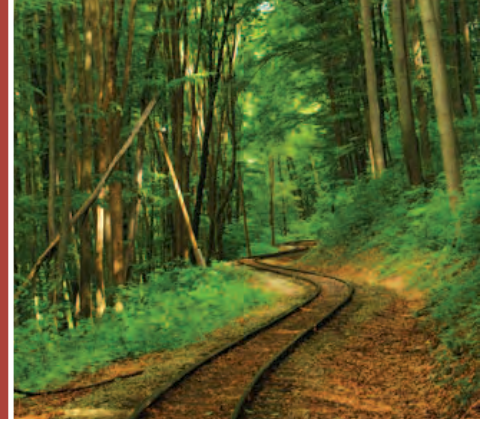




Chapter 2

Forests and the evolution of the modern world



Forests in a historical context

Forests have played a major role in human history, and periodic deforestation has accompanied population growth and development for thousands of years, throughout the world. Climate, culture, technology and trade have had an important influence on speeding up or slowing down – in some cases even reversing – the pace of deforestation. Over time, the interaction between humans and forests has changed in response to social and economic changes. Among the lessons of history is that there are strong links between forest use (including deforestation) and economic and social development, and between the destruction of forests (with irreversible environmental damage) and economic decline. Policy-makers must confront the paradox that although forests, forest products and forest-based ecosystem services are essential, in some circumstances there are more pressing demands for the land that forests occupy. A historical perspective reveals both the importance and the challenge of sustaining forests and striking a balance between conservation and use – practising sustainable forest management – to ensure the full range of forests’ economic, social and environmental contributions.

Forests

The thinning, changing, and elimination of forests – deforestation, no less – is not a recent phenomenon; it is as old as the human occupation of the earth, and one of the key processes in the history of our transformation of its surface.

◆ Williams, 2002

Human history is a story of how the earth’s diverse forests and their many products have been used. Forests have been a source of raw material for buildings, transportation and communication; a source of food, and the fuel for cooking it; and – when forests are cleared – a source of land for farms and cities. Although the need to manage forests and forest-based commodities gave rise to some of the earliest laws, most societies found it extremely challenging to manage forests sustainably. The search for new supplies of scarce forest products was a motivation for trade; and

unremitting scarcity eventually spurred migration. Human history is also a story of deforestation and the severe environmental consequences that can result – at times contributing to the collapse of societies.

As an aid to developing the long-term perspective needed for sustainable forest management, this chapter looks at the history of humans and forests. It provides a brief survey of several thorough and detailed studies, foremost among which is Williams’ (2002) exhaustive survey of the interaction between human history and forests. The survey also draws on other sources, including Perlin (1989) and Winters (1974), who document the importance of forests and wood to a wide variety of societies over thousands of years.²

² Additional historical material is available in Tucker and Richards (1983) and Richards and Tucker (1988).

Forests: looking back

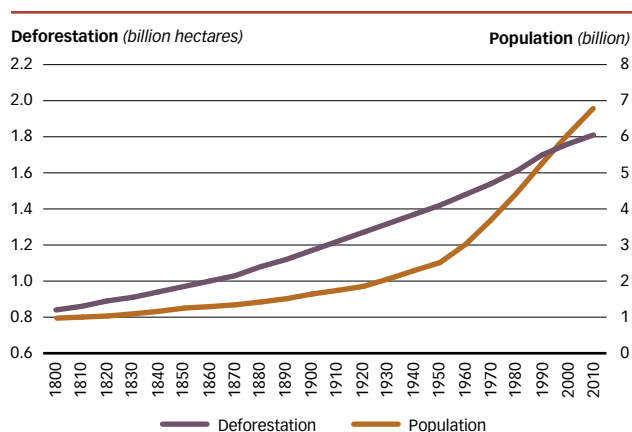
History clearly shows that in countries with abundant natural resources and sparse population there is no thought of the future, and all energy is directed to the exploitation and reckless use of what nature has abundantly provided. The waste under such conditions is naturally very great and a more economic utilization does not pay. As the population increases and industry grows, the demand for raw material of all kinds increases, and there is a gradual awakening of public opinion for the need for a more careful husbanding of natural resources. Practically all nations have travelled the same road. Some reach this point sooner than others, but everyone is inevitably bound to face the same situation.

