has been developed showing the present distribution of these different soil types. Along the shoreline of Lake Constance and on lake terraces, wet soils (several types of gley and bogs of different thickness) occur. Their distribution is close to that in Neolithic times, and the site at Hornstaad is located within this zone. Today for the most part the semiterrestric zone (eulitoral) at an altitude of 395 m above sea level is covered by reed (*Phragmites australis*), which landward is followed by sedges (*Carex elata*). About 100 m behind the site at 396 m above sea level wet woodlands of willow (*Salix alba*) and poplar (*Populus nigra*) occur on two beach ridges. Wet meadows extend up to an altitude of 400 m.

The climax soil type, the luvisol, is found in upper parts of the landscape. These are the locations of typical beech forests with the dominating *Fagus sylvatica* accompanied by *oak (Quercus petraea, Q. robur*), lime (*Tilia cordata*), ash (*Fraxinus excelsior*), maple (*Acer pseudoplatanus*) and elm (*Ulmus glabra*) (Lang 1990). The soil types in eroded areas are mostly situated on ridges and other higher positions, where only the lowest part of the luvisol is preserved. Here two different ecological environments occur. On calcareous, warm, and dry places oak (*Quercus petraea*) plays an important role beside the dominant beech. Other typical plants are *Viburnum lantana, Sorbus torminalis, Sorbus aria, Melittis melissophyllum* and different orchids. On sandy, acid soils derived from tertiary sandstone, pine (*Pinus sylvestris*) occurs with beech and oak. *Luzula albida, L. pilosa, Deschampsia flexuosa* and *Vaccinium myrtillus* (blueberry) are also found in this forest type. On lower slopes and in depressions colluvial deposits with quantities of eroded material occur (Vogt in press b). They occupy the largest part of the landscape and are again the location for typical beech forests.

The Neolithic landscape

To reconstruct the Neolithic situation, the erosion and accumulation processes had to be reversed. The consequence is a quite simple soil pattern with wet soil types on lake terraces and with the climax soil type, luvisol, in the hinterland (cf. Figure 3).

Figure 4 shows a landscape reconstruction prior to the colonization of the lake shores. According to pollen analysis (Rösch 1987) about 4500 cal BC forests with beech (*Fagus*), lime (*Tilia*), elm (*Ulmus*), oak (*Quercus*), maple (*Acer*) and ash (*Fraxinus*) occurred on the luvisols. The wet soils along the lake shore must have been covered with willow-poplar forests and in the area behind them, only rarely touched by annual floods, woodland with oak, ash and elm occurred. As Hornstaad must have been one of the first settlements in the region, it is supposed that the landscape was still in a quite natural state with extended forests when the settlers arrived. The influence of the preceding Mesolithic occupation on the environment is considered to be very small.

Colluvial deposits as evidence of agriculture do not appear on the peninsula before 4000 cal BC. After that date evidence of human activity in the surroundings of Hornstaad is evident in the colluvial deposits. The hypothesis was that higher or lower sedimentation rates represent more or less influence of human being. Climatic effects on erosion and accumulation processes cannot be precluded, but they are covered by the predominating anthropogenic impact. Human disturbance of the environment is a precondition that climatical influence on colluvial stratigraphies can take place. Unfortunately in most cases there is no way of distinguishing climatic and human effects.

The main necessity in this study was to date the layers of colluvial deposition. That was realized by AMS-dating of charcoal, very frequently found in the colluvial stratigraphies. The dating was carried out in the laboratory of the University of Uppsala/ Sweden (the dates in Figure 6 are given at one standard deviation: 68.2 % confidence level).

