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# *Air Pollution and Fuel Crises in Preindustrial London, 1250–1650*

WILLIAM H. TE BRAKE

Throughout much of the great mass of literature generated by the present environmental crisis there runs a persistent misconception: that environmental problems result from modern industrialization and thus are no older than the Industrial Revolution of the 18th and 19th centuries. Such a view implies that there were no serious environmental problems before industrialization, that, could we eliminate certain offending industries or develop the proper technology to control them, our present ecological ills would be cured. More properly, however, the basic problems of disposing of wastes and finding adequate sources of food, water, and fuel, though certainly aggravated by modern industrialization, are as old as civilization itself. I intend to show in this paper that the occurrence of air pollution in London before the Industrial Revolution was symptomatic of one of these basic environmental problems—the exhaustion of a society's preferred source of fuel and the subsequent difficulty of finding an adequate substitute—and, further, that it was intimately connected to certain demographic and economic developments within that society.

\* \* \*

Air pollution was already a very serious nuisance in London by the middle of the 17th century. John Evelyn, a fellow of the Royal Society of London but perhaps better known as a diarist, wrote in 1661: "It was one day, as I was Walking in Your MAJESTIES Palace at WHITE-HALL, . . . that a presumptuous Smoake . . . did so invade the Court" that ". . . Men could hardly discern one another for the Clowd, and none could support, without manifest Inconveniency." This smoke, he explained, came from "one or two Tunnels" (smokestacks) nearby, "indangering as well the Health [of the king and his subjects] as it sullies the Glory of this . . . Imperial Seat." "And what is all this, but that Hellish and dismal Cloud of SEA-COALE," an "impure and thick Mist, accompanied with a fuliginous and filthy vapour, which renders them obnoxious to a thousand inconveniences, cor-

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rupting the *Lungs*, and disordering the entire habit of their Bodies,” causing “*Catharrs, Phthisicks, Coughs* and *Consumptions* [to] rage more in this one City, than in the whole Earth besides.”<sup>1</sup>

John Graunt, a fellow member of the Royal Society, noted four years later that “little more than one of 50 dies in the Country, whereas in *London* it seems manifest that about one in 32 dies, over and above what dies of the *Plague*.” The reasons for this, he concluded, were that London was too crowded and sea coal was too often burned. Whereas before 1600 the death rate for the city was no higher than that of the countryside when little sea coal was burned, by 1665 London was “more *unhealthful*” because “*Sea-Coals* . . . are now universally used.” Many people “cannot at all endure the smোক of *London*, not only for its unpleasantness, but for the suffocations which it causes.”<sup>2</sup>

These statements by Evelyn and Graunt clearly define the problem. For both, the source of the air pollution was sea coal, a very soft, sulfurous, low-grade coal that when burned emitted a “continual cloud of choking, foul-smelling smoke . . . , leaving behind a heavy deposit of thick black soot on the clothing and faces of all attending.”<sup>3</sup> In contrast, the traditional and preferred fuel, firewood (and especially its derivative, charcoal), gave off relatively small quantities of smoke and fumes.

<sup>1</sup>John Evelyn, *Fumifugium: or The Inconveniencie of the Aer and Smোক of London Dissipated. Together with some Remedies humbly Proposed by J. E. Esq; to His Sacred Majestie, and to the Parliament now Assembled* (London, 1661), from the dedicatory epistle and p. 5. The origin of the term “sea coal” is shrouded in mystery. It may first have been used to refer to the coal originating along the Northumberland coast, because it was usually shipped by sea to its destination. It seems more likely, however, that sea coal was first discovered washed up on the beaches of northern England, since the coal seams there extend below the sea. Because it resembled charcoal in appearance it was probably called “sea charcoal” first and “sea coal” later; see John U. Nef, *The Rise of the British Coal Industry* (London, 1932), vol. 2, appendix P, “Note on the Origin of the Word ‘Sea Coal’”; see also Raymond Smith, *Sea-Coal for London: History of the Coal Factors in the London Market* (London, 1961), pp. 2, 7, and appendix A; L. F. Salzman, *English Industries of the Middle Ages*, 2d ed. (Oxford, 1923), pp. 2–3; and Howard N. Eavenson, *Coal through the Ages*, 2d ed. (New York, 1939), p. 9.

<sup>2</sup>John Graunt, *Natural and Political Observations Mentioned in a following Index and made upon the Bills of Mortality . . . with reference to the Government, Religion, Trade, Growth, Air, Diseases and the several Changes of the said City*, 5th rev. ed. of 1676, repr. in William Petty, *The Economic Writings of Sir William Petty*, ed. Charles Henry Hull (Cambridge, 1899), 2:393–94. Graunt’s name is closely associated with the origins of demographic research in Great Britain; see, e.g., D. V. Glass, “John Graunt and His Natural and Political Observations,” *Proceedings of the Royal Society*, ser. B, 159 (1963): 1–32.

<sup>3</sup>Nef, 1:130. Actually, coal containing sulfur eventually produces sulfuric acid. Burning emits oxides of sulfur, some of which—sulfur trioxide (SO<sub>3</sub>) especially—readily react with water to form the acid H<sub>2</sub>SO<sub>4</sub>. Thus, sea coal not only produced choking clouds of foul-smelling smoke and soot but also a very powerful and irritating acid which entered the eyes and breathing passages.

Contrary to Graunt's opinion, however, air pollution was not unknown before the 17th century. Nor were Evelyn and Graunt the first to locate its cause in the use of a particular type of fuel. The smoke of sea coal presumably drove Queen Eleanor from Nottingham Castle at the time of the feast of Saint Michael in 1257.<sup>4</sup> One must look to London, however, to find evidence suggesting that air pollution at this time could be more than simply an isolated problem.<sup>5</sup>

The smoke of sea coal fires was a general nuisance in London by the last quarter of the 13th century. A royal commission appointed in 1285 to inquire into the operation of certain lime kilns found "that whereas formerly the lime used to be burnt with wood, it is now burnt with sea-coal." Consequently, "the air is infected and corrupted to the peril of those frequenting . . . and dwelling in those parts."<sup>6</sup> The lime burners, however, were persistent; a second commission of inquiry was appointed for the same reason in 1288 "on complaint by many inhabitants that they are annoyed by lime kilns."<sup>7</sup> In 1298 a group of London smiths voluntarily decided "that none [of their trade] should work at night on account of the unhealthiness of [sea] coal and damage to their neighbors."<sup>8</sup>

The commissions of inquiry and the voluntary efforts of the smiths

<sup>4</sup>"Propter fumum carbonum maris nullo modo potuit demorari," in *Rerum Britannicarum Medii AEvi Scriptores* (Rolls Series), *Annales Monastici*, no. 36, 3:203–4.

<sup>5</sup>Archaeological investigations have disclosed that coal occasionally was used as a fuel in Roman Britain. Coal cinders have been found amid the remains of some Roman towns and villas, especially near outcropping coal seams in Northumberland as well as in the Forest of Dean, in southwestern England. There is no reason to assume, however, that it amounted to anything more than local use at that time. The Domesday Book, compiled in 1086 by the new Norman administration, was an attempt to catalog everything of economic value in England. It contains no mention of coal or coal mining, although lead and iron mining did figure in it. By 1200, however, the monks of Holyrood and Newbattle abbeys were mining coal along the Firth of Forth at Carriden as well as at Linlithgow; see, for example, Eavenson, pp. 5, 8; as well as Cyril E. Hart, *Royal Forest: A History of Dean's Woods as Producers of Timber* (Oxford, 1966), p. 5; Nef, 1:2; and Salzman, p. 1. When or under what conditions sea coal was first introduced into London is not known. Perhaps it was used as ballast in ships returning from Newcastle. By 1228, however, it was common enough for a street to be named "Sea-Coal Lane," and in 1257 definite mention was made of imports of sea coal into London. The London sea coal trade was extensive enough by the late 13th century to warrant the appointment of a coal meter, an official charged with regulating its import and sale; see H. T. Riley, ed. and trans., *Memorials of London and London Life in the XIIIth, XIVth, and XVth Centuries* (London, 1868), p. xvi, n. 7; *Calendar of Early Mayor's Court Rolls* (1298–1307), p. 30; Salzman, pp. 3–4; Smith, p. 2; J. B. Blake, "The Medieval Coal Trade of Northeast England," *Northern History* 2 (1957): 1–2; and M. M. Postan, *Medieval Economy and Society: An Economic History of Britain, 1100–1500* (Berkeley and Los Angeles, 1972), p. 198.

