



## Dark ages and dark areas: global deforestation in the deep past

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Deforestation is a major earth transforming process but knowledge of what occurred in the ‘deep’ past, before *c.* 1500, is obscure and characterized by ‘dark ages in time and dark areas in space’. Increasingly, however, modern scholarship, in a variety of disciplines, has been able to throw light on the gloom of the past, particularly in the northern, temperate world. The European Neolithic forest dwellers constituted a more stable, sedentary society and diversified economy than thought up to now, and early human impacts on forests of North America and those of the tropical world were immense. The Classical era is characterised by vastly more detail than hitherto, particularly with regard to trade and metal smelting. A plethora of studies has revealed the motivation, extent and nature of clearing during the spectacular clearing episode of the High Middle Ages. With the exception of the iron and steel industry during the Northern Song, clearing in ‘Medieval’ China remains opaque.

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### Introduction

In the history of the human transformation of the earth, one of the key processes must be deforestation. Over 40 years ago, H. C. Darby suggested that “[p]robably the most important single factor that has changed the European landscape (and many other landscapes also) is the clearing of the woodland” and he may well have been right.<sup>[1]</sup> Indeed, perhaps more of the earth’s surface has been affected by this process than by any other single resource-converting activity. And yet for all its widespread geographical and historical importance and magnitude, there is much about deforestation that is not known. It may be about as old as the human occupation of the earth itself, controlled fire being perhaps co-terminous with the emergence of *Homo erectus* some half a million years ago, but there are enormous gaps in our knowledge of where and when the process took place, and equally large problems of interpretation of evidence. Deforestation is characterised by ‘dark ages in time and dark areas in space’, especially in what may be termed the ‘deep’ past, before *c.* 1500.<sup>[2]</sup> Even today, for all the outpouring of literature on tropical deforestation, the process is surrounded by much debate, uncertainty, confusion, and even obscurity.<sup>[3]</sup> If that is true about the present then how much more so must it be about the past?

The ‘darkness’ that envelopes the ages and areas of the forest of the past consists broadly of two elements. First, there are the problems intrinsic to forests as living ecosystems or entities. Many of these are still more or less uncertain and murky. Second, there are the difficulties of knowing what human activity took place. But in recent

years there has been much work in history, archaeology, anthropology and palaeobotany that has lifted the gloom from some of the deeper recesses of space and time, particularly in Europe and the Americas. Broadly speaking for those ages examined below, the Prehistoric is illuminated by reinterpretation, the Classical by greater detail, and the Medieval by both of these together with new insights into motivation.

### Some unknowns

If there was ever a beginning to the forests of the modern world then it was after the end of the Ice Age, *c.* 10 000 years BP. However, the forest did not remain stable after that; its composition and extent altered with further climatic change, and its shifts have been investigated and plotted by palaeo-botanists.<sup>[4]</sup> But nearer to the present it is uncertain as to whether the shift in tree taxa was a totally natural response to climatic phenomena or was humanly induced. In Europe, for example, human disturbance has been significant for at least 6000 years. Forest clearing, cultivation, the cutting of tree sprouts and limbs for fodder, the localization and intensification of grazing have all had their effects on opening-up the forest canopy, and maintaining clearings. Thus, opportunities were created for the invasion by early succession forest taxa, such as fir (*Abies*), birch (*Betula*), spruce (*Picea*), and particularly the mediterranean pine (*Haploxyylon Pinus*), the deliberate propagation of food trees like walnut (*Juglans*) and the olive (*Olea*), as well as the inadvertent spread of weeds and ruderals.<sup>[5]</sup> The cumulative effect of human alteration has been so pervasive and so great that the celebrated palaeo-ecologist, Faegri, recently claimed that even in Scandinavia, often regarded as a wilderness outpost, a virgin landscape has been “a fiction” since the Neolithic. Rather it was a “cultural landscape” in which “with some small and doubtful exceptions all vegetation types were created or modified by man”.<sup>[6]</sup> The story is similar for the tropical forests.<sup>[7]</sup>

Whereas the first sedentary farmers in Europe—the neolithic agriculturalists—began significant forest clearing and established permanent settlement from roughly 4500 BC onwards, in eastern North America it was not until about 1000 AD that comparable settlements began to make a great impression on the vast continental forests, though the known impact was much earlier in southern and central America. The alteration of all types of vegetation in the Western Hemisphere—from the tropical forests of the Amazon to the temperate forests and prairies of North America—was far greater than is generally acknowledged by those who espouse the ‘pristine landscape’ idea, but overall it was probably less marked than in Europe at this time.<sup>[8]</sup>

But the forest not only diminishes with clearing, but regrows and expands with startling rapidity once human pressures are relaxed. Bearing in mind that different forests in different parts of the world respond differently, it is generally true to say that the power of the forest to regenerate is enormous, as has been demonstrated during the last century and a half in the developed world where the intensification of agriculture on the most productive land has led to the abandonment of marginal land and its recolonization by trees. In the USA, for example, abandonment began in the difficult-to-farm New England highlands from 1840 onwards, and then spread south throughout the eastern seaboard states, and was particularly noticeable in the South after the 1920s. Between 1910 and 1979 a net 60·7 million acres (24·5 million ha) were added to the forest, some of the gains being offset by new clearing in the South and the Mississippi Bottomlands. In other words, the forest grew by about 880 000 acres every year between 1910 and 1979.<sup>[9]</sup> The same trends are noticeable in Europe in this century. This

phenomenon has led some research workers to talk of a 'forest transition' related to general economic development.<sup>[10]</sup>