In rare cases artefacts also aided dating. Together with soil analyses (granulometry, carbonate contents, and contents of organic matter) it was possible to interpret a high resolvable stratigraphy of sedimentation. The colluvium, *c.*700 m from the site Hornstaad, has a thickness of more than 2 m and covers the wet soil type humic gley (Vogt 1995). This type has developed at the lower part of a slope and represents the natural soil surface. The accumulations above, resulting from human

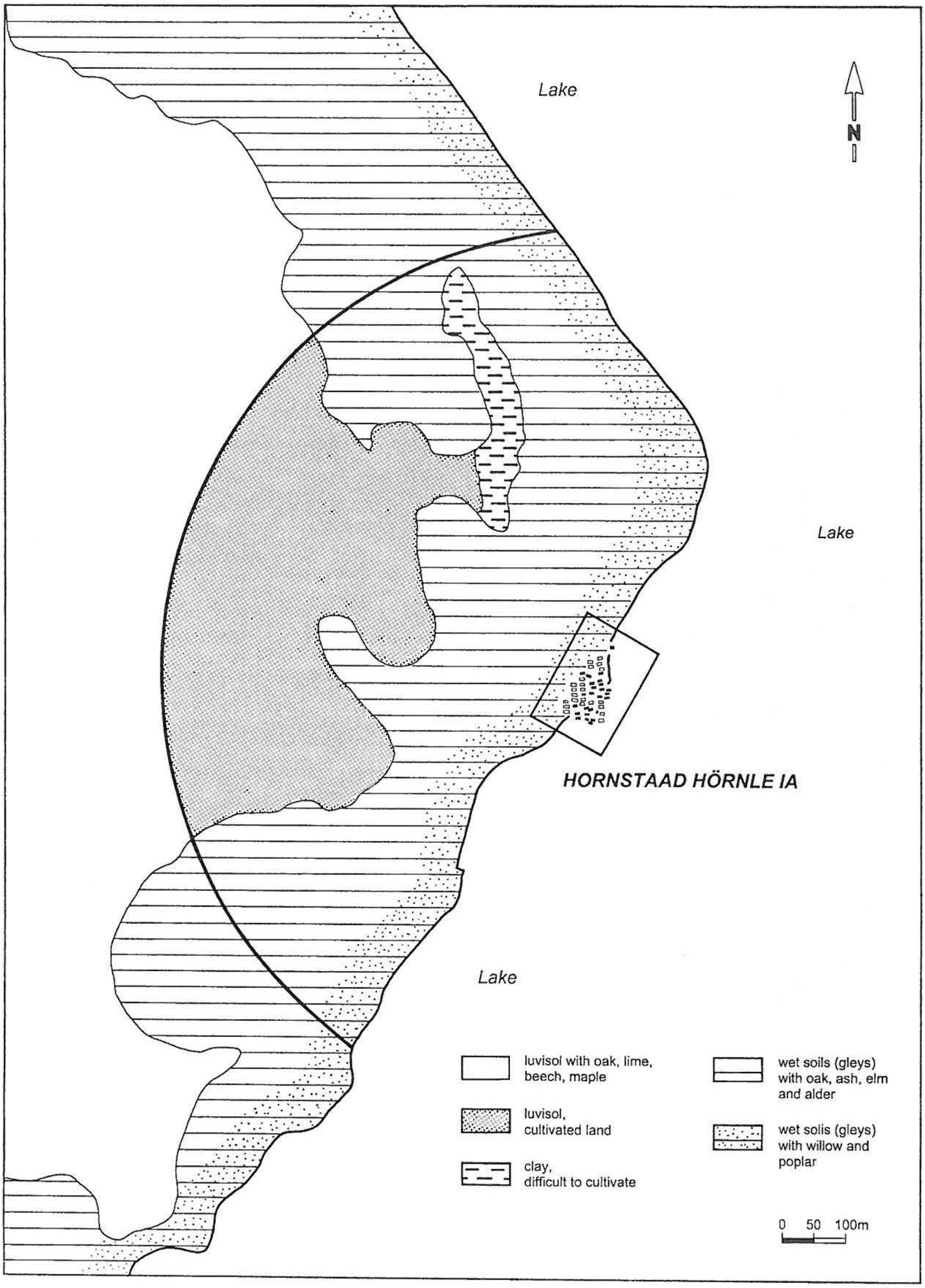

Figure 3: The tip of the Höri peninsula in Neolithic times. The calculated area of the arable land on the luvisols lies within a radius of 700 m behind the Neolithic village. The vegetation types on the different soils are shown.

Figure 4: Landscape reconstruction of Western Lake Constance prior to the colonization of the lake shores about 4500 BC. Dense woodlands are covering the whole area.

