Scanning the historical and scientific significance of charcoal production – local scale, high resolution kiln site anthracology at the landscape level

Thomas Ludemann[1]

1 University of Freiburg, Faculty of Biology, Dept. of Geobotany, Schaenzlestrasse 1, D-79104 Freiburg, Germany; thomas.ludemann@biologie.uni-freiburg.de

Summary: *Airborne laser scanning data have been verified, concerning their utilisation in studies of historical charcoal kiln sites. Thousands of such sites are recognizable in hillshade images based on these data. Exact information could be provided on their geographical position and very high kiln site densities could be established. Laser scanning is a valuable tool for kiln site anthracology, facilitating the field work considerably, increasing the efficiency and precision of the site records and highlighting the historical significance of charcoal burning. Moreover, it underlines the outstanding scientific potential of local scale kiln site studies, of which an example is given. The close dependence of charcoal production on the natural local offering of wood and the large number of analysable sites together provide a unique chance to obtain new exact information on the historical forests and the human impact therein with fine spatial resolution at the landscape level.*

Key words: *Black Forest, charcoal burning, forest history, kiln site, airborne laser scanning*

INTRODUCTION

In many regions of the world charcoal burning was an important practice of woodland use in the past. Remnants of charcoal production are widespread in those landscapes. In mountainous areas of western Central Europe sites of charcoal burning (charcoal kiln sites) are by far the most frequent sites we know with scientifically analysable residues of past fuel wood exploitations. These sites are characterized by distinct anthropogenic changes of the ground surface. Moreover, the charcoal macroremains preserved there contain comprehensive information about the historical forests exploited and the human influences therein. Therefore kiln site anthracological studies are a main key, maybe the only one in many regions, for high resolution forest and landuse history at the local stand-scale level of consideration.

Unfortunately, these historical sites generally are not recorded in written sources or in historical maps and they are not visible in the usual aerial photographs. Up to now time-consuming field work was necessary to locate them and to record their exact geographical position. However, a new tool became available for our investigations, airborne laser scanning, offering completely new and innovative options which should be verified for a large pilot area. We want to know in which cases and to what extent the historical kiln sites are recognizable by laser scan technics. Moreover, an example should be given of the scientific value and potential of local scale anthracological investigations of areas with high kiln site density.

STUDY AREA AND METHOD

For this evaluation we choose the southern part of the Black Forest in SW Germany, covering an area of about 2000 km^2. In this area a maximum number of historical kiln sites was already known and an even larger number of new ones was expected. Hillshade images with maximum resolution (DGM1, 1 m-grid; vertical resolution < 0.15 m; LGL 2011) plotted from the laser scanning data were evaluated systematically, focusing on the visibility of these sites. Moreover, the new (potential) sites visible in the plots have been verified by exemplary field surveys.

RESULTS AND DISCUSSION

A large majority of the kiln sites already known indeed is visible at the hillshades, even in forested areas. Moreover, a very large number is recognizable additionally. However, exemplary field surveys give evidence that there are many other kiln sites, which could not be detected at the hillshades, because of:

(1) bad conservation, e.g. by erosion, forest road construction, wood transport etc.,
(2) heterogeneities of the ground surface or vegetation, e.g. dense herb or shrub layer, or
(3) problems with the laser scan data, e.g. flight too late in the spring, when deciduous trees already had developed their leaves.

Consequently and fortunately, field work could not be substituted completely by the scans, but it could be facilitated considerably. Within the region investigated more than 2000 historical charcoal kiln sites already had been recorded in the course of many years of anthracological investigations. However, we were sure that these are only the smaller part of all sites preserved in this area. By using laser scanning the total number of known kiln sites indeed could be doubled within a short time.

Exact information could be provided for the geographical position of thousands of sites. Maximum kiln site densities of more than 150 sites per km^2 could

be established, so that the average distance from site to site in such areas comes to less than 90 m.

Several examples of local scale results and of the fine spatial resolution of kiln site anthracology already have been given (e.g. Ludemann, 1994, 2002; Ludemann and Britsch, 1997; Ludemann and Nelle, 2002; Ludemann *et al*., 2004; Noelken, 2005). The sites analysed in these studies range over landscape sections of about one or a few kilometers, covering different ecological conditions, e.g. summit plateaus, slopes of different inclination and exposition, valley floors, etc. (cf., Fig. 1A). The example given here ranges over one square kilometer including 34 kiln sites. Charcoal analysis shows regular spatial patterns of the tree taxa exploited, illustrated by iso-%-lines of the frequencies of the predominant taxa *Abies*, *Fagus* and *Picea*, given in 10-%-classes (Fig. 1B). These spatial patterns can be explained quite well by the different growth conditions (altitude, aspect, inclination, edaphical conditions, etc.) of the forest stands in the vicinity of the sites. A pronounced dependence of charcoal production on the local natural distribution of the tree species is discernible.