In the past, plague and war have had a similarly marked effect in *enlarging* forest extent. For example, during the Black Death between 1347 and 1353, the European population probably fell from about 73.5 to 50 million (*c.* 33 per cent).<sup>[11]</sup> Between a fifth and a quarter of all settlements were abandoned across Europe and, as studies of southern German lands show, the forest advanced.<sup>[12]</sup> Major European conflicts have also reduced population causing land abandonment and forest regrowth, notably the Hundred Years War (1337–1453), the Hussite wars in Bohemia (1419–36), and the devastating Thirty Years War with a veritable holocaust in central Europe between 1618 and 1648.<sup>[13]</sup> In the Americas, the introduction of pathogens after 1492 led to a demographic collapse from at least 53.9 million in 1492 to only 5.6 million in 1650, an 89 per cent fall.<sup>[14]</sup> Land abandonment was widespread and the forest increased in extent and density so that by 1750 America was probably more forested than it had been in 1492, and "there was much more 'forest primeval' in 1850 than in 1650". Like Faegri in Scandinavia, Denevan concludes that in the Americas "the pristine image of 1492 seems to be a myth".<sup>[15]</sup>

But the universality of the 'less-people-equals-more-forest' relationship is thrown into some doubt by recent work in the west African woodland-savanna belt. In the Kissidougou area of Guinee, it would seem that history has been read backwards. Rather than decreasing forest coverage, increasing human numbers and more intensive agriculture and tree cultivation have led to the enriching of the open savannas with more woody vegetation and an expansion of forest 'islands' by between 41 and 500 per cent from 1952 to 1992. The forest 'islands' are not remnants of previously larger forest but new forested areas created by humans in ostensibly non-forest environments. This conclusion may well have wider applicability throughout similar zones in Africa, and even Latin America.<sup>[16]</sup>

At least two major questions bedevil our knowledge of change. The first and basic question is 'what is a forest?' The definition varies locationally and culturally and most writers fudge this question and merely make a distinction between open and closed forests that corresponds to our intuitive experience of forest environments.<sup>[17]</sup> Because the distinction between open and closed forests is itself highly problematic, both categories are difficult to map. Between 1923 and 1985, 26 different calculations of the global forest area have been advanced ranging from 60.5 million km<sup>2</sup> to 23.9 million km<sup>2</sup>, a difference that has little to do with natural (or human) change and more to do with ignorance and differing interpretations.<sup>[18]</sup> A second question is at what point does human interference by cutting, fire, grazing or even tree management become deforestation in the commonly accepted (and culturally constructed) meaning of the word? Undoubtedly, large areas of the Brazilian *cerrado*, the eastern North American prairies, or the African savannas, for example, are humanly degraded forest ecosystems, and are now commonly described as woodlands, though as we have already noted, the dynamics of the forest/savanna boundary and the role of humans as agents of change are more complicated than once thought.<sup>[19]</sup>

The attraction of forested environments is not difficult to understand; their uses and products are numerous and basic to human existence. Moreover, in most societies clearing has been regarded as the natural and laudable thing to do, the first step on the ladder of improvement. Clearing requires no sophisticated technology. Humans with stone or flint axes need only boundless energy to fell trees.<sup>[20]</sup> By contrast, fire and browsing animals can wreak havoc in forested areas with little effort.<sup>[21]</sup> The substitution of metal for stone axes *c.* 3500 years ago and the invention of saws in the Medieval

period eased the backbreaking task of clearing and accelerated the rate of change but they did not alter the basic process of destruction and land-use transformation which was still a combination of human “sweat, skill, and strength”.<sup>[22]</sup> But because clearing has been incidental to growing crops and because in most cases it is the result of one person’s effort, or at most that of a family, it is unrecorded, piece-meal, incremental, though in total, massive.

### Prehistoric clearing

While the concept of ‘prehistoric’ is difficult to define outside of Europe, the term is used here to denote a largely pre-literate age that corresponds to pre-history. What is certain is that the evidence of clearing becomes increasingly evident with the imperceptible but nonetheless steady increase and spread of people during the Holocene. In Europe, the prevailing paradigm has been that indigenous, primitive hunter-gathering Mesolithic cultures from *c.* 8000 to 5000 BC have been regarded as the primitive forerunners of the Palaeolithic<sup>[23]</sup> who were engulfed by successive waves of Neolithic proto-agriculturalists sweeping across central Europe from the Near East in a great colonizing wave.<sup>[24]</sup> The primary Neolithics were labelled ‘primitive agriculturalists’ and therefore must have practised ‘primitive agriculture’ based on slash-and-burn clearing which periodically exhausted the soil but provided the momentum for the overall movement.<sup>[25]</sup> The general hypothesis was supported by Grahame Clark in the early 1950s who stated categorically that amongst the earliest farmers there could be

no question of initiating systematic, permanent clearance and the formation of settled fields. Their approach was tentative and their agriculture extensive. Patches of forest would have been cleared, sown, cropped, and after a season or two allowed to revert to the wild, while the farmers took in a new tract.<sup>[26]</sup>

Pollen profiles interbedded with charcoal from Denmark, part of the classic *landnam* example, and the later vogue of the Boserupian thesis of intensification of agrarian systems with population pressure, seemed to verify the hypothesis factually and intellectually.<sup>[27]</sup>

The truth, as is usually the case, is much more complex, and has profound implications for our understanding of forest clearing. First, Mesolithic culture was more sophisticated and of greater significance for forest clearing than was once thought.<sup>[28]</sup> For example, animals other than the dog were probably domesticated in continental Europe, while in Britain there is evidence of cultivation, clearing and use of fire for game hunting. The tree line in the upland fringes of the Pennines, North York Moors and Dartmoor is consistently below the altitude at which climatically it was possible for trees to grow. In places, evidence of successive clearings is accompanied by the presence of pollens of light-demanding plants such as sorrel and ribwort plantain which could only flourish as a result of clearing.<sup>[29]</sup>

Second, Neolithic agriculture and settlement had far more spatial and chronological diversity than once thought. In particular, settlement and agriculture were stable in many locations. The significance of the timbered long houses found throughout Europe has been ignored yet archaeological excavations during the 1970s showed that some had been occupied for many hundreds of years which makes the universal slash-and-burn hypothesis unlikely.<sup>[30]</sup> The current view is that the Neolithics sought out gently shelving sites on the floodplain–lower interfluvial slope zone and that settlements were strung out parallel to streams in lower parts of the catchment. Loessic soils were usually favoured because of their fertility but they were often heavily covered with timber.<sup>[31]</sup>

Trees were chopped down by flint and polished stone axes and the flood plains were used for intensive garden cultivation and meadows. Neolithic settlements would have been entirely recognizable to the modern European farming eye.