<sup>6</sup>*Calendar of Patent Rolls*, Edward I (1281–92), p. 207.

<sup>7</sup>*Ibid.*, p. 296.

<sup>8</sup>*Calendar of Early Mayor's Court Rolls* (1298–1307), p. 34.

were not sufficient to combat London's air pollution problem. Edward I, therefore, issued a royal proclamation in 1307 prohibiting the use of sea coals in kilns,

as the King learns from the complaint of prelates and magnates of his realm, who frequently come to London for the benefit of the commonwealth by his order, and from the complaint of his citizens and all his people dwelling there and in Southwark that the workmen in the city and town aforesaid and in their confines now burn them [kilns] and construct them of sea-coal instead of brushwood and charcoal, from the use of which sea-coal an intolerable smell diffuses itself throughout the neighboring places and the air is greatly infected, to the annoyance of the magnates, citizens and others there dwelling and to the injury of their bodily health.<sup>9</sup>

Two weeks later another royal commission, authorized "to punish offenders by grievous ransoms," attempted to determine why the royal proclamation was not being observed.<sup>10</sup>

For the next two centuries or more, air pollution seems to have been much less of a problem in London. After a complaint in 1371 that the smelting operations of certain plumbers in Wodhawe in the parish of Saint Clements were causing annoying smoke and fumes,<sup>11</sup> which sounds as if sea coal may have been the cause, it is difficult to find further mention of the nuisance until well into the 16th century.<sup>12</sup> This silence may simply reflect a gap in the records, since

<sup>9</sup>*Calendar of Close Rolls*, Edward I (1302-7), p. 537.

<sup>10</sup>*Calendar of Patent Rolls*, Edward I (1301-7), p. 549.

<sup>11</sup>*Calendar of Letter Books of the City of London*, ed. R. R. Sharpe, *Book G* (London, 1905), pp. 283-84.

<sup>12</sup>A document of 1467 from the town of Beverley, some 150 miles due north of London, contains a reference to damaged fruit trees and other inconveniences caused by the stench of brick kilns. In the future, such kilns would be allowed no closer to Beverley than they were at that time: "Item salubriter ordinatum est quod proper fetorem et aeris intemperiem ad destructionem fructuum arborum, aliaque incommoda, que ex inde provenire poterit, nullus edificare presumat decetero aliquod thorale pro cremacione tegularum infra predictam villam Beverlaci, aut propius eandem villam quam throalia tegularum edificata existunt in presenti, sub pena centum solidorum applicandorum et solvendorum usui Communitatis ville antedictæ" (in Arthur F. Leach, ed., *Beverley Town Documents*, Publications of the Seldon Society, vol. 14 [London, 1900], p. 58). The actual wording of this document, however, suggests that this was a sort of zoning ordinance against brick kilns in general, whether fired by firewood, charcoal, or sea coal. Even firewood and charcoal would emit some smoke, especially, perhaps, in the brick-baking process. In any case, there is nothing here to suggest that the town of Beverley was suffering from an air pollution problem at all comparable to that caused by the burning of sea coal in London at the beginning of the 14th century.

sea coal continued to be imported into London.<sup>13</sup> But for reasons that will be discussed in detail below, it is perhaps best to view the lack of complaints about air pollution in London in the late 14th, 15th, and early 16th centuries as actually reflecting a diminution of the problem.

By the second half of the 16th century, air pollution had once again assumed serious proportions in London. Queen Elizabeth was so “grieved and annoyed with the taste and smoke of sea cooles” in 1578 that the Company of Brewers promised to use only wood in their brewing operations in the future.<sup>14</sup> In 1623, the House of Lords passed an act forbidding the use of sea coal in brewhouses “within one mile of any house in which His Majesty’s Court or the Court of the Prince of Wales shall be usually held,” but the Commons dropped it at the end of the session.<sup>15</sup> Hereafter, however, the complaints become very frequent and begin to assume a much more sweeping character. Thus, a 1627 petition aimed at “the farmers of the alum works, on account of the loathsome vapour from [their] works to the great annoyance of the inhabitants within a mile compass,” maintained that sea coal smoke was responsible for “tainting the pastures, and poisoning the very fish in the Thames.”<sup>16</sup>

If the complaints of air pollution were becoming more and more common, the city of London was also becoming more and more dependent on sea coal for fuel. In the winter of 1637–38, Charles I attempted to sell the monopoly of the coal trade to the city of Newcastle, a measure bitterly opposed by London shipowners. The ensuing quarrel temporarily interrupted the supply of sea coal to London, causing considerable discomfort in the city.<sup>17</sup> Six years later, Richard Gesling reported that, whereas previously “some fine Nosed City Dames” used to complain about “the smell of this *Cities Seacoale Smoke*,” they now cry “would to *God* we had *Seacoale*. O the want of Fire undoes us! O the sweete *Seacoale* fire we used to have, how we want them now, no fire to your *Seacoale*!”<sup>18</sup> London was one of the

<sup>13</sup>See, e.g., *Calendar of Patent Rolls*, Edward III (1348–50), p. 50. In 1388 alone, nine persons were issued licenses to ship sea coal from Newcastle to London (*Calendar of Patent Rolls*, Richard II [1385–89], pp. 400, 407, 410).

<sup>14</sup>*Calendar of State Papers, Domestic Series*, Elizabeth I (1578), p. 612.

<sup>15</sup>The Royal Commission on Historical Manuscripts, *Third Report* (London, 1872), p. 28.

<sup>16</sup>*Calendar of State Papers, Domestic Series*, Charles I (1627–28), pp. 269–70.

<sup>17</sup>*Ibid.*, Charles I (1637), p. 295.

<sup>18</sup>Richard Gesling, *Artificiall Fire, or Coale for Rich and Pore* (1644). The relevant page is reproduced in Nef, vol. 1, facing p. 247.

world's leading industrial cities by the reign of Charles I.<sup>19</sup> Its innumerable factories and workshops and tens of thousands of domestic hearths demanded immense quantities of fuel. Sea coal and air pollution had become facts of life for London's inhabitants.

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All of the complaints listed above expressed an obvious distaste for sea coal. It was clearly identified as the source of air pollution. Why then was sea coal burned? Did it have certain characteristics demanded by new industries that could not be matched by wood fuels?

For the technological requirements of pre-Industrial Revolution England, both wood and coal fuels produced sufficient quantities of heat energy. Lime burners and smiths were the first to use sea coal in their fires. By the 16th century, the artisans of many other trades were also beginning to make the fuel substitution: brewers, brick and tile makers, salt makers, dyers, and malt dryers, to name a few.<sup>20</sup> But all of these trades had been practiced for centuries with wood or charcoal. Thus, the changeover was not made to meet the higher energy requirements of new or developing technologies.

On the other hand, sea coal contained such impurities that, in addition to letting off clouds of smoke and fumes, it could cause harmful side effects in the industrial processes themselves. Iron smiths preferred to use charcoal or wood in their forges because the high sulfur content of sea coal made the iron overly brittle. From time to time, brewers would attempt to brew with sea coal fires, though the drinking public generally insisted that beer or ale thus brewed was tainted by the smoke.<sup>21</sup> In the 17th century, artisans and amateur scientists began to experiment with "charring sea coale" so that it could be used in smelting processes as well. Such attempts at producing coke were not really successful, however, until the 18th century.<sup>22</sup>

Sea coal cannot have been an ideal fuel for domestic heating either. During the 12th and 13th centuries major technological innovations in home heating resulted in the widespread diffusion of the fireplace, flue, and chimney throughout all classes of society. In combination,

<sup>19</sup>John U. Nef, "A Comparison of Industrial Growth in France and England from 1540 to 1640," *Journal of Political Economy* 44 (1936): 663.

<sup>20</sup>Nef, *Rise of the British Coal Industry*, 1:11-12, 201-23.

<sup>21</sup>*Ibid.*, 1:11-13, 201-23; Blake, pp. 4-5; and G. T. Salusbury, *Street Life in Medieval England*, 2d ed. (London, 1948), p. 116.