◆ Zon, 1910

The forests of today have evolved over millions of years and have been profoundly shaped by swings between warm and cold climates. Glacial periods usually lasted 80 000 to 100 000 years, interspersed with warmer interglacial periods of 10 000 to 15 000 years. The last great ice age ended about 10 000 years ago, leaving forests on nearly 6 billion hectares, about 45 percent of the earth's land area. During the last 10 000 years, cycles of changing climate and temperature have continued to influence the world's forests, while human activity has also had an increasing impact.

Forests currently cover about 4 billion hectares, about 31 percent of the earth's land surface (FAO, 2010b). As human population and economic activity have increased, so too has humans' ability to manipulate the natural world. This manipulation is most evident in the clearing of forests.

Figure 1: World population and cumulative deforestation, 1800 to 2010



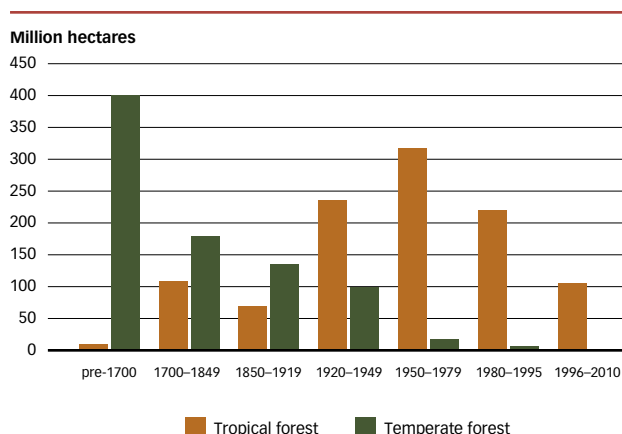
Sources: Williams, 2002; FAO, 2010b; UN, 1999.

Deforestation – the clearing of forests to use the land for other purposes, or to leave it as unused wasteland – is one of the most widespread and important changes that people have made to the surface of the earth. Over a period of 5 000 years, the cumulative loss of forest land worldwide is estimated at 1.8 billion hectares – an average net loss of 360 000 hectares per year (Williams, 2002). Population growth and the burgeoning demand for food, fibre and fuel have accelerated the pace of forest clearance, and the average annual net loss of forest has reached about 5.2 million hectares in the past ten years (FAO, 2010b). The trajectory of global deforestation has more or less followed the global growth rate of the human population, although the pace of deforestation was more rapid than population growth prior to 1950, and has been slower since then (Figure 1).

Deforestation and population growth rates have several other aspects in common: both tend to vary among different regions of the world; and both tend to increase during periods of economic development, while stabilizing or even falling after a society has reached a certain level of wealth.

Until the early twentieth century, the highest rates of deforestation occurred in temperate forests in Asia, Europe and North America. The expansion of agricultural production accounted for most forest clearing, but economic development and the related, often unsustainable, use of forests for raw material and fuel was another contributing factor. This pattern changed during the twentieth century (and even earlier in Europe) and, by mid-century, deforestation had essentially come to a halt in the world's temperate forests (Figure 2). As deforestation slowed in the temperate zone, it rapidly

Figure 2: Estimated deforestation, by type of forest and time period



Source: Estimates based on Williams, 2002; FAO, 2010b.

increased in the world's tropical forests and remains high, largely because of dependence on land-based economic activities.³

Historically, there is a strong correlation between large societal changes and how forests are used. Pre-agrarian societies (including hunter-gatherer communities) are highly dependent on forests for their livelihood. As agrarian societies emerge and expand, the nature of this dependence changes. The demand for agricultural land and the products required in an agricultural economy becomes a main concern, while provision of ecosystem services, particularly water for irrigation, becomes a high-priority objective. Industrialization brings major shifts in the use of forests, with production of raw materials (including wood, industrial crops, energy and minerals) gaining priority, and demand shifting from hardwood species (for fuel and animal fodder) to softwood species (for construction and paper manufacture). Developing agrarian societies have often been under pressure to supply raw materials to support the industrial development of other countries. Development of a post-industrial economy based on the service sector brings further changes in priorities for forest management, with provision of ecosystem services, including amenity values, gaining increased attention. Conflicts related to the use of forests tend to be severe in situations where diverse segments of society – pre-agrarian, agrarian, industrial and post-industrial – use the same forests to meet divergent needs.