CONCLUSION

Airborne laser scanning is a valuable tool for kiln site anthracological studies, facilitating the field work considerably by increasing the efficiency and precision of the site records and providing exact information of the geographical position of the historical sites. Kiln site distribution and density indicate the different local significance of charcoal burning in the past. Moreover, it underlines the outstanding scientific potential of kiln site anthracological studies for forest history and vegetation science at the landscape level. The close dependence of past fuel wood exploitation on the natural tree species composition of the forests exploited on the one hand and the large numbers, wide distribution and high densities of historical kiln sites on the other hand together provide a unique chance to obtain new exact information on the ancient forests and the changes therein with local scale resolution.

ACKNOWLEDGEMENTS

I thank Dr. Randy Cassada (Freiburg) for linguistic editing.

REFERENCES

LGL, 2011. Landesamt für Geoinformation und Landentwicklung Bad.-Württ. www.lgl-bw.de

LUDEMANN, T., 1994. Vegetations- und Landschafts-wandel im Schwarzwald unter anthropogenem Einfluß. *Ber. d. Reinh.-Tüxen-Ges.* 6, 7–39.

LUDEMANN, T., 2002. Anthracology and forest sites – the contribution of charcoal analysis to our knowledge of natural forest vegetation in south-west Germany. *BAR International Series* 1063, 209–217.

LUDEMANN, T., BRITSCH, T., 1997. Wald und Köhlerei im nördlichen Feldberggebiet/ Südschwarzwald. *Mitt. bad. Landesverein Naturkunde Naturschutz* N.F. 16 (3/4), 487–526.

LUDEMANN, T., NELLE, O., 2002. *Die Wälder am Schauinsland und ihre Nutzung durch Bergbau und Köhlerei*. Freiburger Forstl. Forschung 15.

LUDEMANN, T., MICHIELS, H.-G., NÖLKEN, W., 2004. Spatial patterns of past wood exploitation, natural wood supply and growth conditions: indications of natural tree species distribution by anthracological studies of charcoal-burning remains. *Eur. J. Forest Res.* 123, 283–292.

NOELKEN, W., 2005. *Holzkohleanalytische Untersuchungen zur Waldgeschichte der Vogesen.* Diss. Univ. Freiburg.

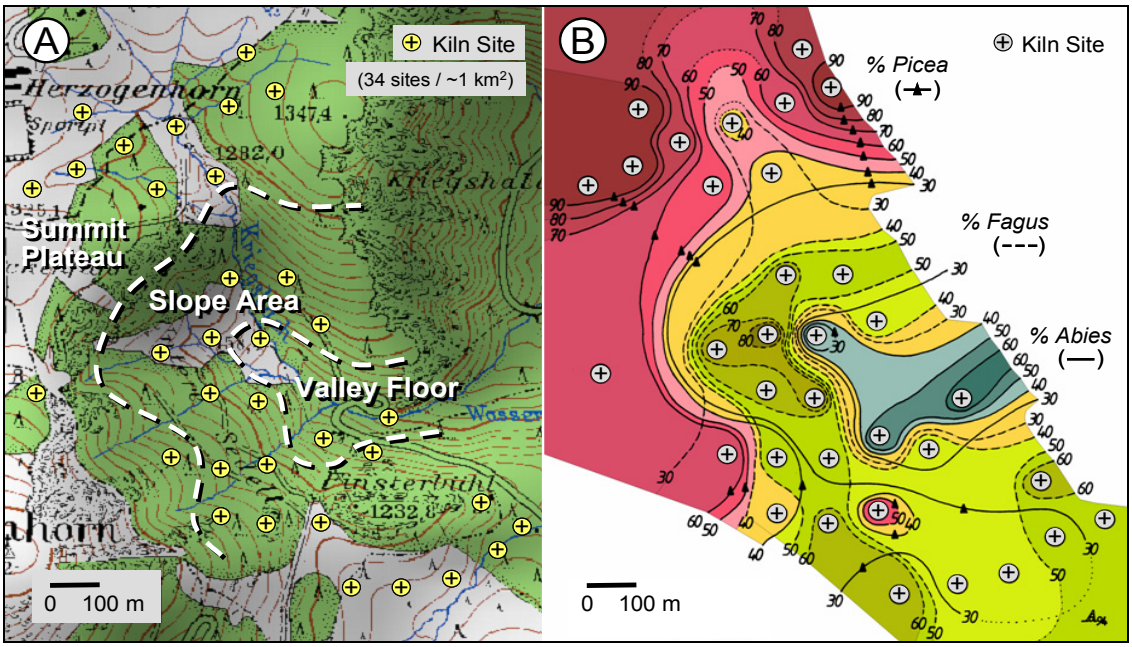

FIGURE 1. Example of local scale kiln site anthracology. A. Site map. B. Taxa frequencies of charcoal samples (Ludemann, 1994, modified). For further explanation see text.