<sup>22</sup>For a description of one of these attempts, see John Evelyn, *The Diary of John Evelyn*, ed. E. S. de Beer (Oxford, 1955), 3:180-81, entry for July 10, 1656. For a recent discussion of 18th-century advances in the use of coal for iron production, see Charles K. Hyde, "Technological Change in the British Wrought Iron Industry, 1750-1815: A Reinterpretation," *Economic History Review*, 2d ser., 27 (1974): 190-206.

these elements provided more usable heat and better control of smoke and fumes in dwellings than did the earlier, central hearth, which allowed smoke and fumes to swirl around the room before exiting through a hole in the roof. But even so, the burning of poor or uncured firewood could still fill rooms equipped with fireplace, flue, and chimney with a considerable amount of smoke.<sup>23</sup> If sea coal were burned, presumably even less satisfactory results would be expected. Thus, people like the 17th-century English diarist Samuel Pepys kept a supply of charcoal, when such could be obtained, to be used instead of sea coal for heating the dining room and bedroom.<sup>24</sup>

If sea coal was no better than wood fuels as far as the amount of heat produced was concerned, if it actually produced undesirable side effects in certain industrial processes, and if it compared unfavorably to firewood or charcoal for domestic purposes, why was sea coal in fact substituted for wood fuel in the late 13th and early 14th centuries and again from the late 16th century on? As the 18th-century British economist Adam Smith suggested, the substitution of sea coal for wood fuels was a matter of economics. Writing in 1776, he too concluded that "coals are a less agreeable fuel than wood: they are said to be less wholesome." Therefore, he observed, "the expence of coals . . . at the place where they are consumed must generally be somewhat less than that of wood."<sup>25</sup> Indeed, what he said can perhaps be applied to an earlier period as well.

Though it is impossible to construct satisfactory price indices for wood products and sea coal during the 13th and 14th centuries,<sup>26</sup> I intend to show that in London, at least, there was a genuine shortage of wood fuels at that time which would have led to an increase in prices. Many Londoners, therefore, began to turn to relatively inexpensive sea coal as an alternative source of fuel despite its other dis-

<sup>23</sup>LeRoy J. Dresbeck. "The Chimney and Fireplace: A Study in Technological Development Primarily in England during the Middle Ages" (Ph.D. diss., University of California, Los Angeles, 1971), esp. chaps. 3, 6. For the effects of poor fuel in the new heating systems, see p. 222.

<sup>24</sup>Samuel Pepys, *The Diary of Samuel Pepys*, ed. Robert Latham and William Matthews, vol. 1 (Berkeley and Los Angeles, 1971), pp. 14, 405, 409.

<sup>25</sup>Adam Smith, *An Enquiry into the Nature and Causes of the Wealth of Nations*, ed. Edwin Cannan (New York, 1937), bk. 1, chap. 11, pt. 2, p. 165. Asta Moller, "Coal-Mining in the Seventeenth Century," *Transactions of the Royal Historical Society*, 4th ser., 8 (1925): 81, observes that during the 17th century, "where no immediate scarcity of fuel, either domestic or industrial use, was felt, the inducement to engage in [coal] mining was only slight."

<sup>26</sup>Postan, p. 231. Hart, pp. 22–28, 60–65, 318–20, compiled some interesting details concerning costs and prices of timber and wood fuels in the Forest of Dean for the 13th and 14th centuries. Unfortunately, they cannot be properly compared with sea coal prices at London, nor are they complete enough to indicate any long-term price trends.

advantages. When supplies of wood fuels once more became adequate in the late 14th, 15th, and early 16th centuries, firewood and charcoal again replaced sea coal in many of London's forges, furnaces, and kilns, thus reducing the frequency of complaints about air pollution. A second fuel crisis began in the second half of the 16th century, and once again sea coal became a less expensive alternative.

Because the necessary price indices are lacking, the alternating phases of shortage and adequate supplies of wood fuels that I have postulated can be indicated only by an examination of some general features of late medieval life and a number of long-term demographic and economic trends common to all of western Europe. Stated most simply and mechanically, land, or rather the use of land for agricultural purposes, was the basis of economic life. Under normal conditions, woodland and other waste (i.e., land not under cultivation) played a very important role in peasant ecology as, among many other things, a constant source of timber and wood fuels. Significant and sustained population increase, however, upset the balance. Demands for timber and wood fuels grew proportionately with population increase, while much waste, including woodland, was reclaimed and cultivated to meet increased demands for food. If these demands were severe enough, woodland dwindled to the point where local fuel shortages developed and alternative sources of fuel were sought. If, on the other hand, population suddenly decreased substantially, fuel and timber demands immediately decreased as well, and some previously cultivated land was allowed to revert to brush and eventually woods capable of supplying most fuel needs.<sup>27</sup>

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<sup>27</sup>On medieval peasant ecology and economy, see Georges Duby, *Rural Economy and Country Life in the Medieval West*, trans. Cynthia Postan (London, 1968), *The Early Growth of the European Economy: Warriors and Peasants from the Seventh to the Twelfth Century*, trans. Howard B. Clarke (London, 1974), and "Medieval Agriculture, 900–1500," in *The Fontana Economic History of Europe*, ed. Carlo M. Cipola, vol. 1, *The Middle Ages* (London, 1972), pp. 175–220; Roger Grand and Raymond Delatouche, *L'agriculture au moyen âge de la fin de l'Empire romain au XVI<sup>e</sup> siècle* (Paris, 1950); B. H. Slicher van Bath, *The Agrarian History of Western Europe, A.D. 500–1850*, trans. Olive Ordish (London, 1963); Guy Fourquin, *Le paysan d'Occident au moyen âge* (Paris, 1972); Marc Bloch, *French Rural History: An Essay on Its Basic Characteristics*, trans. Janet Sondheimer (Berkeley and Los Angeles, 1966); *The Cambridge Economic History of Europe*, vol. 1, *The Agrarian Life of the Middle Ages*, 2d ed., ed. M. M. Postan (Cambridge, 1966); Lynn White, jr., *Medieval Technology and Social Change* (Oxford, 1962); and others. For the process involved in the expansion and contraction of arable lands during the Middle Ages, it may be useful to keep in mind the explanation of Ester Boserup, *The Conditions of Agricultural Growth: The Economics of Agrarian Change under Population Pressure* (Chicago, 1965), as well as her more recent "Environment, population et technologie dans les sociétés primitives,"

At the time of the Norman Conquest, in 1066, England had extensive woodlands. Though Anglo-Saxon and Scandinavian peasants had been busy for centuries converting much of them into pasture and arable land, the Domesday survey of 1086 gave detailed accounts of how much remained. For the county of Middlesex, excluding London, it listed several villages with enough woodland to provide acorns and beech mast for as many as 2,000 swine, with many more villages possessing lesser amounts.<sup>28</sup> William Fitz Stephen, in his 12th-century *Description of London* (ca. 1174), maintained that within a very short distance of London there was "a great forest with wooded glades and lairs of wild beasts, deer both red and fallow, wild boars and bulls."<sup>29</sup>

Though England's woodlands were still extensive at the end of the 11th and into the 12th century, one must not suppose, therefore, that they were unused or vacant. Rather, they were the scene of much activity. Since the earliest times, the woods were an important source of supplemental food, both animal and vegetable. Most household and agricultural tools and implements were constructed, at least in part, of wood. Most dwellings and all ships were constructed of timber. For centuries swine had been allowed to forage on acorns and beech mast; this right of pannage often meant the difference between starvation and subsistence. Much medieval industry was located near camps of charcoal burners, who, for a ton of charcoal—the essential fuel for smelting, glassmaking, and many other industries—leveled

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*Annales: Economies, sociétés, civilisations* 29 (1974): 538–52. Briefly, she maintains that change in population density is the major factor in determining agricultural change. As population increases in a given area, the use of the land is intensified (or the fallow is shortened), producing food for more people but also requiring more labor. Thus, if population declines, with a reduction in food requirements and with fewer hands to perform the labor, the intensiveness of land use is relaxed (or the fallow is lengthened).

<sup>28</sup>H. C. Darby, "The Clearing of the Woodland in Europe," in *Man's Role in Changing the Face of the Earth*, ed. William L. Thomas et al. (Chicago, 1956), pp. 191–92 and fig. 55, and "Domesday Woodland," *Economic History Review*, 2d ser., 3 (1950): 22; William Page, ed., *The Victoria History of the County of Middlesex* (London, 1911), 2:223; and N. Neilson, "Early English Woodland and Waste," *Journal of Economic History* 2 (1942): 56.