The Near East and Mediterranean regions

The Fertile Crescent, spanning the region from the Persian Gulf to the Mediterranean, was covered by vast tracts of forests 5 000 years ago. Humans had long used fire to clear forests for crops and to facilitate hunting and gathering. Technological advances in the Bronze Age (starting about 3 300 BCE), and the Iron Age (starting about 1 200 BCE) provided new tools for felling trees and utilizing the wood. Almost without exception, the rise of ancient kingdoms was driven by the exploitation of forests and their conversion to agriculture. The exhaustion of forest resources was usually accompanied by a decline in the power of these kingdoms.

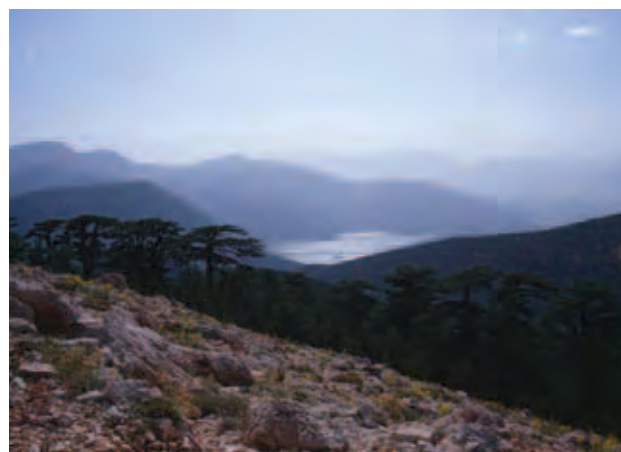
This same trend continued as the locus of power in the ancient world shifted westwards. As Crete, Cyprus, Greece and Rome rose to dominance, their economies

were based on the exploitation of abundant forest resources found in northern Africa and the Mediterranean basin. For example, Alexander the Great used Cyprus as a strategic site for shipbuilding by exploiting the abundant oak forests on the island. Today Cyprus is left with no oak forests.

Long, straight timber was essential for building ships, the main form of transport in the Mediterranean basin; wood was also needed for heating, cooking, construction, fuelling ceramic and metal kilns, and making containers. However, deforestation for agriculture had the unwanted side-effect of reducing the supply of wood, and the price of wood rose to rival the prices of precious metals. The quest for wood drove expansion to the west and north, while the wealth and power of one civilization after another rose and fell with the exploitation of its forests. This was not simply a matter of overusing forests for timber: forest clearing was often the first step in a process of land degradation. Poor agricultural practices and uncontrolled grazing on former forest land frequently resulted in soil erosion, loss of fertility and eventual desertification.

This pattern was repeated with the rise and fall of Rome. The expansion of the Roman Empire throughout western Europe was partly related to the need for access to forests on the Italian peninsula and around the Mediterranean rim. Deforestation was increased by the Romans' habit of clearing trees for a considerable distance from the sides of their roads, to reduce the possibility of ambush. After the fall of Rome in the fifth century, some forests in the region recovered for several centuries.

- Misty mountains, lake and cedar forest in foreground, Turkey. In northern Africa and the Mediterranean basin, wood was needed for building ships, heating, cooking, construction, fuelling ceramic and metal kilns, and making containers



FAO/ILRI, Baturhan Guneser/IC-2021

³ Population density and the accompanying perceptions of space – or its lack – may be a factor in the different patterns of deforestation that can be observed.

