

Chapter 2

Forests in Landscapes – The Myth of Untouched Wilderness

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Landscapes can be considered as the cradle of culture, but culture has also formed these landscapes

(Nassauer 1995)

In the cultural landscapes of Europe, forests are often regarded as the last wild places and vestiges of untouched nature. However, forests have been affected by human activity from the early beginning of human settlement. In fact, the availability of forests and their products has been an essential precondition for the development of human culture and civilization. One of the most important transitions in human history is the change from hunter-gatherer cultures to the early agricultural activities of Neolithic people (Edwards 1988). This change in human culture is closely related to an increasing exploitation of forests, and while agriculture marks the rise of modern civilization, it was often the overuse of forests that contributed to the downfall of cultures (e.g., Thirgood 1981). Hence, many regions of Europe have repeatedly been subject to deforestation, abandonment and afforestation (Behre 1988). Russell (1997) divides the history of forest use into three stages:

- hunting, gathering and shifting cultivation
- primarily agricultural uses
- commercial intensive use for industrial products and processes

In the following, human impact on forest ecosystems in Europe is described from the Upper Palaeolithic period to the introduction of agriculture in the Neolithic period and during early historic times. Consequences for forest distribution and species composition are discussed along with the growing awareness of people of the protection of this natural resource.

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2.1 People and Forests in Prehistoric Times

Early hunter-gatherer societies have altered the flora and fauna of natural ecosystems all over the world, but today it is hard to judge how great their impact has been. Indirect and direct effects were most likely restrained until the dawn of agriculture about 10 millennia ago. With the development of civilizations based on agriculture, the exploitation of the forests was intensified and expanded. This development started in the Near East and spread from the Mediterranean region across Europe. The use of forests became soon an integrated part of the agricultural economy, and exploitation and clearances contributed to the change in European vegetation and a reduction in forest cover. Mather et al. (1998) have estimated that up to one third of the global land surface has been deforested.

2.1.1 *Hunter-Gatherers in Europe*

The first settlements in Europe are known from the Mediterranean region about 800,000 years ago. These early settlers were presumably not able to adapt to environmental conditions above 41°–42° North (Hoffecker 2004). A second stage of human colonisation took place about half a million years ago and can be traced as far north as 50° in Britain and as far east as the Danube Basin (Hoffecker 2004). Modern humans first appear in continental Europe about 40,000 years ago (Fagan 2001).

Living conditions and the diet of the first settlers were affected by changing climatic and environmental conditions. The extinction of larger carnivore animals about 500,000 years ago may have reduced the competition for prey, leaving more carcasses for scavenging (Turner 1992). However, it is difficult to reconstruct how much of the meat consumed by hominids was hunted or scavenged. During warmer climatic intervals (interglacials), many parts of Western Europe were covered with temperate oak woodland. Vegetation flourished and more plant food was available. During glacial periods, living conditions declined, and humans adjusted to the change in the environmental conditions by having a higher proportion of meat as part of their diet (Hoffecker 2004). However, in the early hunter-gatherer societies, gathering was often still more important than hunting. Plants contributed with up to 80% of weight to the consumed food, especially in the southern regions of Europe, while the consumption of plants compared to the amount of meat decreased with increasing latitude (Boyden 1975, cited in Russell 1997, p 114).

The role of plants as natural resource was closely related to the spreading of forests in Europe at the end of the Pleistocene. Forests were important for many necessities in the life of forest-dwelling hunter-gatherers. In addition to being a source for food, forest plants were used for shelter, medicine, arts and dyes and other products; and although possibly feared, as places of wild animals or spirits, forests were generally less regarded as a hindrance than in later periods of human culture (Russell 1997). Palaeolithic and Mesolithic cultures were still very much

dominated by nature, and their way of living was strongly connected to spiritual belief. In their dependence on plants and animals for subsistence, the life of the people was closely interwoven with the cycles and seasonal rhythm of nature (Russell 1997).