Figure 5: Landscape reconstruction of Western Lake Constance for the time of Hornstaad Hörnle IA about 4000 BC, based on archaeological, pedological and botanical investigations. The Neolithic site with its 40 houses is situated in the shallow water zone. In a distance of only a few kilometers from Hornstaad a second pile dwelling with its fields can be seen in the background.

activities, present interesting issues. Their sedimentation started between Middle and Late Neolithic and built up only a few centimeters of deposition, suggesting that human influence on landscape was not very intense at that time. A first distinct increase in the sedimentation rate can be ascertained between 4000 and 3000 cal BC, which may be the result of an important change in agricultural methods – the introduction of draught animals in connection with the occurrence of the first wheel finds about 3300 cal BC (Schlichtherle in press).

Three dates from charcoal of *c.*3000 cal BC are too young respective to their depth and are excluded from Figure 6. They may result from people or animals trampling the muddy and wet ground surface, or the activities of burrowing animals. In this context it also has to be considered that the sedimentation rate was quite low during the whole Neolithic time. The stagnation of the accumulation rate during the latest phase of the Neolithic reflects quite low human activity in the catchment area. In the Early Bronze Age a far greater deposition of nearly 1 m is observed, marking enormous alterations in the landscape and an intense human impact. This probably means that the arable land had increased, perhaps with larger fields that have a greater tendency to be eroded. Another aspect is the development of agricultureal tequniques, because the use of the plough is already proven for that time. During the Middle and Late Bronze Age there is a return to a very small sedimentation rate. This stable period ends with a further increase in the accumulation rate reflecting more intensive human activity in the Urnfield and Hallstatt period. After another period of less sedimentation up to the Early Medieval period the curve begins to rise again, a tendency which continues until today.

When these results are compared with the archaeological finds in this area, a good correlation between sedimentation rate, pedological analyses and artefacts is obtained. There is only one exception: the Early Bronze Age. For that timeslice with its enormous sedimentation rate no single site has been discovered as yet on the tip of the Höri peninsula (Schlichtherle 1991). The reason for that may be that Early Bronze Age sites are covered by colluvial deposits and for that have not been found yet.

The results from the above mentioned profile could be confirmed by further investigations at other colluvial stratigraphies in this region (Ellminger *et al.* 2000), giving us a detailed insight into anthropogenic influence on the environment, especially in cases of small catchment areas.

For the Neolithic settlement of Hornstaad the effects of human activity on the environment can clearly been seen through particular changes in the

