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Intensive woodland management in the Middle Ages: spatial modelling based on archival data

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Abstract

Firewood played an indispensable role in European socio-economic systems from prehistory until the nineteenth century. Recent research has shown that in European temperate lowlands the most important management form to produce firewood was coppicing. In spite of the growing body of research on traditional woodland management, there remain large gaps in knowledge. Detailed studies of individual sites or smaller areas have provided a wealth of information on the methods of medieval coppicing, and at such sites the long-term effects of coppicing on vegetation structure and composition have also been examined. However, little is known about the distribution and extent of coppicing at the landscape scale, and forming a coherent picture of the spatial extent rather than the management details of coppicing in larger regions remains a challenge. This paper investigates the distribution and extent of coppice management in Moravia (eastern Czech Republic, ca. 22,300 km^2) in the Late Middle Ages. We created an extensive database of written sources that contained information on the presence of coppice woods at the parish level. Subsequently we used the MAXENT algorithm to create a model of the distribution of coppicing over the entire area. With the help of wood production and consumption estimates, we also calculated the minimum area of managed woodland for the study period. Results show that coppicing was predominant in the lowlands and often occurred at higher elevations as well, where neither natural conditions nor tree species composition were favourable. The paper also highlights the potential of spatial models based on archival data for historical landscape reconstructions.

Keywords: Coppice; Moravia; Middle Ages; GIS; Historical landscape reconstruction

Introduction

From prehistory until the nineteenth century, most European societies were dependent on firewood to survive winters. Although there were regions in northwestern Europe where peat provided an alternative or even became the main fuel in certain periods, and coal was of considerable importance in some districts as early as the thirteenth century, the majority of Europeans strove to have access to wood.[1] In addition to heating, fuelwood was essential in cooking as well. Charcoal (wood burnt slowly in an oxygen-poor environment) was needed to smelt ore. Since the nineteenth century, a range of fossil fuels (coal, oil and natural gas) have been used to provide energy for an exponentially growing population.[2] The diminishing importance of firewood throughout the past two centuries has had a deep impact on European woodlands. Since ca. 1800 AD, markets have preferred construction timber to firewood, which led to the development of new management methods and was partly responsible for the appearance of modern, 'scientific'

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[1] From the vast literature on peat see, for example, C.H. Cornelisse, The economy of peat and its environmental consequences in Holland during the Late Middle Ages, *Jaarboek voor Ecologische Geschiedenis* (2006) 95–121; P.J.E.M. van Dam, Sinking peat bogs: environmental change in Holland, 1350–1550, *Environmental History* 6 (2001) 32–45; I.D. Rotherham, *Peat and Peat Cutting*, Oxford, 2009; C. Smout, Bogs and people in Scotland, in: C. Smout, *Exploring Environmental History: Selected Essays*, Edinburgh, 2009, 99–112. For coal, see P. Brimblecombe, *The Big Smoke: A History of Air Pollution in London since Medieval Times*, London, 1987. In addition, various other sources of energy were used, such as bracken, gorse or even cow dung, but these could be important only locally. On medieval energy sources in general, see R.C. Hoffmann, *An Environmental History of Medieval Europe*, Cambridge, 2014, 196–215.

[2] R.P. Sieferle, *The Subterranean Forest: Energy Systems and the Industrial Revolution*, Cambridge, 2001.

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forestry.[3] During this process, woodland management was taken over by trained professionals and heavy machinery. While the amount of woodland in Europe has grown in the past two centuries, forests have provided a decreasing proportion of the total energy consumption on the continent. In 2010, a mere 4.8% of energy consumption in the EU was covered by wood.[4]

The relative insignificance of firewood as an energy source in the past two centuries as well as efforts by proponents of modern forestry to downplay or altogether dismiss earlier management systems resulted in a deeply-rooted lack of appreciation for the sophistication and extent of woodland management in pre-industrial Europe. This was coupled with lack of knowledge about the extent of woodland in different periods, substituted by unfounded generalizations about 'vast woodlands' that would have provided all that was necessary without systematic management schemes. Such non-systematic and uncontrolled exploitation of woodland resources is argued to have led to 'timber-famine' in the Early Modern Period (ca. 1500–1800 AD), which necessitated state control over forests and the appearance of timber-oriented forestry techniques.[5]

In the past few decades large numbers of studies have overturned most of these assertions. Palynological research has shown that extensive treeless areas were already created in Europe in the Neolithic, and by the Iron Age at the latest woodland was in most places a limited resource.[6] Computerized models of European deforestation since the Neolithic based on population estimates also reinforced these ideas.[7] The analysis of archival sources demonstrated that in some regions of northwestern Europe forests reached their minimum extent as early as the thirteenth or fourteenth centuries.[8] Traditional ways of woodland management were also intensively studied. It is now clear that in European temperate lowlands the most important management form to produce firewood was *coppicing*.[9] The coppice system is based on the biological fact that after cutting broadleaved trees regenerate vegetatively by growing shoots either from the stool (the part of the tree that remains in the ground) or from the root system. The same tree can be cut many times on a short rotation without losing its ability to grow new shoots. Young coppice shoots (generally referred to as underwood) were ideal for firewood: they could be harvested with minimal energy input and put straight on the fire. Individual shoots were usually tied up in a small bunch called a faggot, which was often measured by the cartload. For building timber, trees of seed origin were used. Such trees had a (relatively) straight trunk and were left to grow for as long as needed to reach the suitable size. Some timber trees grew up in *high-forests* – woodland consisting exclusively of timber trees. More often, however, timber trees were combined with coppice stools, in which case they were called standards. Such a management system is referred to as *coppice-with-standards*.[10] It is important to note that conifers, as opposed to broadleaved trees, do not coppice (with few exceptions, such as yew or cypress). As a result, coppicing was not a viable management option in regions dominated by coniferous trees, mostly in mountainous areas and in the boreal forests of northern Europe. Coppicing was demonstrated by archaeological methods to have existed already in prehistory.[11] The method itself was highly sustainable in the modern sense: areas to be cut yearly were planned so that the resource was not depleted.[12] Already in the Middle Ages people were aware of this. For example, a survey of Hayley Wood (England) from 1356 AD included that the wood 'contains 80 acres by estimate. Of the underwood of which there can be sold every year, without causing waste or destruction, 11 acres of underwood.'[13] On the other hand, a general lengthening of the coppice cycle (the number of years between successive harvests) can be observed all over Europe from medieval values of under ten years to twenty-five or more years in the eighteenth and nineteenth centuries. Although the reasons for this process are unclear, it may have involved the removal of nutrients from the soil, which in effect questions the long-term viability of coppicing.[14]