Between 11,500 and 9,000 years ago, after the retreat of the glaciers, trees occupied most of the land suitable for forest growth (Pott 1993). However, already in the early stage of forest expansion, humans may have modified the natural vegetation by preventing trees from colonising certain sites, by gathering plants, setting fires and hunting animals. Today, it is difficult to prove how much this actually resulted in a change in ecosystems, but against the romantic view on pre-agricultural societies, recent research indicates that setting fires and eliminating species by overhunting may well have modified the environment in major ways (Goudie 2006). Hunting seems to have aggravated the negative impact of changes in climate and habitat for megafauna species and thereby have contributed to their extinction. This could have altered the vegetation that was less disturbed by grazing or trampling but also less dispersed in the landscape (Martin 1984). However, human use of forest resources was still characterized by being locally restricted with little active management. Changes in the nutrient cycle of the ecosystem remained limited in contrast to the impact of later agricultural societies (Emanuelsson 1988). Human impact on nature may therefore have been similar to that of other big omnivores.

From the late Mesolithic Period, traces of human impact throughout Europe become more numerous. On the British Isles, charcoal and pollen data give evidence for recurring fire disturbance of forests both in the uplands and the lowlands (Innes et al. 2003). The manipulation of vegetation and the opening of forests by settlers affected growth conditions and created space for new plants which could be used as food (Zvelebil 1994, cited in Innes et al. 2003). Generally, abrupt changes in pollen frequencies and especially the increase in pollen from species such as hazel (*Corylus avellana*) or birch (*Betula* sp.) on formerly densely forested sites are taken as signs for human impact. While birch is extremely light demanding and hence grows best on open areas, hazel is more shade tolerant and can also be found at forest edges and as undergrowth in open forests. Therefore, the abundance of pollen from these species indicates that clearance or at least the opening or thinning of forests had taken place; a possible result of the change in human culture from hunting-gathering to a more settled way of life.

2.1.2 The Mid-Holocene Elm Decline

One of the greatest changes in arboreal vegetation during prehistoric times was the decline of the population of elm trees (*Ulmus* sp.) about 5,000 ¹⁴C years BP. It has been recorded for most parts of northern and northwest Europe by the analysis of pollen frequencies (e.g., Smith and Pilcher (1973)), stretching from Scandinavia, Ireland and the British Isles to the Netherlands, the northern part of Germany and

the Baltic countries. Some cases have also been recorded from France, Austria and the Czech Republic (Berglund et al. 1996). In southeast Europe, evidence of elm decline has been traced earlier in time (Huntley and Birks 1983). Interestingly, the decline seems to have taken place almost synchronously throughout this part of Europe. A review of pollen data from 138 sites in England, Scotland, Wales and Ireland showed that the mean dates of these four areas were lying within just 104 years of each other, on sites located from 2 m below sea level to altitudes of 500 m above sea level. According to these data the elm decline occurred on the British Isles around 5,036 ^{14}C year BP (± 247 years) (Parker et al. 2002). Up until this period, the lowland forest cover of at least Scotland and Ireland was presumably still complete (Rackham 1988).

The relative synchronicity of the event has been reason for many discussions and hypotheses of the actual cause of the dying back of the tree species. Human beings are generally not considered as the only factor, as this would have meant a synchronous cultural development throughout northwest Europe. However, it is assumed that human utilization of the environment has aggravated other natural factors that contributed to the reduction of the elm population, such as climate, soil changes and especially the influence of the elm bark beetle (*Scolytus scolytus* F.). The beetle is carrier for a fungus (*Ceratocystis ulmi* (Buis.) Moreau) which causes Dutch elm disease. Fossil records of the beetle from just before the beginning of the elm-decline were made at West Heath Spa near London (Girling and Greig 1977). As the beetle thrives best in clearings, hedges and on isolated trees rather than in dense forests, its distribution may be related to the presence of human communities. Practices such as foliage or bark-stripping from elm trees and the creation of clearings may have weakened trees and opened up the forest. In western Ireland, the disease was found to have had a lower impact on the elm populations than in other places of Europe, despite the presence of human disturbances. Lamb and Thompson (2005) attributed this partly to the absence of the most disease-susceptible ecotypes of elm on the island and the limit of the range of the distribution of the pathogen. They emphasize that presumably a combination of human impact and the disease was necessary for a permanent decline in local elm populations. Hence, the mid-Holocene elm decline may be seen as the first record of how human activities can aggravate negative environmental effects on vegetation. Interestingly, also the latest wave of elm disease seemed to have reached Ireland later than mainland Britain. Long after elm trees had disappeared from Britain, British timber merchants travelled to Ireland to purchase the last elm trees in the 1990s (Keith Curtis 1994, personal communication). Apparently, elm trees have again been more resistant on that island than in the rest of the disease affected regions of Europe.