Third, there is evidence that crop yields, particularly of cereals, were sustained for long periods on these soils, and that shortfalls in diet were made up by a greater reliance on stock than has hitherto been thought possible. In particular, cattle supplied meat, blood, milk and cheese, but sheep were also present, as were some pigs. Dairy products were particularly important and constituted what Sherratt has called the “secondary products revolution”; milking being “an advantageous way of using the rich pasture grasses that would have colonized abandoned fields”.<sup>[32]</sup> But when the reproductive dynamics of domesticated herds and livestock generally are considered in detail the true significance of Neolithic pastoralism becomes evident. Quite large numbers were needed to make it economically feasible to extract milk and meat produce. Herds of between 10 and 20 are too small; 30 to 50 head are more realistic.<sup>[33]</sup>

Put together, then, the evidence for Neolithic occupation over some 3000 years suggests a stable, sedentary society and a diversified economy which must have made intensive use of the predominant deciduous forest cover and its resources. Gregg has simulated nutritional requirements and optimal farming strategies to arrive at the needs and management of risks in a hypothetical village settlement in central Europe. In her model, woodland is placed in a prime position. A typical six-household, 30-person settlement would have needed to plant 13.2 ha of wheat and run a 40-head herd of cattle with 40 sheep or goats (Figure 1). The settlement would require 4.5 ha for houses, outbuildings and garden plots, a woodlot of 52.8 ha with a further 4.8 ha for timber for construction purposes. The livestock would require 18.18 ha of pasture land (perhaps cleared forest), 19.66 ha of natural meadows and 2.56 km<sup>2</sup> for forest browse which could be doubled to guard against over-grazing the forest resource in a locationally fixed settlement. Thus, each group of 30 persons needed a little over 6 km<sup>2</sup> of woodland to survive, a staggering 20 ha per person.<sup>[34]</sup>

Undoubtedly, large areas of forests were cleared with flint and stone axes which modern experiments show were capable of being used for forest felling.<sup>[35]</sup> Burning and animal grazing, if intensive enough, would have thinned and ultimately eliminated forest in other areas. The process continued unabated during the late Neolithic to early Bronze ages (*c.* 3000 to 1000 BC). Charcoal layers and successive decreases in forest pollens, followed by increases in cereal and weed pollens in peat deposits, together with interbedded farming and clearing implements, leave one in no doubt about the sequence of events.

The evidence for similar processes of early forest disturbance with clearing are beginning to unfold for other parts of the world. With the exception of the long settled savanna-woodland and adjacent belts in west Africa, knowledge about deforestation in Africa in the ‘deep’ past is sparse. Indeed, the process may not have happened on a scale sufficient to be recorded. In South America, however, burnings, swiddens, and manipulation of trees in the rainforest of equatorial upland areas may date from at least the early Holocene and Uhl goes so far as to say “[i]n much of the Amazon it is difficult not to find soils studded with charcoal”.<sup>[36]</sup> Of course, the charcoal could be due to natural lightning strikes but as these are usually accompanied by abundant rain in tropical areas then Indian fires must account for most fires in prehistory.<sup>[37]</sup> Indeed, ethnobotanists like Posey, Balée, and Roosevelt now suggest that much of the Amazonian forest is a cultural artefact as native peoples have developed successive resource management strategies to cope with fluctuations in population dynamics.<sup>[38]</sup> Similar arguments can be made for the Maya lowlands and other parts of tropical

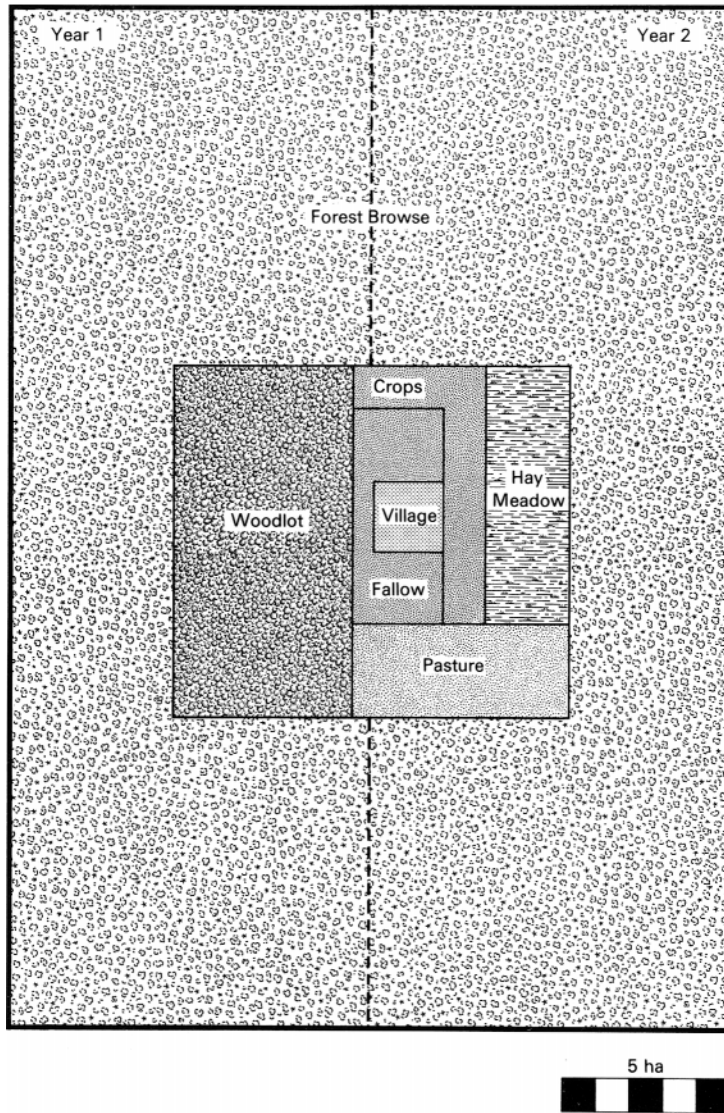


Figure 1. A hypothetical Neolithic village settlement in the European forest and its timber needs. Source: S. Gregg, *Foragers and Farmers: Population Interaction and Agricultural Expansion in Prehistoric Europe* (Chicago 1988) 165.