<sup>29</sup>William Fitz Stephen, *A Description of London*, trans. H. E. Butler, published in *Norman London: An Essay*, ed. F. M. Stenon et al., Historical Association Leaflets, nos. 93, 94 (London, 1934), p. 27. It is quite possible, however, that Fitz Stephen was using the term "forest" in its legal sense, to describe an area reserved by the Crown or nobility for the chase and, therefore, off limits to most people in search of firewood; yet his statement does give us an idea of woodland in close proximity to London—perhaps it was some of the woodland described by the Domesday Book a century before. On the other hand, G. J. Turner, ed., *Select Pleas of the Forest*, Publications of the Seldon Society, vol. 13 (London, 1901), p. cviii, maintains that there were no forests or forest law in the counties of Kent and Middlesex, except for a warren at Staines, Middlesex, already disafforested in 1227 (i.e., its legal status was changed from forest to ordinary land).

huge stretches of timber.<sup>30</sup> In almost every way imaginable, woodland was essential to preindustrial European society. In Germany, Heriger, bishop of Mainz (913–27), when told of a false prophet “who with many good reasons had advanced the idea that Hell was completely surrounded by a dense forest,” is supposed to have replied, “I would like to send my swineherd there with my lean pigs to pasture.”<sup>31</sup> One suspects that, say, the bishop of Winchester would have reacted in a similar manner.

Because of the central role that woodland played in the medieval economy, an elaborate system of rights and usages based on customary law codified and regulated its exploitation. One should remember that, in addition to obtaining the Magna Carta from King John, the English barons also placed a check, in the form of the Forest Charter, on royal attempts to put additional land in the royal game preserves. This Forest Charter, in Doris Stenton’s opinion, was perhaps as important as the Magna Carta itself and became one of the foundations of the medieval English social scene.<sup>32</sup> The complex body of forest law, rights, and usages was designed to guarantee access for a number of groups to England’s woodlands. At the same time, it was intended, for various reasons, to guard against their destruction, for if the woodlands disappeared, they would take with them the very life of the medieval economy.<sup>33</sup>

In spite of such efforts to preserve the woodlands, there were compelling reasons for destroying them as well. Peasants often had an interest in extending their arable lands by assarting, that is, by cutting down trees and digging out their roots. Until well into modern times, the margin of security against starvation was extremely thin. The failure of a single year’s harvest often brought on genuine famine

<sup>30</sup>Three lime kilns consumed 26 acres of timber in 1229 (*Calender of Close Rolls*, Henry III [1227–31], p. 268). In the 16th century, two iron forges and their charcoal works consumed 2.7 million cubic feet of timber in two years; see Salzman, p. 39; and H. R. Schubert, *History of the British Iron and Steel Industry from c. 450 B.C. to A.D. 1775* (London, 1957), pp. 112–14. For an extensive list of the uses of woodland in the Middle Ages, see Clarence Glacken, *Traces on the Rhodian Shore: Nature and Culture in Western Thought from Ancient Times to the End of the Eighteenth Century* (Berkeley and Los Angeles, 1967), pp. 320–22; as well as the discussions of Duby, *Rural Economy and Country Life in the Medieval West*, pp. 143–44; Grand and Delatouche, pp. 410–44; Slicher van Bath, pp. 72–73; Salzman, throughout; Neilson, pp. 54–62; and Cyril E. Hart, *The Verderers and Forest Laws of Dean* (Newton Abbot, 1971), p. 19, and *Royal Forest*, p. xix.

<sup>31</sup>Quoted in Glacken, p. 321.

<sup>32</sup>Doris Stenton, *English Society in the Early Middle Ages*, 4th ed., Pelican History of England, vol. 3 (Harmondsworth, 1971), pp. 100–122, esp. p. 109. For mostly Continental examples, see Glacken’s discussion of medieval forest laws in France and Germany, pp. 322–40.

<sup>33</sup>Glacken, p. 336. See also Grand and Delatouche, p. 433; and Neilson, pp. 54–62.

conditions.<sup>34</sup> Therefore, efforts were constantly made to increase the supply of foodstuffs. This was done in essentially two ways: by improving the yield per acre through the use of better seeds, different types of crops, fertilizer, and a more efficient organization of fallow and cultivation; or by increasing the acreage under the plough. The latter method, the expansion of arable land at the expense of woodland and other waste, was the one most used until the end of the Middle Ages; between 1000 and 1300 it was sufficient to prevent serious food shortages in most of Europe.<sup>35</sup>

The period from the 11th through the 13th centuries was a significant era of environmental change in western Europe, the great age of reclamation.<sup>36</sup> Almost everywhere woodland and marsh yielded to arable farmland. Though the patterns and chronology of reclamation varied from place to place, certain common factors were involved. The key element was the growth of population; plots of agricultural land had been divided and subdivided for generations to the point where they were no longer large enough to provide the food needed by the people who depended on them for subsistence.<sup>37</sup> The

<sup>34</sup>F. Curschmann, *Hungersnöte im Mittelalter: Ein Beitrag zur deutschen Wirtschaftsgeschichte des 8. bis 13. Jahrhunderts*, Leipzig Studien aus dem Gebiet der Geschichte, vol. 6, pt. 2 (Leipzig, 1900); Hans van Werveke, "De middeleeuwse hongersnood," *Mededelingen, Koninklijke Vlaamse Academie voor Wetenschappen, Letteren, en Schone Kunsten*, klasse der letteren, vol. 29, no. 3 (1969), entire issue, and "La famine de l'an 1316 en Flandre et dans les régions voisines," *Revue du Nord* 41 (1959): 5–14; Henry S. Lucas, "The Great European Famine of 1315, 1316, and 1317," *Speculum* 5 (1930): 343–77; Leopold Genicot, "Crisis: From the Middle Ages to Modern Times," in *The Cambridge Economic History of Europe*, vol. 1, *The Agrarian Life of the Middle Ages*, 2d ed., ed. M. M. Postan (Cambridge, 1966), pp. 672–74; Ian Kershaw, "The Great Famine and Agrarian Crisis in England, 1315–1322," *Past and Present*, no. 59 (1973), pp. 3–50; and Odo Rigaldus, *The Register of Eudes of Rouen*, ed. Sydney M. Brown (New York and London, 1964), pp. 253, 306–7, 410–11, 502–3.

<sup>35</sup>Duby, "Medieval Agriculture, 900–1500," p. 199; and B. H. Slicher van Bath, "The Rise of Intensive Husbandry in the Low Countries," in *Britain and the Netherlands*, vol. 1, ed. J. S. Bromley and E. H. Kossmann (London, 1959), pp. 130–53.

<sup>36</sup>Glacken, p. 291; and Grand and Delatouche, pp. 237–46.

<sup>37</sup>For medieval population changes in general, see Josiah C. Russell, "Late Ancient and Medieval Population," *Transactions of the American Philosophical Society*, n.s., vol. 48, pt. 3 (1958), and "Population in Europe, 500–1500," in *The Fontana Economic History of Europe*, ed. Carlo M. Cipolla, vol. 1, *The Middle Ages* (London, 1972), pp. 25–70. See also Duby, *Rural Economy and Country Life in the Medieval West*, p. 67; F. L. Ganshof and A. E. Verhulst, "Medieval Agrarian Society in Its Prime: France, the Low Countries, and Western Germany," in *The Cambridge Economic History of Europe*, vol. 1, *The Agrarian Life of the Middle Ages*, 2d ed. ed. M. M. Postan (Cambridge, 1966), p. 294; M. M. Postan, "Medieval Agrarian Society in Its Prime: England," in *ibid.*, pp. 563–65; J. Z. Titow, "Some Evidence of the Thirteenth Century Population Increase," *Economic History Review*, 2d ser., 14 (1941): 218–24; Norman J. G. Pounds, "Overpopulation in France and the Low Countries in the Later Middle Ages," *Journal of Social History* 3 (1970):

simultaneous growth of nonagricultural centers of merchants and craftsmen, as at Paris and London and in Flanders, demanded agricultural surpluses and tended to inflate prices of foodstuffs.<sup>38</sup> As a result, a snowballing process began: as the number of people increased and agricultural prices remained high, new lands were wrested from the waste; as population continued to increase, more cropland was added. This process proceeded virtually without interruption until, by the beginning of the 14th century, few lands remained to be cleared.<sup>39</sup> At the same time, the marshlands of northwestern Europe were drained and occupied for much the same reason.<sup>40</sup>

It is not possible to give any set of accurate figures or percentages of the amount of land brought into cultivation during this period, but, while it lasted, the growth was significant.<sup>41</sup> In the mountain areas, especially the Alps and the Pyrenees, the edge of human settlement crept to ever higher elevations.<sup>42</sup> The huge wooded areas of France, Germany, and England shrank dramatically. The most striking evidence of this growth is found in the vast numbers of new towns

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225–47; and Slicher van Bath, *Agrarian History of Western Europe*, p. 73. For a general discussion of medieval population trends and some problems associated with their study, see Carlo Cipolla, Jean Dhont, M. M. Postan, and Philippe Wolff, "Anthropologie et démographie: moyen âge" (a collective report given to the Ninth International Congress of Historical Sciences at Paris, August 28–September 3, 1950), *Rapports* (Paris, 1950), 1:55–80.