The boundary of the elm decline is also considered as marking the line of the advance of agricultural societies, i.e. the change from the Mesolithic to the Neolithic Period. However, records of cereal pollen have actually been recorded at settlements already prior to the elm decline (Edwards 1988). The alteration of vegetation, indicated by a consistent rise in alder (*Alnus*) pollen in sediment dated about 7500 BP, has been associated with forest disturbances by Mesolithic people through

much of the British Isles (Chambers and Elliott 1989). The recovery from the elm decline occurred at different times in Europe, but at some places never. In Ireland, elm trees seem to have recovered on fertile soils already around 4,500 ^{14}C years BP (O'Connell 1980), while in areas like the Upper Thames and Norfolk the elm population never came back to its original strength (Peglar and Birks 1993).

2.1.3 *The Great Transition*

The Great Transition describes the change from hunter-gatherer societies towards peasant farming societies. It started in the Near East about 8,000–6,000 BC and is one of the most important developments in human civilization and of great significance for food procurement, land use and settlement (Edwards 1988). The development of agriculture had a great impact on the natural vegetation. The composition of plant communities was changed in favour of those species that were considered suitable for nutrition. Furthermore, land had to be cleared to enable the cultivation of the favoured crops. This started forest clearances and the development of cultural landscapes that form most of Europe today.

In the temperate zone, the shift from hunting to farming and the first significant impacts on forests by human beings can be traced back to the Stone Age (Probst 1991). However, it is difficult to draw a clear line that shows the advance of agricultural societies though Europe. There seems to have been a co-existence of hunter-gatherer societies and agricultural societies in many regions, for example in Denmark (Iversen 1941). The arrival of forest farming techniques and early agricultural cultivation in the British Isles and north-west Europe may well have occurred within a period of 200–300 years at the beginning of or soon after 6,000 years BP (Innes et al. 2003). Other records from ca. 4,000 to 6,000 BP indicate that there was a co-existence of the two lifestyles within Britain and Ireland. Presumably hunter-gatherer activities continued on marginal soils while good soils supported the development of agricultural societies (Edwards 1988). Especially the fertile loess soils of central Germany have a very early cereal pollen date (Pott 1992). However, the first settlements were not necessarily placed on good soils, but rather on soils that were easy to clear from forest cover. These were typically dry and sandy places or calcareous soils. It is therefore possible that on these spots, no natural vegetation has ever been able to develop after the last ice age owing to the very early human activity (Remmert 1985). Records from the British Isles indicate that no major tree removal occurred before or during the cereal pollen phase. Low intensity forest exploitation and farming characterized the earliest agricultural activity in northwest Europe rather than the higher intensity of woodland clearings, slash-and-burn practices and fields in the fully developed Neolithic times and later (Innes et al. 2003). The development of agriculture changed human attitudes towards forests. While still necessary for many products in daily life, forest became partly a hindrance, and trees had to be destroyed in order to create space for crops.

2.1.4 Early Agricultural Impacts on Forests

The Great Transition was only the beginning of an increasing impact on and manipulation of vegetation by human beings. Although 70–80% of the land area was still covered with forests in the last century BC, hardly any forest had escaped human impact (Huttl et al. 2000). Agricultural land use and husbandry became essential for the food procurement of Neolithic societies. Life conditions improved and subsequently the human population grew. Forests were removed to obtain more arable land, and the remaining forests were often heavily exploited; much more than by pre-agricultural societies. Hence, the development of agriculture must be seen in the context of two major processes:

- the reduction in forest cover
- the increase in and intensification of forest use

The immediate consequence of the expansion of agricultural land use in Europe was a massive deforestation. In England, the destruction of forests in order to create farmland can be traced back to about 4500 BC. While forest cover may still have been about 50% during the Iron Age, early documents indicate that it had decreased furthermore to 15% in 1086. With time, forests became more integrated in the agricultural economy, providing a variety of products in the daily life of human beings. They were used as a source of materials such as firewood, fencing, and lumber (Innes et al. 2003). Domestic animals were brought into the forests for grazing, a practice which has been known since the later Stone Age. In the oceanically influenced area of the temperate zone, initial deforestation started in the coastal areas where food supply was covered by fishing, intensive agricultural and silvo-pastoral management (Ellenberg 1990). As wood-pasture, litter raking and burning continued over long time periods, natural forest regeneration occurred only locally. In many areas of Europe, woodland was eventually replaced by heath and moorland, for example in western France, England, Ireland and Scotland (Walter and Breckle 1994). Much of this was related to the overuse of forests for wood and charcoal production and the impact of grazing animals.