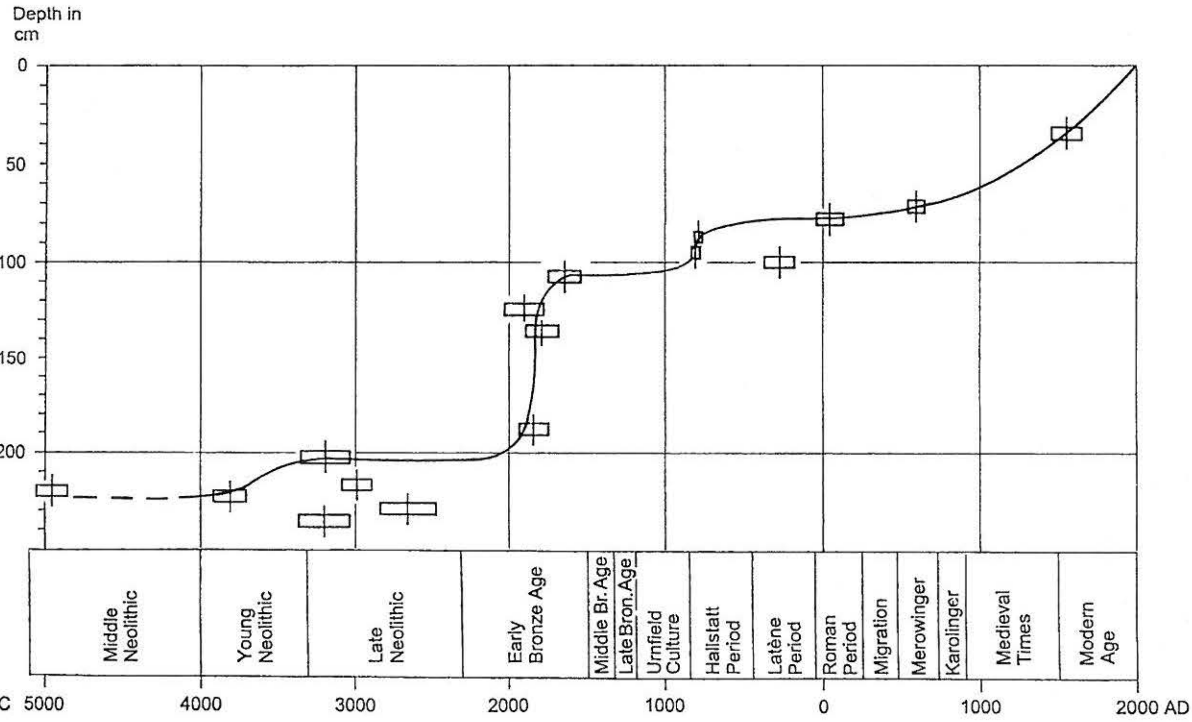

Figure 6: Time-depth-diagram of AMS dated charcoals in a colluvial stratigraphy in 700 m distance of the Neolithic site Hornstaad Hörnle IA. The curve shows phases of changing sedimentation rates.

flora and vegetation. The woodlands had already been decimated in the hinterland of the village (Figure 5), reflected in plant macro-remains within the cultural layer, the high proportion of willow, poplar, oak and ash, suggesting that the wet woodlands close to the site must have been cleared for constructing the houses. Cattle grazing in the clearings produced intensive spreading of herbs and grass-species (*Lychnis flos-cuculi, Molinia caerulea, Cirsium tuberosum, Dianthus superbus, Cirsium oleraceum, Deschampsia cespitosa* and many others) as initial stages for wet meadows. This vegetation type was totally new and had not existed before Neolithic times. On the settlement area itself special weed communities indicate an intense eutrophication through waste and faeces. Many seeds and fruits from *Erucastrum nasturtiifolium, Ranunuclus sceleratus, Myosoton aquaticum, Bidens tripartita, Polygonum hydropiper, P. lapathifolium* and others were identified (Maier in press).

Vegetation change is also recorded further away from the site. On the luvisols, which only began *c*.300 m away from the settlement, the forests of beech, lime and oak were cleared by the settlers to create arable fields (Figures 3 and 5). The result was that completely new locations with different ecological conditions arouse. During the Mesolithic, and probably still in the Early Neolithic, extensive, quite homogenous woodland with only a limited number of plant species covered nearly the whole landscape. In contrast, from 4000 BC onwards the number of species, in particular herbs and grasses, increased enormously. After removing the woodland numerous clearings and woodland margins arouse, in which strawberries, raspberries, blackberries, sloes, hips, hazelnuts and many other plants could grow, and which have been identified in the cultural layer in considerable amounts. Medical plants like *Hypericum perforatum* (St. John's wort), *Origanum vulgare* (wild marjoram) *and Agrimonia eupatoria* (agrimony) were also regularly collected by the settlers (Maier in press).

The fields, and along their margins and pathways, were colonised by numerous different weed species, adapted to the specific ecological conditions at these places. By analysing the wild plant macro-remains in the carbonized cereal stores 39 species of this group could be identified (Maier in press). The ecological interpretation of the Neolithic cereal weeds as well as the pedological investigations (Vogt in press a) suggest that a fertile loamy soil, rich in humus and nutrients was cultivated. The luvisols must have been of excellent quality for agriculture, comparable with the soils derived from loess, cultivated by the people of the Danubian Culture (Bandkeramik). Soil fertility should not have been a problem during the 20 year existence of the settlement and manuring therefore was not necessary.