<sup>38</sup>See, for example, Slicher van Bath, *Agrarian History of Western Europe*, pp. 116, 132.

<sup>39</sup>*Ibid.*, pp. 134–36; and Genicot, pp. 669–70.

<sup>40</sup>Concerning the reclamation of some English marshes, see H. E. Hallam, *Settlement and Society: A Study of the Early Agrarian History of South Lincolnshire*, Cambridge Studies in Economic History (Cambridge, 1965). For coastal Flanders, see A. Verhulst, "Historische geografie van de Vlaamse kustvlakte tot omstreeks 1200," *Bijdragen voor de geschiedenis der Nederlanden* 14 (1959–60): 1–37. Peat bog reclamation in the county of Holland and the bishopric of Utrecht is carefully studied by H. van der Linden, *De Cope: bijdrage tot de rechtsgeschiedenis van de openlegging der Hollands-Utrechtse laagolakte* (Assen, 1955). For an environmental history approach to marshland reclamation in a part of the county of Holland, see William H. Te Brake, "The Making of a Humanized Landscape in the Dutch Rijnland, 1000–1500" (Ph.D. diss., University of Texas, Austin, 1975).

<sup>41</sup>Ganshof and Verhulst, p. 295; Postan, "Medieval Agrarian Society in Its Prime," pp. 548–52; Richard Koebner, "The Settlement and Colonization of Europe," in *The Cambridge Economic History of Europe*, vol. 1, *The Agrarian Life of the Middle Ages*, 2d ed., ed. M. M. Postan (Cambridge, 1966), pp. 43–91; and Glacken, pp. 291, 328. H. Draye (*Landelijke cultuurvormen en kolonisatie geschiedenis van B. Huppertz: "Räume und Schichten bäuerlicher Kulturformen in Deutschland,"* Toponymica: bijdragen en bouwstoffen uitgegeven door de Vlaamse Toponymische Vereeniging te Leuven [Louvain and Brussels, 1941], p. 60) maintains that two-thirds of the presently cultivated land in the originally wooded areas of Belgium were reclaimed in the 10th through 13th centuries.

<sup>42</sup>Slicher van Bath, *Agrarian History of Western Europe*, pp. 133.

founded during this period.<sup>43</sup> Place names containing elements referring to woods, clearings, assartings, and the like (as well as marshes, dikes, and drainage canals), are common throughout all of western Europe, and most date from the 11th through the 13th centuries.<sup>44</sup>

The patterns of medieval growth and expansion so prevalent in western Europe in general were present in England in particular. It is estimated that England's population grew from 1.1 million at the time of the Domesday survey (1086) to about 3.7 by the early 14th century.<sup>45</sup> Meanwhile, London grew from about 20,000 inhabitants in 1200 to at least 40,000 by 1340.<sup>46</sup> And, as was the case for Europe as a whole, ploughland made heavy inroads into the woodland. An Anglo-Saxon poet once described the ploughman as the "grey enemy of the wood."<sup>47</sup> This is also the picture that one must keep in mind for the 11th through the 13th centuries. The ever increasing food needs of the burgeoning population eventually made lands so scarce that even soil of vastly inferior quality was cultivated—areas "where no or virtually no grain was grown in any other period of English history." These were lands which a society would cultivate only in times of "real land hunger."<sup>48</sup>

<sup>43</sup>See, for example, Maurice Beresford, *New Towns of the Middle Ages: Town Plantation in England, Wales, and Gascony* (New York and Washington, D.C., 1967), p. 366, table 13.6. Beresford concludes that, of the total of 368 new creations between 1066 and the end of the Middle Ages, all but 51 occurred between 1066 and 1300. See also R. P. Bekinsale, "Urbanization in England to A.D. 1420," in R. P. Bekinsale and J. M. Houston, *Urbanization and Its Problems* (Oxford, 1968), p. 18.

<sup>44</sup>Slicher van Bath, *Agrarian History of Western Europe*, p. 133; Darby, "Clearing of the Woodland in Europe," pp. 191–95; Duby, *Rural Economy and Country Life in the Medieval West*, p. 80; M. Gysseling, *Toponymisch woordenboek van België, Nederland, Luxemburg, Noord-Frankrijk en West-Duitsland (vóór 1226)*, 2 vols. (Brussels, 1962), passim; and D. P. Blok, "Plaatsnamen in Westfriesland," *Philologia Frisica anno 1966*, no. 319 (1968), pp. 11–19.

<sup>45</sup>Josiah C. Russell, *British Medieval Population* (Albuquerque, N.M., 1948), pp. 246–60, and "Late Ancient and Medieval Population," p. 105. After the demographic decline of the second half of the 14th century, England's population reached 3.7 million again only shortly before 1600, a time for which we have better evidence of a fuel crisis; see Julian Cornwall, "English Population in the Early Sixteenth Century," *Economic History Review*, 2d ser., 23 (1970–71): 44, table 5.

<sup>46</sup>Russell, *British Medieval Population*, p. 287, estimated London's population at 30,000 early in the 13th century and not much below 60,000 by 1340. For a criticism of Russell's figures, see Gwyn A. Williams, *Medieval London: From Commune to Capital* (London, 1963), pp. 315–17. See also Russell, "Late Ancient and Medieval Population," p. 47 (table 48), p. 61 (table 64), p. 68, and p. 69 (table 71).

<sup>47</sup>Darby, "Clearing of the Woodland in Europe," p. 191.

<sup>48</sup>Postan, "Medieval Agrarian Society in Its Prime," pp. 551–54, 565. Also see J. B. Harley, "Population Trends and Agricultural Developments from the Warwickshire Hundred Rolls of 1279," *Economic History Review*, 2d ser., 11 (1958–59): 11–12; Maurice

It should be remembered, however, that there were still substantial amounts of woodland in England forming the nuclei of royal and noble forests and warrens which could be exploited only with special charters and grants. The fines for trespassing were so severe that for the ordinary man it was disastrous to be caught simply lopping off the branch of a tree. Essentially, therefore, forests and other preserves of this sort were not viable sources of fuel, since their reason for existence was to provide cover for game, not firewood or charcoal.<sup>49</sup>

By the middle of the 13th century, the effects of increasing population, requiring more and more wood products and the extension of arable lands at the expense of waste, began to be strongly felt. Consequently, one can find an occasional complaint about the destruction of England's woodlands during the 13th century. In 1232, Henry III was told that the timbers he had ordered for his building project at Westminster could not be found in the forests of Windsor or Cornbury.<sup>50</sup> In 1255, he learned that the forges in the Forest of Dean were "harmful to the forest because the destruction of the forest exceeds the issues of the forges,"<sup>51</sup> meaning that the fuel consumed was worth more than the iron produced. Later in the same year the king rescinded an order to sell off part of his timber in Northampton because "in process of time one trunk will fetch as much as three or four now,"<sup>52</sup> indicating that the king, or at least his councillors, were aware of a growing shortage of good timber. In 1258 and 1259 Henry III again expressed concern about the destruction of his forests and ordered that sales of timber be stopped.<sup>53</sup>

That a demand for timber and wood fuels existed is shown by the fact that, during the 1260s, a certain Peter de Neville managed to dispose of 7,000 oaks and other trees from the king's park of Ridlington at a value of 350 pounds and caused further inestimable damage to the underwood and branchwood by illegal sales or gifts.<sup>54</sup> And on

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Beresford, *The Lost Villages of England* (London, 1954), p. 201; W. B. Hoskins, *The Making of the English Landscape* (Harmondsworth, 1970), chap. 3; Titow, pp. 222-23; and Pounds, p. 241.

<sup>49</sup>Margaret L. Bazeley, "The Extent of the English Forest in the Thirteenth Century," *Transactions of the Royal Historical Society*, 4th ser., 4 (1921): 140-72; Stenton, pp. 100-122; and Hart, *The Verderers and Forest Laws of Dean*, pp. 20-24, and *Royal Forest*, pp. 7-8, 13-14.