Hence, overexploitation of forests resulted often in their destruction. Thereby, forest use contributed to the deforestation of the land. In most countries, woodland survived only on steep or poor land. Only during times when cultivation decreased and ecological control was lost, secondary woodlands could develop on a local scale.

The impact of people on the landscape changed in parallel with the development of tools and an increase in population. There are different theories whether technological inventions led to larger human populations or the invention of tools occurred independent of increases in population. One result of better technology was that more people could be supported by less land area. With the development of the iron-tipped plough, farmers were able to cultivate larger fields and less favourable soils (Ellenberg 1996).

Emanuelsson (1988) suggests four main steps between five technological levels. These had a marked effect in changing the natural environment into a cultural landscape. The different levels are characterised by an increasing number of persons

who can be supported per square kilometre and a change in the net balance of nutrients. He proposed, based upon different studies, that in the fertile parts of Scania, southern Sweden, 0.5–2 persons of a hunter-gatherer society could survive on 1 km². With the development of agriculture and the introduction of shifting cultivation or pastoralism, this number increased to about 20 persons per km². At the same time, a net loss of nutrients from the cultivated area occurred, and restoration was only possible during periods of non-exploitation. Farming in permanent fields during early agricultural use with manure application allowed about 50 persons to survive on 1 km². For Sweden, this type of agricultural use is assumed to have existed already 2,000 years ago and may have continued in some regions until the eighteenth century. Despite the overall net loss, nutrients were already better used than during the state of shifting cultivation and pastoralism (Emanuelsson 1988). A distinct change in the nutrient balance was first achieved during the Agricultural Revolution, eventually resulting in a nutrient excess after the introduction of artificial fertilizers in the twentieth century.

2.2 Forest Development in Historical Times

The process of deforestation accelerated during the time of Charlemagne (about AD 800) with concomitant pressure on natural ecosystems. While culture was related to the cultivation of land, forests were considered as a synonym for wilderness; a myth that somehow has survived until today (see also Chap. 10). However, much more than agriculture, the demand for timber as building material and in armed conflicts became an increasingly important factor in the deforestation process. The consequences of this hunger for timber were most disastrous in arid regions. A well known example is the great deforestation that took place in the Mediterranean region during Greek-Roman times, but a similar development occurred later in Central and Northern Europe. At the time of the Industrial Revolution (c. 1790–1900 in Europe), forests in many European countries had been subject to clearances (Kaplan et al. 2009). The recovery of forests from the massive human impact was only possible after periods of pests or great wars that resulted in a significant reduction of the human population, or to a minor extent when new technologies helped replace the need for timber. However, human population is not the only factor that has an effect on the change in forest cover. Cultural and political factors, e.g., forest laws and regulations for land use and landscape management, play an important role as well.

2.2.1 *The Great Deforestation of the Ancient World*

The Mediterranean Region has a long history of manipulation of trees, forests and landscapes, and the exploitation of forests reached its first remarkable peak during Greek-Roman times. The long-term consequences of the overuse of the forests

that once covered the Mediterranean region are still present today. Human settlers and their herds of domestic animals caused the virtual disappearance of most climax forests. Development of agricultural innovations such as the iron plough-share increased food production, hence, population, and thus the need for more forest clearances. Wars and especially the demand of timber for shipbuilding had a major impact on the Mediterranean forest (Thirgood 1981). Like in other parts of Europe, Greek-Roman civilizations used timber for energy production and construction. Timber was also an important subject of inter-regional trading. To meet the high demand of timber, the exploitation of forests was not restricted to the easily accessible lowland forests, but stretched even to upland forests, for example in the Apennines with their vulnerable site conditions (Meiggs 1982). Especially during the Roman times, intensive settlements caused large-scale transformation of forest into arable land (Huttl et al. 2000). With the cultivation of land, human impact also included the introduction of new species for non-wood products.