central America. “There are no virgin tropical forests today”, it has been claimed, “nor were there in 1492”.<sup>[39]</sup> In temperate North America the impact of the native Americans on forest vegetation is being revealed by an abundance of archaeological and palaeobotanical evidence which more than supports the vivid descriptions of indigenous clearing and agriculture in sixteenth and seventeenth-century travel accounts.<sup>[40]</sup> From at least 12 000 BP the aboriginal population occupied the rich bottom lands of the many river systems of the continent, and even more than the European Neolithics, they never abandoned hunting and gathering. Progressive clearing of the forests on the flood plains and lower terraces, and the intensification of cropping gradually converted the

landscape into “a mosaic consisting of permanent Indian settlements and cultivated fields, early successional forests invading abandoned Indian old fields, and remains of the original deciduous forest in the uplands”.<sup>[41]</sup> By AD 1000, the Indians of the Woodland Culture were colonizing the eastern woodlands, where the composition of the forest and the climatic regime made fire a much more potent force than in Europe.<sup>[42]</sup> Benjamin Hawkins’s 1798 description of the density and complexity of clearings, fields and villages in the forests as he crossed and recrossed the numerous Creek settlements along the Tallapoosa and adjacent rivers in Georgia is probably a reasonably accurate analogue of earlier conditions and represented the culmination of a near millennia of clearing.<sup>[43]</sup>

Whether in Europe, Africa, Asia or the Americas, the record is clear: the axe, together with dibble-and-hoe cultivation and later the light plough, often integrated with pastoral activity in Old World situations, reduced the extent of the forest and altered its composition. Fire was particularly destructive in the process. Delcourt has suggested that early humans produced four major changes:<sup>[44]</sup>

1. The increased frequency and magnitude of disturbance resulted in the expansion of non-forested patches or clearing.
2. The increasingly sedentary life style, the development of territorial control, and the high energy investment in the cultivation of crops resulted in a new sort of disturbance in which large areas were kept in the early stages of succession, which allowed the invasion of subsequent weed populations.
3. The selective utilization of plants by humans and animals resulted in long-term changes in the dominant tree structures within forest communities.
4. There were substantial changes in the distributional limits of certain species.

As the evidence is reinterpreted it seems that the impact of early humans on the forests was greater than suspected, and greater than many would care to admit. Consequently, whereas environmental determinism was once the favoured theoretical explanatory framework used to explain change in the forest, today the dominant explanatory model is historical.<sup>[45]</sup> As a result, the opacity of the past is becoming more comprehensible.

### **Clearing in the Classical world**

Although the changes that occurred during the conventionally labelled ‘classical’ period overlap with the prehistorical, they were extensive and distinctive enough to be separated. From about 3000 BP to the end of the Dark Ages, increasing population, burgeoning urbanization, mineral extraction, and trade by different cultures and civilizations throughout the Mediterranean basin, but particularly on its northern rim, brought enormous changes in forest vegetation.<sup>[46]</sup> Perhaps a more important distinguishing feature is the fact that we do not have to rely on archaeology or the inferences drawn from pollen diagrams to understand what was happening to the forests. Instead, we can turn to the pages of, for example, Homer, Strabo, Theophrastus, Cicero, Varro, Columella or Pliny. This was an intensely literate world in which, for the first time, people recorded what they saw, did to, and thought of their external world, though it is difficult at times to know if some of the examples are to be taken on face value or as literary tropes. What is certain, however, is that humans were conscious of their power to control and even ‘create’ nature. In the words of Sophocles, through their inventions and energy they had become “clever beyond all dreams”.<sup>[47]</sup>

The detail of forest use becomes more plentiful, and suffice it to say that clearing either to grow food or for grazing was the primary cause of change, followed in

some uncertain order by domestic fuel procurement, ship-building and metal-smelting. Tantalizingly, the detail of each process comes in roughly a reverse order to its importance. Thus, as ever, clearing for food growing gets little mention as it is subsumed into the larger practice of agriculture. On the other hand, metal-smelting looms disproportionately large because of the intense local impact, as at Rio Tinto, Populonia, Laurion, or Cyprus, although it is doubtful if it was anything like as devastating in aggregate as it is commonly made out.

Nonetheless, clearing was common enough for Homer in the ninth century BC to find a ready comparison between the noise of battle and “a crashing sound where woodmen fell the trees” in “mountain dells”, though whether this was cutting for agriculture alone is doubtful. And in later centuries the image of the industrious ploughman who “subdues his woodland with flames and plough” and who “carted off the timber he has felled” was common enough. But on the large estates clearing was done by slaves and the heroic nature of the task of the individual proprietor was replaced by routine of servile, forced labour.<sup>[48]</sup> More explicit was the comment of the first century BC Roman writer Lucretius that “day by day they [the agriculturalists] would constrain the woods more and more to reside up the mountains” until only the most inaccessible mountain areas remained wooded.<sup>[49]</sup> Later, Strabo commented on the clearing of the forests of Avernian in Campania which had been “brought by the toil of man into cultivation, though in former times they were thickly covered with a wild and untrodden forest of large trees”. The vast Ciminian forest of southern Tuscany, which Livy described at the turn of millennium BC/AD as “more impassable and appalling” than the forests of Germany, had been vastly diminished two centuries later. It also seems likely that the forests of the plain of the Po were felled systematically during the second and first centuries BC as part of the ‘Romanization’ of the Celtic Cisalpina, and the creation of large estates within a framework of extensive centuriation.<sup>[50]</sup> But these references are few, and there is more abundant evidence about felling to smelt metal or to produce fuelwood for domestic use and baths<sup>[51]</sup> or to service the general timber trade to imperial Rome and other cities.<sup>[52]</sup> The demands of war, and particularly through the shipbuilding of Venetian and Arab traders during the seventh to eleventh centuries AD, has been analysed in precise detail by Lombard.<sup>[53]</sup>