In spite of the growing body of research on traditional woodland management, there remain large gaps in knowledge. Detailed studies of individual sites or smaller areas have provided a wealth of information on the methods of medieval coppicing, and at such sites the long-term effects of coppicing on vegetation structure and composition have also been examined.[15] However, little is known about the distribution and extent of coppicing at the landscape scale, and forming a coherent picture of the spatial extent rather than the management details of coppicing in larger regions remains a challenge for key periods. From around the late eighteenth century state-wide tax records and forestry surveys provided such information. However, before that period little is known beyond the existence of individual managed forests.[16] This holds true

[3] R. Hölzl, *Umkämpfte Wälder. Die Geschichte einer ökologischen Reform in Deutschland 1760 bis 1860*, Frankfurt am Main, 2010; K.J. Puettmann, K.D. Coates and C. Messier, *A Critique of Silviculture: Managing for Complexity*, Washington, 2009, 1–40.

[4] Eurostat Commission, Production and consumption of wood in the EU27, Press Release Stat 12/168, Brussels, 2012.

[5] P. Warde, Fear of wood shortage and the reality of the woodland in Europe, c.1450–1850, *History Workshop Journal* 62 (2006) 28–57.

[6] A good starting point for orientation in the vast palynological literature is R.M. Fyfe, J.-L. de Beaulieu, H. Binney, R.H.W. Bradshaw, S. Brewer, A. Le Flao, W. Finsinger, M.-J. Gaillard, T. Giesecke, G. Gil-Romera, E.C. Grimm, B. Huntley, P. Kuneš, N. Kühl, M. Leydet, A.F. Lotter, P.E. Tarasov and S. Tonkov, The European Pollen Database: past efforts and current activities, *Vegetation History and Archaeobotany* 18 (2009) 417–424.

[7] K. Klein Goldewijk, A. Beusen, G. van Drecht and M. de Vos, The HYDE 3.1 spatially explicit database of human-induced global land-use change over the past 12,000 years, *Global Ecology and Biogeography* 20 (2011) 73–86; J.O. Kaplan, K.M. Krumhardt and N. Zimmermann, The prehistoric and preindustrial deforestation of Europe, *Quaternary Science Reviews* 28 (2009) 3016–3034.

[8] G. Tack, P. van den Bremt and M. Hermy, *Bossen van Vlaanderen: Een historische ecologie*, Leuven, 1993; O. Rackham, *Ancient Woodland: Its History, Vegetation and Uses in England*, 2d edition, Dalbeattie, 2003.

[9] For a general overview of coppicing, see G.P. Buckley (Ed), *Ecology and Management of Coppice Woodlands*, London, 1992.

[10] For an overview of the various high-forest management systems as well as of coppice-with-standards, see J.D. Matthews, *Silvicultural Systems*, Oxford, 1989.

[11] A. Billamboz, Tree rings and wetland occupation in southwest Germany between 2000 and 500 BC: dendroarchaeology beyond dating in tribute to F.H. Schweingruber, *Tree-Ring Research* 59 (2003) 37–49; A. Dufraisse, Firewood management and woodland exploitation during the late Neolithic at Lac de Chalain (Jura, France), *Vegetation History and Archaeobotany* 17 (2008) 199–210.

[12] For the semantic changes of the word 'sustainability', see R. Hölzl, Historicizing sustainability: German scientific forestry in the eighteenth and nineteenth centuries, *Science as Culture* 19 (2010) 431–460.

[13] Quoted in O. Rackham, *Hayley Wood: Its History and Ecology*, Cambridge, 1975, 26.

[14] Rackham, *Ancient Woodland* (note 8), 137–141; E. Johann, Wirtschaftsfaktor Wald. Am Beispiel des österreichischen Alpenraums, *Das Mittelalter* 13 (2008) 28–38.

[15] For example Rackham, *Hayley Wood* (note 13); R.L. Keyser, The transformation of traditional woodland management: commercial sylviculture in medieval Champagne, *French Historical Studies* 32 (2009) 353–384; K. Verheyen, B. Bossuyt, M. Hermy and G. Tack, The land use history (1278–1990) of a mixed hardwood forest in western Belgium and its relationship with chemical soil properties, *Journal of Biogeography* 26 (1999) 1115–1128; J. Müllerová, P. Szabó and R. Hédl, The rise and fall of traditional forest management in southern Moravia: a history of the past 700 years, *Forest Ecology and Management* 331 (2014) 104–115.

[16] Detailed large-scale information is occasionally available earlier. See for example P. Warde, *Ecology, Economy and State Formation in Early Modern Germany*, Cambridge, 2006, 226–242; Rackham, *Ancient Woodland* (note 8), 118–119; J.A. Galloway, D. Keene and M. Murphy, Fuelling the city: production and distribution of firewood and fuel in London's region, 1290–1400, *Economic History Review* 19 (1996) 447–472.