The consequences of ruthless forest exploitation were dramatic. Erosion reduced agricultural productivity, resulting in further forest clearance to make new areas of fertile land available for agriculture. Industries depending on timber supply developed, such as iron smelting, pottery and shipbuilding, only to be hit hard later by an increasing shortage of wood. Already by about 400 BC, Plato noted the damage to soil resources resulting from the deforestation of Attica (Hamilton and Cairns 1961). In his description, he compares the treeless hills of Greece with skeletons. The overuse and loss of forest cover resulted in severe soil erosion, especially in steep mountain regions. Today, shrub landscapes dominate where forests used to cover the hills and lowlands. The remaining forest stands are altered and more or less intensively managed. Although it is sure that forest cover was more extensive in the Mediterranean regions 2,000 years ago, Thirgood (1981) points out that it is not clear to what extent and of which type the forests were; what was described as forest by classical writers may very likely have been close to today's *marquis*, i.e. a resistant type of dense scrub formation.

On the other hand, in his book *Folklore and the Old Testament* (Vol. III), Frazer (1918) quotes several descriptions of the landscape of the Mediterranean region from Palestine to Syria during the nineteenth century. The abundance of different, partly very old, oak (*Quercus*) species forming park-like landscapes to "impressive oak forests" has been recorded by the writers, like W.M. Thomson who travelled the plain of Sharon and published his observations in 1881:

It is conducting us through a grand avenue of magnificent oaks, whose grateful shade is refreshing to the weary traveller. They are part of an extensive [oak] forest which covers most of the hills southward to the plain of Esdraelon.

(W.M. Thomson 1881, in Frazer 1918, p 32–35).

Apparently, there may have been more forests present than we may assume when looking at the Mediterranean landscapes today.

In general, only a few forests escaped intensive use through time. In Ancient Greece, sacred groves were protected from felling. These forests could be considered

as precursors to “national parks”; vestiges of pristine wilderness. However, already by the fifth century BC wood shortages had become so acute that religious sanctions were no longer enough to protect these forests from human impact. Instead, secular regulations were introduced with the aim of protecting the groves, like a decree in Athens that prohibited even the removal of twigs (Farrell et al. 2000). Timber became a symbol of power. Macedonia overtook Attica while it still had great resources of unexploited timber, just until it was in turn overpowered by the Roman Empire. However, with Roman civilization, over-exploitation of the forests continued.

The later collapse of the Roman Empire resulted in profound changes in land use. Cultivated land was abandoned owing to the reduction in human population and consequent loss of available manpower, and forest regenerated in the areas where agricultural production ceased (Darby 1956). However, during the post-classical era, exploitation continued and even increased. Shipbuilding remained the greatest consumer of timber and later became a political factor from the mid-seventeenth to the mid-nineteenth centuries when appropriate timber became scarce in many regions (Thirgood 1981). First forest laws limiting or prohibiting the use of forest products by local people were introduced with varying success. The destiny of forests often depended on whether a nation needed material for war. In addition, increasing architectural demands and the progressing use of wood for fuel and charcoal production contributed to the degradation and extinction of forests.

Mediterranean vegetation has never recovered completely from the impact of long-term deforestation, and unfortunately much of the knowledge of the severe environmental consequences got lost during the following generations (Meiggs 1982). Hence, the evolution of the interaction between people and forest landscapes that occurred in the Ancient World was later paralleled by developments in Central and Northern Europe.

2.2.2 Impacts on Forests in Northern and Central Europe

The expansion of agriculture in Northern and Central Europe contributed to a growth in population and the need of timber for construction, production and energy. The impact on forests and trees was intensified, and more and more forests were removed or modified by human use. By the beginning of the Middle Ages, forests in Central Europe were already under the control of human activities. Only in remote areas some primary forests may have survived. Cultural landscapes developed and formed a mosaic of fields, pastures and wooded areas, characterised by a higher degree of fragmentation. During the Late Middle Ages, forest cover in Central Europe had been reduced to less than 30% owing to energy demand and the need for construction wood (Grossmann 1934; Hammel 1982, cited in Huttl et al. 2000).

For the reduction of forest cover, duration of human settlement seems to be less important than the vulnerability of the forest ecosystems against human impact.