Thus, although evidence of forest clearing is patchy, a general picture emerges of considerable change, especially when other environmental consequences of clearing, such as soil erosion, are taken into account. Compared to the deciduous forests of northern Europe the evergreen forests were easier to clear, but their regeneration was more difficult because of the marked seasonality of the regional climate, combined with the prevalence of fire and overgrazing by stock, particularly goats. The result was the succession of an inferior woodland—garrigue or marquis—which in turn could be degraded to poor pasture.<sup>[54]</sup> Ultimately massive erosion with associated deposition in virtually tideless coastal locations led to the widespread onset of malaria from as early as the fourth century BC. In an almost contemporaneous observation, Plato noted the disappearance of the forests of Attica (though he may well have been referring to a long gone period) and commented: “What now remains compared with what existed is like the skeleton of a sick man, all the fat and soft earth having been wasted away and only the bare framework of the land being left”. No wonder later Italian writers were to talk of the *polpa* and *ossia* of the land—the flesh and bones. Centuries of overgrazing and clearing which were to continue during the Medieval period made the contrast clear.<sup>[55]</sup>

It is possible that continued clearing and subsequent erosion weakened the economic basis of these predominantly agrarian societies, and may well have been a contributory,



though by no means deciding, factor in their declining power by the fifth century. One can agree with Osborn that the history of deforestation in the Ancient world and its consequences “assumes the character of a prologue to modern times. Assuredly there is an affinity between *then* and *now*”. But the caution remains not to over-state that forest devastation which, with a few exceptions, furnished the timber needs of the time and also those well into the early Renaissance period, as evidenced when Venice, Genoa, and Catalonia launched great fleets built from abundant, though diminishing, forests.<sup>[56]</sup> It is likely that the ultimate denudation of the Mediterranean world was the product of the population pressures of the last century and a half.<sup>[57]</sup>

### Clearing in the Middle Ages

The Middle Ages, particularly in Europe, but also in China, encapsulated an active and energetic world in which humankind began to make conscious and purposeful decisions about land use and population densities. In that surge of activity the forest and its multiple riches played a central part.

#### *Europe*

The extent of the forests in Europe are not known for certain but Higouinet’s reconstruction of major core areas of ‘forest’ land on the eve of *les grands défrichements* of the eleventh to the thirteenth centuries (Figure 2)—a study which he described disarmingly as a mere *esquisse*, or sketch—is less a useful summing-up of his research than a starting point for further work. His map greatly exaggerates the ‘forest’ area in the British Isles, for example.<sup>[58]</sup> As with the Ancient world, caution needs to be exercised in our generalizations. The areas are not necessarily areas of woodland or forest; as Wickham reminds us “there were plenty of trees outside the forest system, as there were clearings inside” and it is more likely that they outline areas of proprietorial, political and juridical power, especially those held by royalty and the nobility, and were related to hunting.<sup>[59]</sup>

The modification of the European forest environment had several distinctive features that have few counterparts in any other age. There was an intricate interplay between “ideas, ideals, and practical needs” which formed a ‘cultural climate’ for change.<sup>[60]</sup> Some of the elements of this ‘cultural climate’ have emerged with greater clarity in recent years. A belief in the divine role of creating something new was coupled with a vast empirical knowledge of, and interest in, how to modify the landscape which had been handed down from at least Roman times and which was augmented by a series of significant and interrelated technological developments. A belief in a divine, designed earth, in which nature was likened to a book revealing the magnificence of God, was shared with a need to understand and use nature for practical ends. These encompassed clearing, draining, domesticating and fertilizing. It was, said Glacken, “a chain from theology to manuring”. For Lynn White, the transition was more ominous; it was one that moved from man being a part of nature to man being her exploiter. Christianity and its doctrine of territorial domination were the root cause of this new coercive attitude to natural resources. By the ninth century, “Man and nature are now two things, and man is master”. It was the origin of the West’s environmental dilemma.<sup>[61]</sup>

Whatever the truth, the upshot was that vast areas of forest land were settled for the first time; settlement in existing areas was intensified; and the visual landscape was changed as trees were replaced by grass, crops, and farms. In fact, the clearing of the forest by individuals and great domains, both lay and ecclesiastical, and the cultivation

