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Selective woodland exploitation for charcoal production. A detailed analysis of charcoal kiln remains (ca. 1300–1900 AD) from Zoersel (northern Belgium)

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ABSTRACT

A detailed study of charcoal burning activities has been made for the Zoersel forest (Northern Belgium) based on an inventory of charcoal kiln remains, the analyses of wood charcoal and other charred botanical macroremains and radiocarbon dating of 10 of these kilns. Age determination of the youngest kilns was refined by dendrochronological analysis of trees growing on top of these kiln sites. The results show that, although many kilns were found, charcoal was produced in Zoersel only at certain moments during late and post-medieval times suggesting that charcoal burning was not a part of the regular management practice of these forests. The wood used for the production of charcoal mainly consists of taxa of alluvial (alder) forests while the kilns are situated on sites that currently are rather dry, with an oak dominated vegetation. For the older kilns, this contrast could be explained by an important change in local soil conditions. The younger kilns may be related to the conversion of alder woodland to grassland in the lower parts of the domain, with the kilns being constructed in the nearby dryer woodland areas.

1. Introduction

Charcoal production used to be an important activity in NW European woodland management in medieval and post-medieval times. In most areas, traditional charcoal production was abandoned in the 19th century due to the rapidly increasing and widespread use of coal. Until then, charcoal was an essential fuel for several artisanal and industrial activities which require high temperatures, like iron and glass production (Gale, 2003). Charcoal is also a lot lighter and has a higher caloric value than wood and peat and is therefore a more economic fuel type if it needs to be transported over longer distances (Hollingdale et al., 1999).

Remains of charcoal production sites (kilns) can often still be found in ancient woodlands in central and north-western Europe (e.g. Ludemann, 2003; Nelle, 2003). As it is assumed that the wood used for charcoal production originates from the vicinity of the kiln site, the archaeological remains of these kiln sites are often used, through anthracological analysis and radiocarbon dating, for the reconstruction of former woodland composition and management practices on a stand-scale (e.g. Ludemann, 2002, 2003; Ludemann et al., 2004; Pèlachs et al., 2009; Nelle, 2002, 2003; Nelle et al., 2010; Schirren, 2007). This information on former woodland composition and past management practices is valuable, not only for the understanding of the history and evolution of woodlands but also for setting out targets for today's nature and woodland conservation policy (e.g. Foster et al., 2003; Willis and Birks, 2006). Moreover, as the wood used in the kilns is considered to be of local origin only and that no selection for certain taxa has been made, the advantage over pollen analysis for the reconstruction of the composition of the local woody vegetation is clear (e.g. Ludemann, 2003; Nelle et al., 2010).

In northern Belgium, well preserved relics of charcoal kilns are rare however, and have previously only been reported for the Zoniën forest (van der Ben, 1997). The discovery of such relics in Zoerselbos (Fig. 1) has therefore given rise to a research project to study the distribution, composition and age of the remains of these charcoal production sites. Moreover, together with the available historic documents on former land use and management for the area, it created a unique opportunity to reconstruct the forest composition and exploitation since late medieval times in detail.

The study presented here aimed at a full inventory and a thorough analysis of kiln remains in the study area. For the inventory

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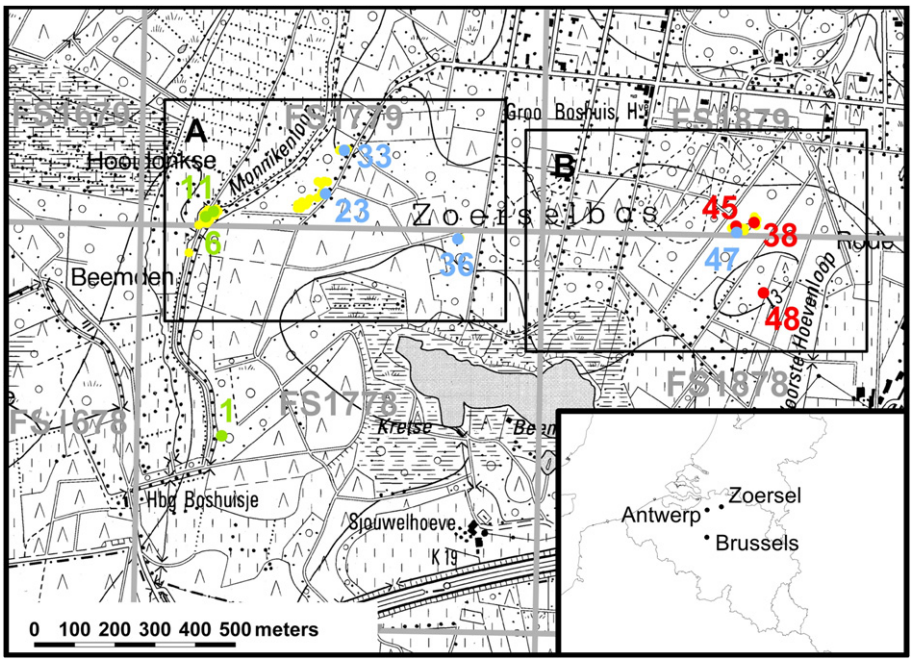