In the Central European Chernozem (black earth) areas of the lowlands, first farmers settled during the early Neolithic periods in the second half of the sixth millennium BC (Kreuz 2008). Despite this long-term intensive agricultural use, there is still a considerable forest cover of about 25% providing a relatively high timber production. In contrast, in the north-western regions of Scandinavia, the British Isles, Iceland and the Faroe Islands, overuse of the natural tree vegetation quickly reduced the original forest cover. Iceland was one of the last places in Europe settled by human population, about AD 874, and yet this country has one of the least forested landscapes in Europe (UNEP 2000). It took the first settlers less than 200 years to reduce the natural forest cover from c. 25% to less than 1% of the land area (Anonymous 2001). Something similar is seen in the history of the Scottish Highlands when people with pastoral life style occupied the uplands from the eleventh century onwards. They practised the shielding system, a regional form of the seasonal movement of livestock used in other places in Western Europe, and hardly any woodland has been left unaffected by the influence of this grazing management (Holl and Smith 2007). The Faroe Islands are one of the places where deforestation was basically already complete 1,000 years ago (Hannon et al. 2001). In these regions, natural regeneration of trees is strongly hampered due to short vegetation periods and difficult environmental conditions, poor soils and grazing of domestic animals. Consequently, wide areas are nowadays marked by soil erosion and the loss of valuable fertile land.

The impact on forest ecosystems was not only caused by agricultural land use. Natural tree species composition was modified by the preferential use of certain species and the avoidance of natural disturbances. In villages, lime (*Tilia*) and especially oak trees were planted to prevent the spreading of fires between the thatched roofed houses. In addition, the acorns were used as fodder for domestic animals, while the honey of lime trees was an important sugar source (Remmert 1985). Many new tree species have been introduced throughout the centuries because of their aesthetic values, independent of their timber value. Thus, exotic species came to play an important role in the development of parks and gardens in Europe. Other trees came as invasive species introduced through human activities, e.g., trading and travelling.

In northern Scandinavia, Norway spruce (*Picea abies*) competed better against Scots pine (*Pinus sylvestris*) when human beings started to control wild fires. The Scandinavian spruce forests that nowadays may be considered as “natural” are therefore actually a plant community that, although not introduced or planted, was caused by human control of natural ecosystem processes. In Central Europe, the major impact of human activity can today be seen in a change in tree species. Natural beech (*Fagus sylvatica*) forests have converted to mixed oak-hornbeam (*Quercus-Carpinus*) forests or replaced with spruce (*Picea* sp.) and Douglas fir (*Pseudotsuga* sp.) (FAO 2000). Today, coniferous trees account for 68–88% of the temperate forest area that naturally would be dominated by deciduous species (Ellenberg 1996). The natural vegetation of deciduous broadleaved tree species has been substituted with coniferous forests in production-oriented forest management that started with industrialization in the eighteenth century. However, the

quality of these stands is often very variable as the trees do not grow on their natural site conditions. This has resulted in major losses of timber during storm events like the ones in December 1999 when 165 million m³ of timber were wind-blown in Europe (mainly France, Germany, Switzerland, Sweden, Denmark and Poland), which was about 43% of the annual average harvest (European Forestry Commission 2000).

Another important function of forests through history was energy production. Close to settlements, forests were managed for firewood. As a well functioning saw was not known before modern times, trees had to be felled with the axe. Therefore, thin stems and branches were preferred. People thereby made use of the ability of most native tree species to grow shoots from the cut stumps or the root system, either by coppice or suckers. For the practice of coppicing, young trees were cut at their base and recovered by developing multi-stems that could be cut again after a few years. Typical tree species suitable for this practice are ash (*Fraxinus excelsior*), wych-elm (*Ulmus glabra*) and beech (*Fagus sylvatica*). Today, old coppice forests (in German: *Niederwald*) can still be recognised by their multi-stemmed trees. In the vernacular, their bizarre forms are often associated with witches, spirits or fairytales.

When trees are cut higher up, the practice is called pollarding. Pollarding can increase the life time and health of trees. It also made it possible to combine wood-pasture with wood production because grazing livestock could not reach the young shoots of the trees as opposed to the coppice. Burnham Beeches west of London is a good example of this type of forest use. Coppicing and pollarding were not only used to obtain firewood and wood for charcoal production but also material for hop vines and fences. Ash was typically used for hop poles, while hazel was preferred for weaving into fences. In many European countries, coppicing was still practised during the nineteenth century (Austad 1988). In England, some former coppiced forests can still be traced back to medieval times by their names.