On these soils the Hornstaad farmers were growing seven different cultural plants: the main crop was naked wheat (*Triticum durum/turgidum-type* along with barley (*Hordeum vulgare*), *einkorn (Triticum monococcum*) and emmer (*Triticum dicoccum*), flax (*Linum usitatissimum*), poppy *(Papaver somniferum*) and peas (*Pisum sativum*). Morphological studies of 270 reasonably intact ears suggest that different varieties of tetraploid free-threshing types (*Triticum durum* and *T. turgidum*) were cultivated (Figure 7). Similar forms had already been found in other Neolithic lakeshore settlements in Switzerland and southwest Germany (Jacomet and Schlichtherle 1984), and meanwhile it is quite clear that from *c*. 4300 BC these naked wheats had migrated from the western Mediterranean into the northern foreland of the Alps (Maier 1996).

In the case of the Neolithic village Hornstaad we can estimate the extent of the cultivated land (Figures 3 and 5) from evidence contained within the unthreshed cereal stores preserved by the conflagration, mentioned above. We calculated, that on average one house contained a minimum of *c*. 200 to 300 kg of cereals. As the settlement probably had 40 houses, the storage of the whole village must have been in the region of 8000 to 12000 kg. The extent of the arable lands was calculated on presumed yields of 600 kg and 800 kg

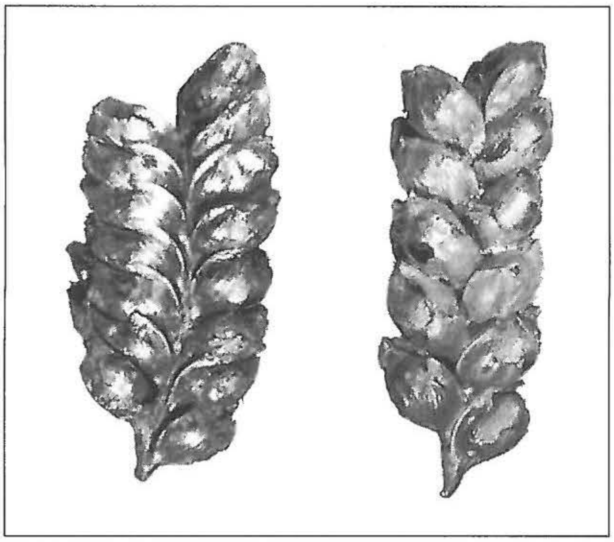

*Figure 7: Carbonized ears of two different types of naked wheat (*Triticum durum/turgidum*) from Hornstaad Hörnle IA.*

per ha. Hence, for the cultivation of cereals the Hornstaad village needed 10-18 ha or 25-44 acres (Maier 1999).

Relative to field size and distribution of the fields in the environment of the settlement two different models are plausible. In a first model every single field was one small clearing surrounded by woodland. However, such small cultivated areas have many disadvantages: relatively long contact zones with the surrounding woodland, the necessity of intensive protection, and long walking/transport distances. The colonisation of wild plants from the surrounding forests into the fields is also a potential problem. In another model the whole arable land of the village covered one large area. In this case the land required to support the community could have been within a radius of *c.* 700 m around the settlement. The advantages are obvious: protection of the fields is much easier to achieve, walking and transport distances are shorter, and collective work necessary for example during harvest was simplified. The wild plant remains in the cereal stores quite clearly suggest that model two was the situation at Hornstaad, as only 4% of these weeds are from forests and forest borders. As mentioned above, model two is also confirmed by investigations of the colluvial deposits.

Shifting cultivation is often supposed to be a typical agricultural system for Young Neolithic times (Rösch 1987, 1991), but the Hornstaad results led to very different conclusions (Maier 1999). As in the cereal stores, more than 90% of the wild plant seeds belong to typical field weeds, it is obvious that already in the neolithic fields characteristical weed plant communities were present. These, however, could only have developed under typical field conditions which lasted at least for several years. Besides, perennial weeds as indicators for short time fallows were not found in the analyzed material. This suggests that the arable land, once wrested from the forest, had been cultivated continuously for many years, probably for the whole duration of the village.

The investigations at western Lake Constance not only give detailed insights into Neolithic life and economy, but also give a good idea of man's influence on his natural environment during this time. Every site in certain respects has unique natural conditions, and we should beware of generalisation. For that reason, Hornstaad Hörnle IA could be a model for other Neolithic settlements.

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Dr Ursula Maier
Richard Vogt
Landesdenkmalamt Bade-Württemberg
Fischersteig 9
D-78343 Hemmenhofen
Germany