<sup>50</sup>*Calendar of Close Rolls*, Henry III (1231-58), pp. 41, 85. By the late 12th and the early 13th centuries, imports of Baltic and Scandinavian timber were already quite common at ports such as Lynn and Boston; see E. Carus-Wilson, "The Medieval Trade of the Ports of the Wash," *Medieval Archaeology* 6-7 (1962-63): 191.

<sup>51</sup>*Calendar of Patent Rolls*, Henry III (1247-58), p. 432.

<sup>52</sup>*Ibid.*, p. 436.

<sup>53</sup>*Calendar of Close Rolls*, Henry III (1256-59), p. 345.

<sup>54</sup>See the Rutland Eyre of 1269 in Turner, ed., *Select Pleas of the Forest*, pp. 44-45.

February 12, 1290, Edward I ordered that exports of timber and wood fuels through the Cinque Ports (Hastings, Romney, Hythe, Dover, Sandwich, Winchelsea, and Rye) be suspended:

To Stephen de Penecestre, warden of the Cinque Ports. Order to cause proclamation to be made throughout his bailiwick prohibiting all persons, under pain of loss of their goods and chattels, from taking out of the realm or causing to be taken out any timber, brushwood or charcoal without the king's license, as the king learns that many men cause timber, brushwood and charcoal to be taken from Sussex and Kent to divers places by sea, whereby inestimable damage may arise to the king and the men of those parts when they need such things.<sup>55</sup>

If shortages of timber and wood fuels existed at all, they were felt most keenly, of course, where the demand was the greatest, where population was most dense. In this respect no part of England could compete with London with its 40,000 inhabitants or more by 1340.<sup>56</sup> The woodlands within easy reach of London were the first to go. Costs of transportation made the price of firewood prohibitive if it had to be carried overland for any great distance.<sup>57</sup> On the other hand, water transport was much more economical.<sup>58</sup> As firewood had to be transported over ever greater distances to reach London, the prices rose steadily. Eventually Londoners began to look for less expensive alternatives. What they found was sea coal from Newcastle, easily transported by water to London and therefore much less costly.<sup>59</sup>

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<sup>55</sup>*Calendar of Close Rolls*, Edward I (1288–96), p. 70.

<sup>56</sup>See above, n. 46.

<sup>57</sup>In the middle of the 13th century, the costs of transporting timber overland from the Forest of Dean to Gloucester or Bristol (about 15–25 miles) resulted in at least a doubling, at times even a quadrupling, of the retail price of the commodity (Hart, *Royal Forest*, p. 27). In the 16th and 17th centuries, the price of sea coal doubled for every 10 miles it was transported by land carriage (Nef, *Rise of the British Coal Industry*, 1:102).

<sup>58</sup>During the 17th century, e.g., the price of Newcastle coal at Stockton, carried 50 miles by water and loaded several times, competed successfully with coal from the Durham pits, 15–20 miles overland from Stockton; see Nef, *Rise of the British Coal Industry*, 1:102, as well as R. Smith, p. 5.

<sup>59</sup>L. F. Salzman, *Building in England down to 1540: A Documentary History* (Oxford, 1952), p. 150. The point here is not that England experienced a general wood crisis but, rather, that there were shortages and price increases in particular localities. If England's 3.7 million inhabitants had been evenly distributed over the countryside, presumably there would have been no problems. But the fact that at least 40,000 lived in London alone put a severe strain on those areas that could supply wood fuels to the city without excessive overland transport—essentially the lower Thames valley and immediately adjacent lands. Thus, if there had been plentiful supplies of wood fuels at Leicester, for example, they would nevertheless have been too far away overland to be

The peak of the expansion of arable land at the expense of woodlands and other waste in western Europe was reached by the last quarter of the 13th century, except for some scattered areas on the eastern frontier where population was less dense. In the most densely settled areas of France, western Germany, the southern Low Countries, and England, the extent of agricultural land began to decrease by the first years of the 14th century.<sup>60</sup>

The first areas to be abandoned were marginal lands capable of providing a few crops of cereals but unsuitable for continued exploitation. They became exhausted very quickly with the depletion of their meager supplies of nutrients.<sup>61</sup> And because much common land and pasture had been turned into cropland during the 12th and 13th centuries, there was less livestock per acre of cultivated land, severely curtailing the amount of manure for fertilizer.<sup>62</sup> Some of the lighter, marginal soils in the Low Countries, parts of Germany, and some areas of south Wales were so seriously eroded after being

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easily accessible to London and thus have any beneficial effect on the fuel supplies and prices there. See G. Hammersley, "The Crown Woods and Their Exploitation in the Sixteenth and Seventeenth Centuries," *Bulletin of the Institute of Historical Research* 30 (1957): 156–59, who considers the accessibility factor in relation to local shortages and rising prices of wood products in the 16th and 17th centuries. Reference should be made here to the pioneer work of J. H. von Thünen, *Der isolierte Staat in Beziehung auf Landwirtschaft und Nationalökonomie* (Rostock, 1826), and the large body of literature on the subject of location that has appeared since then. Von Thünen found that, around a given central city, different types of land use were arranged in more or less concentric circles based on "the Economic Rent accruing to each type of land use at various distances from the central city" (Michael Chisholm, *Rural Settlement and Land Use: An Essay on Location*, 2d ed. [London, 1968], p. 28). In preindustrial Europe, wood products were in constant demand for construction and fuel; because they were bulky and incurred high transportation costs, they were normally located in close proximity to the market—sandwiched between a band of horticulture and dairying very close to the city and a band of intensive cereal cultivation a little farther away (see *ibid.*, p. 27, fig. 4, and p. 28). Under the abnormal conditions pertaining to the London area, with its unprecedented population densities in the late 13th and early 14th centuries, the band of silviculture near the city was eliminated by the dual pressures of increased demands for wood products and the ability of cereal cultivation to outcompete (because of rising food prices; see Slicher van Bath, *Agrarian History of Western Europe*, pp. 116, 132) silviculture in such close proximity to the city.

<sup>60</sup>Alan R. H. Baker, "Evidence in the 'Nonarum Inquisitiones' of Contracting Arable Lands in England during the Early Fourteenth Century," *Economic History Review*, 2d ser., 19 (1966): 518–32; M. M. Postan, "Some Economic Evidence of Declining Population in the Later Middle Ages," *Economic History Review*, 2d ser., 2 (1950): 245, and "Medieval Agrarian Society in Its Prime," p. 557; Slicher van Bath, *Agrarian History of Western Europe*, pp. 133, 142; and Wilhelm Abel, *Die Wüstungen des ausgehenden Mittelalters*, 2d ed. (Stuttgart, 1955), pp. 74–75.

<sup>61</sup>Slicher van Bath, *Agrarian History of Western Europe*, p. 87; and Duby, *Rural Economy and Country Life*, p. 89.

<sup>62</sup>Slicher van Bath, *Agrarian History of Western Europe*, p. 89.

cleared that it is impossible to grow anything on them even today.<sup>63</sup> That lands of inferior quality were being cultivated is shown by the fact that the average yield per quantity of seed generally declined in Western Europe between the years 1230 and 1350.<sup>64</sup> Assarting, the extension of agricultural land at the expense of woodland, had arrived at the point of diminishing returns.

While the rate of expansion of cultivation leveled off, or even reversed, population continued to increase. Plots of arable land became so fragmented that many were no longer large enough to support those who depended on them for subsistence. On the manor of Taunton, in Somerset, the average acreage per person decreased from 3.3 in 1248 to 2.5 or less by 1311.<sup>65</sup> If it is true that an average yield of three acres of good farmland was required at that time to support one person,<sup>66</sup> then this manor was overpopulated by the early 14th century. In such a situation, the margin of security against widespread starvation became most fragile. Add to this the widespread use of lands of low fertility, and the situation becomes critical. Even under poor growing conditions, land of good quality will produce something. But dependence in part on the harvests of inferior marginal croplands meant that harvests would at best be barely adequate in the face of the pressure of overpopulation.<sup>67</sup>

The worst shortages of food occurred in 1315–17. Because of an unusually wet spring and summer in 1315, there was a very poor harvest in most of Western Europe that year. Food stores were completely inadequate, and what few reserves remained from the previous year were soon selling at highly inflated prices. By the spring of 1316, many of those unable to pay the high prices were dying of starvation. Though the harvest in 1316 was somewhat better, the starvation continued; various diseases spread through a badly weakened population, taking a heavy death toll well into 1317.<sup>68</sup> Mal-

<sup>63</sup>Ibid., pp. 142, 162. Duby, "Medieval Agriculture, 950–1500," maintains that much land was nearing exhaustion because "the food needs of the ever-increasing population had necessitated an abusive exploitation of the land" (p. 198).