When forests became part of husbandry practices, in addition to the already well known and widely practised habit of using forests for grazing, this resulted in major impacts on the ecosystems. In regions with difficult climate like in northern Europe, livestock was kept in stables during the long and cold winter period. Farmers started to collect leaves and twigs and used them for winter fodder. Leaves and needles were furthermore used for fillings of mattresses and beddings (Roth and Bürgi 2006). The removal of litter from forests had a profound effect on the nutrient status of forest ecosystem. It could change the plant community, result in substantial soil impoverishment and reduce the neutralization capacity of the soils. Dzwonko and Gawronski (2002) showed that current vegetation composition in mixed oak-pine woodland in Poland can still be related to past biomass removal by people. The collection of litter was very popular during the Agricultural Revolution, at the end of the eighteenth century (Bürgi 1999). Different studies have estimated a removal of 0.5–3 t litter per hectare from forests stands in different regions of Switzerland (Bürgi and Gimmi 2007). However, the actual extent of this practice is debatable owing to missing written records. An important role in the fattening of pigs was played by the acorns of oak trees. Since oaks do not have acorns every year when growing in

closed forest, they were often grown as solitary or scattered trees within wood-pastures (in German: *Hütewald*). This enabled the fattening of pigs every year.

The improvement of food production contributed to an increase of the population in central Europe. Towns developed and crafts improved. More wood was needed for fuel, production and as building material. In the Auvergne in France, forests in the lowland areas were so much depleted that people had to use straw for fuel already by the seventh and eighth century. Only in the mountains, forests survived because they were protected for hunting. This protection continued with the settlement of German immigrants, in contrast to the south of France where deforestation was almost complete. The settlers in the south of France, coming from the Mediterranean regions, did not establish hunting preserves (Devèze 1864/1965, cited in Russell 1997, p 119).

The anthropogenic influence has locally changed environmental conditions for tree growth and is often stronger than the natural effect of the bedrock or the local soils (Pott 1993). Many land sites have lost their original fertile conditions through erosion, drifting sand or podsolization after the removal of a closed forest cover or the introduction of new tree species. Reforestation with exotic tree species has affected soil conditions through the impact of litter quality, nutrient cycling or the filter effect of the canopy. Furthermore, forests have an effect on the local microclimate of landscapes (Brown and Gillespie 1995). If forest management was stopped, it would still take a long time for the original site conditions to be re-established and for potential natural vegetation to regenerate. As a recent development, it can be observed that human induced climate change may have an effect on the distribution and spreading of tree species in Europe (e.g., Bradshaw et al. 2000).

2.2.3 *Forest Protection and Forest Expansion*

It was the overuse and the loss of many necessary forest functions that resulted in the first approaches to the protection of forests in Europe (Farrell et al. 2000). The oldest protective regulations are recorded from Switzerland in 1339 (Muotathal) and 1387 (Altdorf) (Anonymous 1983, cited in Farrell et al. 2000). In these mountainous areas, forest protection was driven by the fear of avalanches and landslides. Simultaneously, authorities in England tried to counteract the local lack of timber by enclosing forests and preserving them for firewood production (Glasscock 1976). Timber shortages also stimulated the first reforestation activities on felled sites, such as the planting of the state forest at Nurnberg (*Nürnberg Staatswald*) in south Germany in the fourteenth century.

However, it was less the human initiative to protect shrinking forest resources but rather natural factors that resulted in the last great expansion of forests in Europe. This was when the human population declined significantly during the time of the Black Death and then after the 30 Years' War. Agricultural land could no longer be cultivated by the reduced population, and the exploitation of forests diminished. Hence, forests could recover from human impact, and natural regeneration started to

occupy the abandoned land. Also during the Germanic migration, secondary forests developed on former cultivated land (Farrell et al. 2000). Many of the forests that today are considered as old growth forests or “natural forests” are actually secondary forests that had developed on the fields that people left uncultivated during the Early Middle Ages (Peterken 1996).

However, this break in human impact on the European forest vegetation did not last long. With exploration of the world’s seas and the expansion of shipbuilding, the hunger for timber grew and then outpaced former fellings. From the seventeenth century onwards, when the Industrial Revolution spread from England, the demand for timber to fire the many furnaces increased further. Industrial centres, such as Ironbridge near Telford in England, were therefore often sited close to forests which were managed for firewood production, mostly utilising the practice of coppicing.