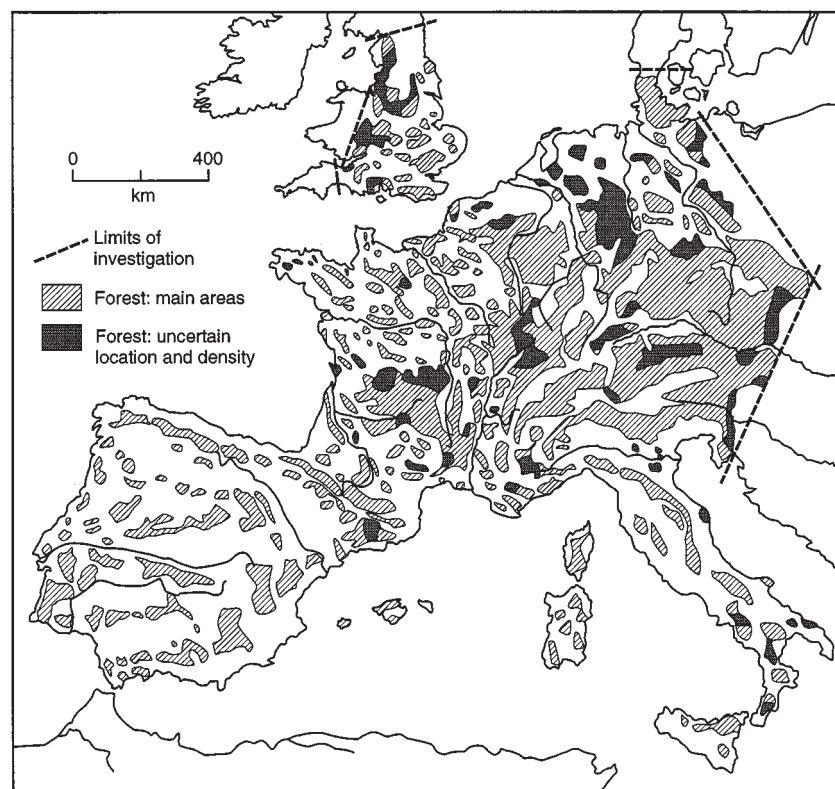


Figure 2. A reconstruction of the major forest areas of Europe on the eve of *les grands défrichements* of the eleventh to thirteenth centuries. Source: C. Higounet, *Les forêts de L'Europe occidentale du V<sup>e</sup> au XI<sup>e</sup> siècle*, in *Agricultura e mondo rurale in Occidente nell'alto medioevo: Settimane di studio del Centro italiano di studi sull'alto medioevo*, Vol. 13 (1966) 398.

of the waste over much of western and central Europe, was one of the most dramatic changes made to human landscapes anywhere up to that time, and “one of the greatest creative achievements of Medieval man”.<sup>[62]</sup> Within that general climate for change several driving forces seem clear. A well-established feature of the age was the tremendous growth of population between the two ‘low’ points: the dissolution of the Roman empire following the ‘barbarian’ invasions and the Black Death. Between about 650 and 1350 population increased six-fold to reach a level, and an achievement, in the early thirteenth century not to be equalled for another two hundred years.<sup>[63]</sup> Population impact on the forest was broadly two-fold, and roughly sequential. First, increasing densities during the early centuries resulted in the colonization of what Lewis has called the ‘internal frontier’ in the European heartland of northern Italy, France, western Germany, the Low Countries, and south-east England.<sup>[64]</sup> In these long-occupied areas, the previously unsettled and lightly settled lands were transformed by reclamation through draining, but above all by forest clearing, and land-use intensity was increased. Second, the outward expansion of the ‘external frontier’ occurred so that new lands were incorporated into the European heartland. Sometimes the two ‘frontiers’ were coincident and coterminous, such as in the massive Germanic colonization of the sparsely populated Slavic lands of central and eastern Europe from the tenth to twelfth centuries.<sup>[65]</sup>

Faced with an increasing size and density of population the Medieval agriculturalist needed to increase food production. As the existing intensity of land use was relatively light one obvious way to do this was to shorten the fallow period, either during cropping or in grazing rotations, a strategy which, according to Boserup, would be likely to occur when population densities reached about 30 per km<sup>2</sup> as it had in a few localities by that time.<sup>[66]</sup> Eventually a point would be reached when the percentage of arable land at any one time was higher than that not under the plough and production would shift from pastoral to arable. The disadvantage of this shift was that labour investment (the only spare technology available) increased substantially to compensate for the loss of fertility gained through fallowing. Therefore, that fallow-shortening appears to have been undertaken suggests that the increase in population was a compelling reason for the changes. In the complex and dynamic interplay between land and labour, population growth was the cause of technological change (and hence terrestrial transformation) rather than the reverse, though there is considerable debate about this.<sup>[67]</sup>

During the period of predominantly 'internal colonization' from about 650 to 950, three broadly technological innovations were of profound significance. First, the dominant two-field system of early agriculture, each field cultivated alternately, was gradually replaced by a three-field system. The fallow period was thus shortened, labour requirements were more evenly spread, and new crops, such as oats and legumes on summer fields, could be planted in addition to wheat and rye on winter fields, thus reducing the incidence of famine. The new system appeared in the ecclesiastical lands of north-east France during the ninth century and spread throughout much of north-west Europe. Declining fertility levels, however, still remained a major problem.<sup>[68]</sup> Second, the continual expansion of colonists into forest lands took them out of the areas of lighter soils that could be scratched open with the *ard*, to the heavier, moist (and usually heavily wooded) soils that were potentially more productive, but more difficult to cultivate.<sup>[69]</sup> Until the adaption of the wheeled plough with a coulter to cut the soil vertically, a ploughshare to slice it horizontally, and a mouldboard to turn over the resultant furrow slice, these soils were rarely used. The new plough was a symptom of expansion and a powerful piece of new technology. Third, the impact of the plough was increased by the inventions of the rigid collar and of nailed horseshoes which preserved hooves in wet soils, both of which appeared a little after the ninth century. Both favoured the horse over the ox, and increased speed and pulling power. Fourth, there may have also even been an improved felling axe.

While the prime engine of change was the growth of population and the reduction of famine, aided by technological innovations, undoubtedly other factors played a part. The close links between Medieval European religious motivation and land reclamation, particularly land clearing, already mentioned, need to be stressed. There was a deep belief in the human ability to transform the earth, and the monastic orders of the Benedictines, Carthusians, and particularly the Cistercians, who had 750 foundations by the fifteenth century, were the 'shock troops' of clearing.<sup>[70]</sup> They often sought solitude in the wilderness and extolled the virtues of physical labour. Piety was an accompaniment of improving zeal, and the creation of new landscapes fit for Christian settlement gave a just reward for that devotion. It is also becoming increasingly clear that there was an extension of territorial organization as local lay (as well as ecclesiastical) rulers consolidated political control for reasons of defense and personal gain. Gradually they assumed the right to dispose of waste land like any monarch. Thus the colonization of new lands and a reduction of the unsettled area

took place with the active connivance of the territorial princes of France, the Low Counties, and Germany, who proceeded to allot the wilderness under their control to groups of colonists who agreed to bring it into the realm of human affairs.<sup>[71]</sup>