<sup>64</sup>Slicher van Bath, *Agrarian History of Western Europe*, p. 136; and Duby, "Medieval Agriculture, 950–1500," p. 198.

<sup>65</sup>Titow, pp. 222–23.

<sup>66</sup>Pounds, p. 241.

<sup>67</sup>Genicot, p. 669; and Slicher van Bath, *Agrarian History of Western Europe*, pp. 134–36. In addition, see the comments of Duby, "Medieval Agriculture, 950–1500," p. 200.

<sup>68</sup>Kershaw, pp. 3–50; Curschmann, pp. 209–17; Lucas (who maintains, p. 352, that the average price for a quarter of wheat in England in 1313 was 5 shillings; by June 24, 1315, it was reportedly selling for 40 shillings per quarter); van Werveke, "La famine de l'an 1316 en Flandre"; Josiah C. Russell, "Effects of Pestilence and Plague, 1315–1385," *Comparative Studies in Society and History* 8 (1966): 466; and H. van Werveke, "Bronnenmateriaal uit de Brugse Stadsrekeningen betreffende de hongersnood

nutrition, aggravated by continued food shortages, became a common, recurring phenomenon.<sup>69</sup> Population growth slowed, and a period of stagnation followed.<sup>70</sup> The medieval boom period was over.

The Black Death of 1348–51 transformed this stagnation into a collapse that affected virtually all of Europe. A population already severely weakened by malnutrition had little chance in combating the virulence of the plague. Approximately one out of every four people died in Europe during this initial outbreak,<sup>71</sup> with some areas relatively spared and others much harder hit. Those areas with the densest populations often suffered the most.<sup>72</sup> Repeated attacks of the plague continued to force down the population tallies.<sup>73</sup> At times it would linger in an area; at other times it would lie dormant in one place and flare up in another—generally local in scope but very

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van 1316,” *Bulletin de la Commission royale d’histoire, Académie royale de Belgique* 125 (1959): 431–510.

<sup>69</sup>Van Werveke, “La famine de l’an 1316 en Flandre,” pp. 5–14; Slicher van Bath, *Agrarian History of Western Europe*, pp. 84, 87–88, 90; and Kershaw, pp. 3–50.

<sup>70</sup>Pounds, p. 239; Norman J. G. Pounds and Charles C. Roome, “Population Density in Fifteenth Century France and the Low Countries,” *Annals of the Association of American Geographers* 61 (1971): 117; and Genicot, p. 667. See also Russell, “Effects of Pestilence and Plague,” and the reply by Sylvia L. Thrupp, “Plague Effects in Medieval Europe,” *Comparative Studies in Society and History* 8 (1966): 474–83.

<sup>71</sup>Karl Helleiner, “Europas Bevölkerung und Wirtschaft im späteren Mittelalter,” *Mitteilungen des Instituts für Oesterreichische Geschichtsforschung* 62 (1954): 254–60, and “The Population of Europe from the Black Death to the Eve of the Vital Revolution,” in *The Cambridge Economic History of Europe*, vol. 4, *The Economy of Expanding Europe in the Sixteenth and Seventeenth Centuries*, ed. E. E. Rich and C. H. Wilson (Cambridge, 1967), p. 9.

<sup>72</sup>Hans van Werveke, “De Zwarte Dood in de Zuidelijke Nederlanden (1349–1351),” *Mededeelingen, Koninklijke Vlaamse Academie voor Wetenschappen, Letteren en Schone Kunsten*, klasse der letteren, vol. 12, no. 3 (1952), entire issue. On the other hand, a broad band in the Low Countries (parts of modern-day Belgium and the Netherlands, especially along the North Sea coast) was hardly struck at all. It is quite possible that the inhabitants of this area, by regularly supplementing their diets with fish containing valuable protein, were in better health and therefore less susceptible to the plague (see *ibid.*, pp. 20–23; Pounds and Roome, p. 117; and Slicher van Bath, *Agrarian History of Western Europe*, pp. 84, 89–90). Van Werveke’s exceptions for parts of the Low Countries have not gone completely unchallenged, see, e.g., P. Rogghé, “De Zwarte Dood in de Zuidelijke Nederlanden,” *Revue belge de philologie et d’histoire* 30 (1952): 834–37, and Hans van Werveke’s reply, “Nogmaals: De Zwarte Dood in de Zuidelijke Nederlanden,” *Bijdragen voor de geschiedenis der Nederlanden* 8 (1954): 251–58.

<sup>73</sup>Even the Low Countries succumbed in 1400–1401 (van Werveke, “De Zwarte Dood in de Zuidelijke Nederlanden,” p. 23). T. S. Jansma says that in 1369 the plague struck Leiden in the county of Holland (“Un document historico-démographique concernant le plat pays de Hollande [environ 1370],” in *Miscellanea medievalia in memoriam Jan Frederik Niermeyer* [Groningen, 1967], p. 335).

deadly all the same. Often, also, the plague would be aggravated by famine and dearth.<sup>74</sup>

In England, outbreaks of the plague in 1348–51, 1360–61, 1369, and 1374 reduced population totals from the preplague level of over 3.7 million to 2.25 million in 1374. The bottom was reached sometime between 1400 and 1430 at around 2.1 million, less than 60 percent of the preplague figure.<sup>75</sup> The population of London suffered as severely.<sup>76</sup>

Because of these losses in population, cultivated lands were abandoned in many areas of western Europe. It is estimated, for example, that one out of every four settlements established in Germany in the period of medieval expansion was depopulated during the Later Middle Ages.<sup>77</sup> There was a considerable contraction of the arable in England as well. Those lands least suitable for raising cereals, the marginal lands, were the first to be abandoned.<sup>78</sup> Fields, farms, and in some cases whole villages were deserted beginning in the first years of the 14th century and accelerating after the mid-century pestilence.<sup>79</sup>

Much of the land taken out of cultivation became pasture for increasing numbers of cattle and especially sheep.<sup>80</sup> But some also was

<sup>74</sup>Helleiner, "The Population of Europe from the Black Death to the Eve of the Vital Revolution," pp. 10–11; and Pounds and Roome, pp. 116–17.

<sup>75</sup>Russell, *British Medieval Population*, pp. 263, 269, and "Late Ancient and Medieval Population," p. 121. Thrupp says that there was probably no recovery until the 1470s or 1480s. Still others say that there was no real recovery until the 16th century (see Ian Blanchard, "Population Change, Enclosure, and the Early Tudor Economy," *Economic History Review*, 2d ser., 23 [1970]: 428, 435, 437).

<sup>76</sup>Russell, *British Medieval Population*, pp. 287, 297, concludes that London's population totals fell from nearly 60,000 to somewhere around 35,000 by 1377; in contrast, see Williams, pp. 315–17. For a description of the conditions for mortality in medieval London, see Sylvia L. Thrupp, *The Merchant Class of Medieval London (1300–1500)* (Chicago, 1948), pp. 201–2.

<sup>77</sup>Wilhelm Abel, "Verdorfung und Gutsbildung in Deutschland zu Beginn der Neuzeit," in *Morphogenesis of the Agrarian Cultural Landscape* (papers of the Vadstena Symposium at the Nineteenth International Geographical Congress, August 14–20, 1960), published in *Geografiska Annaler* 43 (1961): 1–3. See also Abel, *Die Wüstungen des ausgehenden Mittelalters*, throughout; Helleiner, "Europas Bevölkerung und Wirtschaft in späteren Mittelalter," pp. 262–64; and Duby, "Medieval Agriculture, 950–1500," p. 201.

<sup>78</sup>Baker, "Evidence in the 'Nonarum Inquisitiones' of Contracting Arable Lands"; Beresford, *The Lost Villages of England*, pp. 200–1; Postan, "Some Economic Evidence of Declining Population in the Later Middle Ages," pp. 245–46; Neilson, p. 61; and Duby, "Medieval Agriculture, 950–1500," p. 201.

<sup>79</sup>Hoskins, pp. 117–23; Postan, "Some Economic Evidence of Declining Population in the Later Middle Ages," pp. 227, 238–40; Beresford, *The Lost Villages of England*, p. 202; and Kershaw, pp. 29–36.