By the early nineteenth century, forest cover had reached its lowest point in historic times in many Western European countries. For example, the minimum forest cover in Denmark (in the 1800s) and Portugal (in the 1870s) was 4% and 7%, respectively, and even Switzerland had only 18% forest cover left (in the 1860s) (Mather et al. 1998). Kaplan et al. (2009) have used a preindustrial anthropogenic deforestation model to generate historical land clearance maps of Europe. It illustrates clearly the increasing loss of forest cover in many European countries from 1000 BC to AD 1850.

Since the mid-nineteenth century, forest cover started to increase again and, for the first time in forest history, this happened despite a continuing population growth (Mather et al. 1998). In 2005, forest cover in Denmark, Portugal and Switzerland was back at 11.8%, 41.3%, and 30.9%, respectively (FAO 2006). The total forest cover of Europe (without the Russian Federation) is today 32.6% of the land area (without inland water) (FAO 2006). This change in the interaction between population and forest cover can be explained by several factors, among others a decline in the proportion of rural population, but also a change in the perception of forests and a development of new philosophies and political thoughts which led to new (scientific) approaches to forest management (Mather et al. 1998). In many European countries, this development started with the time of Enlightenment and the rise of Romanticism: “Belief in the power of rationality and science to solve problems led to silvicultural advances; romantic notions provided a lens through which forests could be viewed positively by urban élites” (Mather et al. 1998). Furthermore, the development of technology helped increase processing yields during the twentieth century. Hence, forests can be used more efficiently now when it comes to the consumption of wood products in society.

For many decades, afforestation efforts aimed primarily at increased forest productivity. Plantation establishment often involved the replacement of deciduous with coniferous tree species, especially Norway spruce. While native in the boreal region, Norway spruce grows outside its natural range in most other European regions. It is therefore sometimes not sufficiently adapted to the local climatic and edaphic features, and as a result management difficulties can occur (Huttl et al. 2000). Trees are more often weakened by drought stress and forest damage which makes them susceptible to insect attacks and windblow. Windblow accounts for 53%

of the total damage to forests in Europe (Schelhaas et al. 2003), and the frequency of windblow damage has increased during the last decades of the twentieth century. However, no increase in storm frequency could be observed for Europe; storm frequency has on the contrary been remarkably stable for the last 200 years (Carretero et al. 1998; Heino et al. 1999; Bärning and von Storch 2004). Increased windblow damage may therefore probably not be attributed to stronger and more frequent storm events. For Norway spruce, it is suggested that higher losses occur because a larger proportion of trees has reached the age class when they become susceptible to windblow damages, and because trees are grown in monocultures instead of mixed stands (Schlyter et al. 2006). However, the negative experiences of the past have changed this trend. Today, more native tree species and those adapted to the actual growth conditions at the forest sites are increasingly used in forestry.

2.3 Conclusion

The intensity of human impact has varied temporally and spatially, and the exploitation of forests has not passed without leaving a mark on forest ecosystems. Human use of forests may have started as the mimicking of natural processes, but it soon became more distinctive. In contrast to most natural processes, except natural wild fires, many human activities are characterised by removing forest products from their source. With the development of agriculture, forest cover was reduced over larger areas which only partly reconverted to secondary forests, and deforestation became a dominant action in most European countries throughout their history. Furthermore, human beings contributed to the extension of species ranges by introducing new tree species to regions where they are not indigenous. The removal of forest products, the introduction of new tree species and the selective use of existing species resulted in the modification of species composition and forest structures and affected processes in the forest ecosystems such as nutrient recycling and soil retention. Hence, human activities have left traces on trees and forests in European landscapes in three major ways:

- extent and distribution of tree cover
- species composition
- local site conditions relevant for tree growth

Intensive and extensive forest use in much of Europe has affected forest ecosystems so much that today's forests have to be understood in the context of past and present patterns of forest use. Even ecosystems that may have escaped direct impact by human use are nowadays threatened by man-made influences such as increased nutrient input through atmospheric deposition or acidification. Hence, "natural" ecosystems untouched by human beings can hardly be found in Europe. With few exceptions, forests in Europe do not represent the wilderness that they are often assumed to be. Rather, they are a part of landscapes with long historical dimensions and as such influenced and controlled by human culture.

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