But the significance of this trend was greater than territorial aggrandizement alone. The interest of these rulers was quite the opposite of that of the manorial landlords who wished to keep peasants confined to traditional areas of settlement in order to supervise them and garner greater rents. Now, colonizers were offered generous terms, which included ownership and disposal of land, personal freedom, and often no restrictive requirement to clear-cut and grub out the stumps, which enabling girdling, burning and rapid occupation to take place. Thus, more land meant greater opportunity for advancement and freedom, and land reclamation contributed in a general way to the emancipation of the common man. In addition, with the fairly widespread adoption of primogeniture, outlets had to be found for younger sons, and in this way “clearing represented for the peasants what the Crusades and wars of conquest were for the nobles”.<sup>[72]</sup> There is some evidence, too, that low population densities on the Medieval frontier resulted in younger marriages and larger families. Historical analogies are often dangerous, but in these characteristics at least, the Medieval frontier of the tenth to twelfth centuries was similar to the Neo-European frontier of the seventeenth to nineteenth centuries, and bears no small resemblance to the frontier facing the landless peasant in the tropical rainforest frontier at the present day. The forest was then, as it is now, in the words of a Scandinavian proverb “the mantle of the poor”, and its exploitation and destruction was a means of survival and advancement.

As a result of all these forces village fields were expanded at the expense of the surrounding ‘waste’ that lay within the village territory, which was sometimes swamp and marshland, but more usually woodland. The woodland was a valuable resource, sometimes cultivated on an infield/outfield system, usually grazed, and the source of fuel, wild produce, game and fowl. Bush fallows in the surrounding woods were intensified, aided by periodic burning and heavier grazing, which degraded the stand and which might eventually become cleared farmland. In the sixth century it is calculated that fields accounted for less than five per cent of land use; by the later Middle Ages the figure could have been 30 and 40 per cent.<sup>[73]</sup> By implication, woodland must have accounted for a large proportion of the remaining land. Beyond the village territory lay the true wilderness of unbroken forest (*silva*) which was eventually colonized.

With plough and new field systems absorbed within its economic life Europe now entered into its era of spectacular expansion into the largely unsettled forests on its ‘external frontier’ from the end of the tenth century. It is impossible to summarize the sometimes mind-numbing local detail about the nature and history of deforestation in Europe, particularly during the eleventh to thirteenth centuries—“l’âge des grands défrichements”—that led to so much clearing in the cold deciduous forests. That is done more than adequately by others.<sup>[74]</sup> Place names indicative of clearing attest to the universal nature of the process, but the documentary evidence of the colonization of German peoples as they expanded east is by far the most impressive. From roughly 900 to 1200, organized colonization under lay and ecclesiastical lords, often under generous terms, changed the map of the heart of central Europe, culturally and physically. One great thrust was across the northern German plain into Silesia and Mecklenburg, Pomerania and Brandenburg along the Baltic fringe; the other was roughly south east, across the Alps and Sudeten Mountains, down the Danube to create Austria and to leave many isolated pockets of German settlement well into Bohemia, Hungary and Transylvania. In addition, Slavonic landlords were not slow to

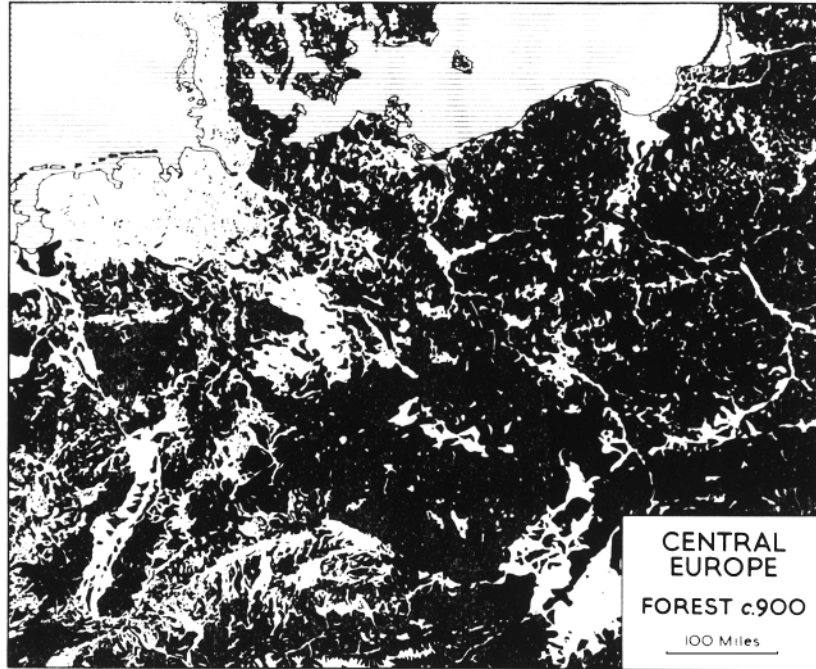


Figure 3. The extent of forest in central Europe, AD 900. Source: H. C. Darby, The clearing of the woodland in Europe, in W. L. Thomas (Ed.), *Man's Role in Changing the Face of the Earth* (Chicago 1956) 98–9, based on O. Schlüter, *Die Siedlungsräume Mitteleuropas in frugeschichtlicher Zeit: Part 1—Forschungen zur Deutschen Landeskunde*, Vol. 61 (Hamburg 1952). Reproduced with the permission of Chicago University Press.

do the same and encouraged peasants to clear throughout Bohemia and Moravia. Schlüter's massive work on changes in forest cover in north central Europe during the millennium between c. 900 and 1900 based on botanical, soil, pollen, documentary and place name evidence, and his (perhaps over-optimistically exact) maps, summarize the whole process of transformation perhaps better than words (Figures 3 and 4).<sup>[75]</sup>

By the end of the twelfth century, the reduction in forest cover and forest jurisdiction, coupled with the increased desire of the nobility for greater territorial control, led to redoubled efforts on their part to reserve forests as hunting grounds. Inevitably, this ran into the opposition of the peasantry who had always gathered fuel, grazed stock, hunted game, or increased the amount of cultivable land in the forest. Consequently, a body of custom, usage and rights grew up either to govern the use of this valuable common resource or to prohibit the use of its many products.<sup>[76]</sup> It was a measure of the increasing scarcity of forest.