Box 1: The Agdal system of traditional resource management in Morocco

The term “Agdal” is widely used among northern African pastoral societies to refer to an area, a resource, and the rules laid down for managing this resource space. In Agdal forests, local communities establish rules governing the permitted periods, quantities and species for harvesting; violators have to pay a hefty fine to the local community. This ancient practice is found in all Berber-speaking regions in northern Africa and the Sahara. It shares common features with other

traditional land management systems, such as “Hema” in the Near East. Agdal provides a holistic conceptual framework for integrating a territory’s ecosystems and resources, knowledge and practices, rules and institutions, and representations and beliefs.

Source: Auclair *et al.*, 2011.

The Arab conquest of the Mediterranean area between 700 and 900 was driven by the expanding demand for cropland and enabled by the use of wood to build ships. Over several centuries, the forests of the Mediterranean were gradually depleted, and people in northern Africa lacked wood for shipbuilding. The power centres shifted back to the northern side of the Mediterranean; by the fifteenth century, the Venetians in Italy were battling the Ottoman Turks for control of the region. Venice had access to timber from central Europe, while the Ottoman Turks had access to forests on the Black Sea. In northern Africa, most of the scarce forest resources had been lost during the Roman period and the early Middle Ages. Today, the few remaining forests are well protected, and afforestation schemes are increasing the forest area in several countries. Traditional community management of natural resources has helped to protect forests; some of these systems, such as the Agdal system in Morocco, have proved to be resilient in accommodating external and internal changes (Auclair *et al.*, 2011) (Box 1).

Although widespread deforestation coincided with the rise and fall of Mediterranean powers, it would be an oversimplification to conclude that deforestation was the sole or even the primary cause of the fall of the great Mediterranean empires. Deforestation, land degradation and loss of access to wood were factors in many cases, but wars, epidemics and failures in governance were also important in the decline of cultures, in both the Mediterranean and other parts of the world.

Europe

Two thousand years ago, forests covered an estimated 80 percent of the land in Europe; today they cover 34 percent, excluding the Russian Federation.⁴

Over these 2 000 years, different parts of Europe have experienced high rates of deforestation at different times, depending on population growth, migration and the spread of technology. The clearing of trees to plant cereals began when Neolithic people occupied the land as the last ice age receded. These early human activities brought changes in tree composition as well as in the extent of forest land as in the extent of forest land.

Deforestation in Europe increased gradually but steadily during the Middle Ages, as forests were cleared to make space for arable land to feed the expanding population. About half of western Europe’s forests are estimated to have been cleared prior to the Middle Ages. The collapse of Europe’s population due to the bubonic plague in the mid-fourteenth century resulted in the abandonment of up to 25 percent of all croplands, and forests returned in many areas. However, population growth resumed within a generation, and the pace of deforestation had returned to its previous levels within a hundred years.

The European Renaissance of the fifteenth and sixteenth centuries triggered another boom in Europe’s population and economy. The rate of deforestation remained high during the early decades of the industrial revolution in the eighteenth and nineteenth centuries; wood was the principle source of industrial energy until it was gradually replaced by fossil fuels.

The highest rates of deforestation were on the land best suited for farming, especially in France, Germany and the United Kingdom of Great Britain and Northern Ireland. Periods of more intense deforestation coincided with periods of high economic activity. Trees were felled when grain prices rose and forest lands were converted to cropland. The use of wood for construction and shipbuilding also contributed to forest degradation and eventual deforestation in France, Portugal and Spain.

⁴ Forests cover 49 percent of the Russian Federation, but most of this forest land is in the Asian part of the country.

By 1700, Europe had an estimated 100 million hectares of cropland, about one-third of it in what was then Russia. By the turn of the twentieth century, cropland had increased by another 145 million hectares in Russia and 80 million hectares in the rest of Europe, mostly on land that had previously been forest (Williams, 2002).

The coniferous forests of Finland, Norway and Sweden were an exception to the pattern of deforestation in Europe as a whole. While deforestation occurred in these countries, especially near cities, it was not as extensive as it was further south, where population pressure was higher. In addition, shorter growing seasons and rocky soils set a natural limit on the clearing of forests for farming, although shifting cultivation was practised in some areas. Eventually, shortages of arable land contributed to emigration, especially to North America in the nineteenth century.