<sup>80</sup>Beresford, *The Lost Villages of England*, pp. 200–202.

allowed to grow up in brushwood and eventually timber. With the concurrent decrease in demands for building materials and fuel, the woodlands were given a chance to regenerate. It is difficult to find direct evidence for this, but it is indicated indirectly in some cases. As noted above, exports of timber and wood fuels through the Cinque Ports were banned in 1290. By 1357, however, they had resumed in one of these ports, Winchelsea, at least. On July 7, 1357, Edward III intervened in a quarrel of competing groups of merchants over which had the right to export firewood through the port. The same document noted that some shipowners, English as well as foreign, were in the habit of loading their ships with wool or hides and covering them with firewood, thus avoiding payment of the customs on the goods so concealed;<sup>81</sup> in other words, they were using firewood as a cover for smuggling operations. In the Forest of Dean in 1369, it was reported that there were "200 acres of underwood [used for firewood and charcoal] worth nothing a year for want of buyers."<sup>82</sup> More convincing evidence comes from the complaints about air pollution from the 16th and 17th centuries. Almost all of these complaints contain implied references to a previous age when firewood and charcoal, not sea coal, were burned—reference to a recent, not a distant, past, perhaps within the lifetimes of many.<sup>83</sup> The lapse in complaints concerning air pollution in London corresponded perfectly to this period, from the late 14th to the late 16th century, when England's woodlands were once again able to supply most of London's fuel needs.

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After being severely reduced by famines and plagues during the entire 14th century, the English population made only a very slow recovery in the 15th and early 16th centuries. From a low of about 2.1 million between 1400 and 1430, the numbers slowly began to increase to about 2.3 million by 1525 and nearly 2.8 million by the middle of the 16th century. Then by 1600, there was a sharp increase to a level equaling that of the early 14th century—over 3.7 million.<sup>84</sup>

Again, increased demands for wood products and new woodland

<sup>81</sup>*Calendar of Patent Rolls*, Edward III (1354–58), pp. 578–79.

<sup>82</sup>Hart, *Royal Forest*, pp. 58, 64. The eyre rolls of the Forest of Dean for 1270, in contrast, had complained about the wholesale destruction of both tall wood and underwood in the Forest (*ibid.*, p. 48).

<sup>83</sup>See, e.g., Graunt (p. 394), who maintained in 1665 that the use of sea coal was quite uncommon in London before 1600. Graunt's opinion, in particular, is valuable here. Because he was always a very careful researcher, one is inclined to believe him and not write off such a statement as an antiquarian's longing for a proverbial golden age.

<sup>84</sup>See Cornwall, p. 44, table 5, as well as the items cited in n. 75 above.

clearances for agricultural purposes began to take their toll on England's woodlands. By the second half of the 16th century, a second period of fuel and timber shortages began.<sup>85</sup> A draft of an act "prohibiting coal export" (ca. 1595) stated: "Whereas as by reason of the great scarcity, dearth, and decay of woods" in England, "the use of coals commonly called sea coal or stone coal is of late years greatly augmented not only for fuel but also to serve divers tradesmen and artificers of this our realm."<sup>86</sup> A few years earlier Parliament had passed an act "for the bringing in clapboard from the parts beyond the seas, and the restraining of transporting of winecasks, for the sparing and preserving of timber within the realm."<sup>87</sup> By 1662 the English timber supply was so depleted that the commissioners of the Royal Navy, concerned that the miserable condition of England's woods was jeopardizing the future of the Navy, asked the fledgling Royal Society for its assistance in finding ways to remedy the situation.<sup>88</sup>

This second fuel and timber crisis manifested itself in a serious inflation that can be traced in the sources. The prices of firewood increased by 780 percent between 1540 and 1640, compared with a contemporaneous 291 percent general inflation for most other commodities.<sup>89</sup> The increase in the retail price of sea coal, meanwhile, corresponded closely to the general inflation of 291 percent.<sup>90</sup> Once again Londoners began to look around them for less expensive fuels,

<sup>85</sup>Nef, "Comparison of Industrial Growth," pp. 173, 402, says that England's woodlands were suffering severely already by the reign of Henry VIII and were virtually depleted by the second decade of the reign of James II.

<sup>86</sup>Paul L. Hughes and James F. Larkin, eds., *Tudor Royal Proclamations* (New Haven, Conn., and London, 1969), 2:154.

<sup>87</sup>*Statutes of the Realm*, 35 Elizabeth I, cap. xi.

<sup>88</sup>Thomas Birch, *The History of the Royal Society of London for improving of Natural Knowledge from its first rise* (London, 1756), 1:110–20; Evelyn, 3:340; and Robert K. Merton, *Science, Technology, and Society in Seventeenth-Century England* (New York, 1970), pp. 178, 244–45. Evelyn's masterpiece, *Silva; or a Discourse of Forest-Trees . . .* (1664), was written in response to the commissioners' request. It is a careful, minute consideration of the many types of trees that grew in England, with many hints about planting and raising them. Among other things, he encouraged widespread plantings and the banishment of industries that were particularly destructive to the woods (especially iron making) to the New World colonies; see esp. secs. 1 and 2 of the introduction and chap. 30 to the end. I read the third edition of 1679.

<sup>89</sup>See the table in Nef, *Rise of the British Coal Industry*, 1:158. It is important to keep in mind once again that these shortages were most keenly felt in London and that places outside the London hinterland may well have been spared. Again, it was the cost of overland transport that made the difference. Hammersley, esp. pp. 156–59, rightly criticizes Nef for assuming a wood crisis and rise in prices in all parts of England, allowing instead only local crises much as I have tried to indicate.

<sup>90</sup>Nef, *Rise of the British Coal Industry*, 20:402–5, appendix E.

and once again they found sea coal from Newcastle.<sup>91</sup> This time, however, the change was permanent.

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My purpose has not been to undermine the arguments of those who blame modern industrialization for the deterioration in the quality of life on our planet. To do so would ignore the extent to which the pressures on our natural environment have been aggravated during the last two centuries. Rather, I have attempted to show that the present environmental crisis is much more complex than is often admitted, that it is the result of centuries of struggle by Western man to achieve dominance over his natural world, and that there is no magic date which marked the transition from a simple, pristine world to our complex, polluted world.

This implies an alternate view of the course that Western civilization has taken in the past 1,000 years. Because many of the great achievements of the Middle Ages were temporarily aborted by the effects of overpopulation, famine, and plague during the 14th and 15th centuries, historians have had great difficulty in disposing of the notion that the entire Middle Ages were nothing more than a low water mark between two highs: classical antiquity and the modern era. If, on the other hand, one thinks of the last 1,000 years of history as part of Western man's rise to ecological dominance, then the Middle Ages no longer remain such an insignificant interlude. In fact, the medieval period of land reclamation constituted one of the great turning points in the process, in spite of temporary setbacks. It was during this period that a number of new, powerful weapons were first added to Western man's arsenal, weapons that were essential to the more recent scientific, technological, and industrial revolutions. Lynn White, jr., has found that only in the Latin West were the activities that change man's relationship to his environment—manual labor and invention—considered real acts of piety. He concludes that, with the blessing of the church, medieval man invented invention.<sup>92</sup> Clarence Glacken has shown that the key to the great period of medieval European landscape change lay in man's growing awareness of his ability to alter and control nature, to create something new, and to

<sup>91</sup>This new demand for sea coal was a great stimulant to the Newcastle mining and shipping industry. Newcastle came to be "worth more to the King in customs and coals than all the revenue of Scotland by far" (*Calendar of State Papers, Domestic Series*, Charles I [1640-41], p. 50).

<sup>92</sup>Lynn White, jr., "Cultural Climates and Technological Advance in the Middle Ages," *Viator: Medieval and Renaissance Studies* 2 (1971): 171-201.

destroy. He concludes that these attitudes, largely unknown to classical civilization, have been with Western society ever since.<sup>93</sup> It is difficult to conceive of today's technological achievements and their almost complete control of the natural world without these medieval underpinnings.

Just as today's environmental crisis is the unwanted side effect of man's alteration and exploitation of his natural environment, so it was in the preindustrial era. Early air pollution in London was the unwanted result of population increase and the subsequent clearing of England's woodlands. Only scale and degree are different today. Contemporary man possesses a much greater capacity for environmental manipulation and exploitation than did his medieval ancestors, but the ecological disturbances he causes are also proportionately more severe. Perhaps it will be instructive for us to keep in mind that the one great environmental crisis caused by human abuse before our own was resolved by a population reduction of 40 percent during the 14th century.

<sup>93</sup>Glacken, pp. 288–351, esp. pp. 330–51.