Whatever the true causes of deforestation during this era the elements interlocked neatly to produce what White has labelled “the agricultural revolution of the Middle Ages” which shifted the focus of Europe from the south to the north, from the restricted lowlands around the Mediterranean to the great forested plains drained by the Loire, Seine, Rhine, Elbe, Danube and Thames.<sup>[77]</sup> Here the distinctive features of the Medieval world developed—a build-up of technological competence, self-confidence, and accelerated change—which, after 1500, enabled Europe “to invade the rest of the world, conquering, looting, trading and colonizing”.<sup>[78]</sup> In that long process of global expansion the forest and the wealth released from it played a central part.

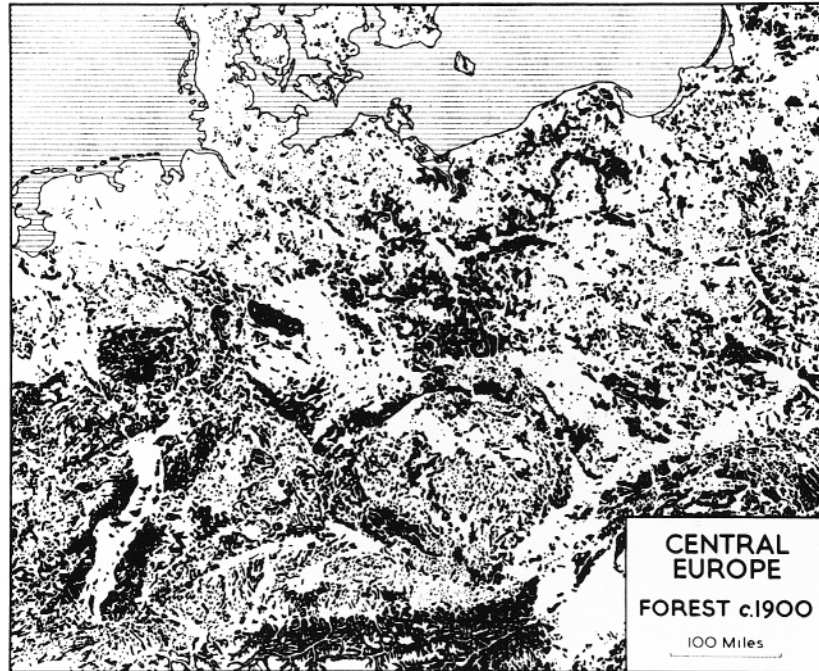


Figure 4. The extent of forest in central Europe, AD 1900. Source: H. C. Darby, The clearing of the woodland in Europe, in W. L. Thomas (Ed.), *Man's Role in Changing the Face of the Earth* (Chicago 1956) 98–9, based on O. Schlüter, *Die Siedlungsräume Mitteleuropas in frugeschichtlicher Zeit: Part 1—Forschungen zur Deutschen Landeskunde*, Vol. 61 (Hamburg 1952). Reproduced with the permission of Chicago University Press.

### China

The comparison between Europe and China, where change to the forests must have happened throughout all these three ages, cannot be more stark. Before the beginning of the Ming dynasty in 1368, the story is truly ‘dark’, and is almost wholly confined to the musings of the third century BC philosopher Mencius on the lopping of trees for fuel around cities, the destructive grazing of animals, and the resultant bare nature of mountains.<sup>[79]</sup> The sparsity of information prompted a leading scholar on deforestation to conclude that the information gap is “of a different order from that for other areas”, making China a land of “ponderous unknowns”.<sup>[80]</sup> There is a paucity of information on status, property rights, individual wealth, and duties of individuals and even of classes, but an abundance on the working of bureaucratic government, government agricultural policies, fiscal reforms and development plans. Thus, material for a ‘bottom-up’ approach is missing, and it is unlikely that sinologists “will ever be able to produce regional studies or monographs of a depth or quality to match those written on Europe”,<sup>[81]</sup> a comment that is borne out by the most recent work on Chinese forests.<sup>[82]</sup>

As ever, the detail of clearing for agriculture is murky, but the demands of industry have some firmness. In particular, the development of a flourishing iron and steel industry in the Shantung region in north-east China during the Northern Sung (AD 910 and 1126), and the early substitution of coal for charcoal suggests not only precocious technological development but widespread devastation and shortages of fuel. Towards the end of the Sung dynasty (AD 1078), production was about 125 000 to 150 000 tons,

which compares favourably with the total West European production (including European Russia) of 145 000 to 180 000 tons at the beginning of the eighteenth century, and was a figure only just surpassed in England and Wales in 1796. By 1300, the northern Sung production had declined by a half, whether through exhaustion of fuel, the Mongol invasions, or some other factor, is not known.<sup>[83]</sup> It is not until the planned imperial expansion of settlement into the forested hill country of Hunan and other parts of southern China during the late seventeenth century that we even begin to penetrate the darkness that surrounds agricultural clearing in this vast country.<sup>[84]</sup>

### Conclusion

Bit by bit the darkness of the 'deep' past is being penetrated by the light of patient, cumulative scholarship to reveal the motivation, reasons, and extent of the destruction of the earth's forest mantle. Bearing in mind all the qualifications over definition, measurement and regrowth characteristics of different forest types in different cultures and environments then according to Matthews, a climatic modeller, the pre-agricultural closed forest probably once covered 46.28 million km<sup>2</sup>, and more open woodland 15.23 million km<sup>2</sup>, and these have been reduced by 7.01 million km<sup>2</sup> and 2.13 million km<sup>2</sup>, respectively. Other evidence based on historical reconstructions of clearing supports the general magnitude of change as being between approximately 8.05 million km<sup>2</sup> and 7.44 million km<sup>2</sup>.<sup>[85]</sup> We will never know how and when all these areas were cleared, but the global reduction of between 7 and 8 million km<sup>2</sup> of closed forest, and between 2 and 3 million km<sup>2</sup> of open woodland and shrubland goes a long way to support Darby's contention that deforestation is an important, if not the major, process of change in many of the landscape of the world.

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### Notes

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