Fig. 1. The study area with the location of the detected former charcoal kilns (yellow: undated kilns, red: 1297 AD–1426 AD; blue: 1409 AD–1640 AD; green: 1635 AD–1923 AD). Location of the area within Belgium is shown in the inset in the lower right hand corner. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

a GIS-based methodology was developed in order to detect potential areas with kiln remains in a flat and forested area. Ten charcoal kilns were selected for charcoal analysis and radiocarbon dating. It was also assessed whether the study of non-wood botanical macroremains from these kiln sites provides supplementary information on the former vegetation, i.e. on the herbaceous vegetation component.

2. Material and methods

2.1. Site

Zoerselbos is one of the few sites in the sandy Campine area that contains an important area of ancient woodland (continuous woodland cover), as most of this region historically was covered by heathland. Therefore, the site has a high conservation value and is of great importance for forest history and historical–ecological research.

The study area covers 360 ha and is situated in the northern part of Belgium. It is located in UTM zone 31N, within following 1 km × 1 km grid cells: FS 17 78; FS 17 79; FS 18 78; FS 18 79 (Fig. 1). It comprises the ancient domain of Zoerselbos-Hooidonckbos, owned by the religious Order of Cistercians from 1233 until 1796. Afterwards, the French regime confiscated the domain and later on it was sold to private owners, which resulted in a highly fragmented ownership. From the 1990s onwards, both state and private nature conservation organisations started to acquire forest and open land within the area of the ancient domain.

The area now contains residential areas, grassland, small heathland patches, but mainly consists of forest. About 2/3 of the forest stands have been continuously covered by forest at least for the last 230 years. These forest stands mainly are mixed oak stands. The remaining forests are Scots pine stands that have been planted during heathland afforestation. Grassland traditionally was managed as water-meadows, irrigated with nutrient rich water from small rivulets to increase productivity.

2.2. Detection of charcoal kiln sites

As it can be expected that charcoal kiln remains have been levelled out by e.g. agricultural practice on former arable land within Zoerselbos, a selection was made of all forest stands within the study area, that are considered to be 'old forest' parcels (i.e. continuously under woodland since 1777). This was done by making an overlay of the land-use presented by the historic map of de Ferraris, drawn between 1770 and 1777, and all other subsequent maps.

The field survey was supported by a high resolution Digital Elevation Model (DEM) created by means of 1.450.000 LIDAR ground level point data, as provided by the Flemish Geographical Information Agency (AGIV). The sampling density equalled 1 Lidar point per 2.5 m^2 in our study area and the vertical error of these data is estimated below 0.2 m (Stal et al., 2011). The point data were interpolated to create a high resolution DEM grid image (raster size 1 m) using ordinary spherical kriging with a search radius that only included 3 points to preserve a maximal level of detail. The DEM was converted to a hillshade model to visualize the microtopography. All GIS operations were performed with ArcGis 9.2™. The hillshade model allowed us to eliminate areas in the ancient forest where the topography has been disturbed, e.g. by a dense pattern of ditches or by the creation of now abandoned fish farming ponds (Fig. 2). On the other hand it also allowed to delineate zones with potential charcoal kilns as these sometimes appear as small anomalies in the topography on the hillshade model. These areas were checked in the field with a gouge auger (3 cm diameter) for charcoal and burned soil. Finally, the reduced study area was double-checked by a full field survey in parallel 50 m wide tracks for possible kilns that remained invisible on the DEM. The location and dimensions of each charcoal kiln were recorded in the field using FieldMap™.

2.3. Sampling and charcoal analysis

Ten kilns were sampled for charcoal analysis and radiocarbon dating. In each of these 10 kilns, a pit of 30 × 30 cm was dug and the