The landscape of Germany – the birthplace of modern forestry – was transformed by deforestation from the Middle Ages until the nineteenth century. Not only were forests cleared for agricultural land, but there was also a need for wood to fuel foundries and smelters in the early industrial revolution, resulting in further forest degradation and deforestation, even on land not suitable for agriculture.

In central Europe, deforestation was not reversed until the early twentieth century, when changes in agricultural practices improved productivity and slowed the clearing of forests for crops, and fossil fuels replaced wood as the main source of industrial energy. During the nineteenth

■ Dolomite Mountains, Italy. Two thousand years ago, forests covered an estimated 80 percent of the land in Europe



FAO/J. Bailey/FO-6875

century, forests, which had once covered more than 90 percent of the total land area, shrank to a low of about 10 percent. Old-growth, primary forests essentially disappeared from central Europe; today the region's forests are shaped by humans through extensive planting and tending (Plochmann, 1992). In the last 150 years, the expansion of planted forests has brought dramatic recovery in Germany, where forests now cover about 32 percent of the total land area.

Throughout western Europe, the rate of deforestation started to decline in the late nineteenth century: little of the remaining forest land was suitable for farming; farm productivity was rapidly improving; Europe was relying increasingly on imported food and wood from other regions; and coal was replacing wood as a source of fuel. Throughout Europe, investments in the reforestation and regeneration of former farmlands were rising, encouraged and supported by national and regional policies. By the end of the twentieth century, forest areas in all of Europe were stable or increasing; deforestation was a problem of the past.

Asia

Asia is the world's largest continent and has a wide diversity of forest ecosystems. At the region's geographic extremes, these ecosystems include extensive boreal forests in Siberia, moist tropical forests in southeastern Asia, subtropical forests in the mountains of southern Asia, and juniper forests on the Arabian Peninsula. Asia is also home to more than half of the world's human population and, as in other regions, population growth and development have been accompanied by widespread deforestation.

China experienced increasing population and declining forest area for many centuries. Four thousand years ago, China's population was about 1.4 million people, and forests covered more than 60 percent of the land area (Fan and Dong, 2001). At the beginning of the first feudal dynasty (the Qin Dynasty in 221 BCE), the population had increased to about 20 million, and forests covered nearly half of the land. When the Ming Dynasty started in 1368, China's population had increased to about 65 million, and forest cover had declined to 26 percent. In 1840, China's population reached 413 million, and forest cover was 17 percent. At the foundation of the People's Republic of China (1949), forest cover had decreased to its historically lowest point – less than 10 percent of the land area – and population had increased to more than 541 million.

- Lotus blossoms and mountain forests, Republic of Korea. Asia is the world's largest continent and has a wide diversity of forest ecosystems



FAO/SeoFO7391

Wars and colonial exploitation were significant factors in historical patterns of deforestation in China. In the nineteenth and early twentieth centuries, regional and global conflicts contributed to overexploitation of timber resources, forest destruction and degradation, widespread soil erosion, and enduring shortages of fuel and building materials. In the last 60 years, investments in planted forests, for both the production of wood and protection against desertification, have added roughly 80 million hectares, effectively replacing the forest area that was lost in the eighteenth and nineteenth centuries. Even with these successes, however, forests currently account for only 22 percent of China's total land area, compared with the global average of 31 percent (FAO, 2010b). In addition, China's dependence on imported timber has increased significantly.

Japan also experienced periods of rapid population growth accompanied by the expansion of agricultural land and inevitable deforestation. Although this pattern was similar to that in many other countries, Japan developed an affinity for forests as part of the managed landscape, and for wood as an essential material for traditional construction. Extensive deforestation and the expansion of timber harvesting on to higher elevations on steep slopes, which took place in the seventeenth and eighteenth centuries, were eventually modified by recognition of the benefits of forest management and conservation. In the nineteenth and twentieth centuries, planting expanded the forest area by millions of hectares, to nearly 70 percent of Japan's total land area. This situation was aided by the emergence of an industrial economy in which agriculture accounts for very small shares of income and employment, and by the ability to import raw materials, including timber resources,

from other countries. Forest conservation is integrated into Japanese culture and customs, particularly through the traditional *satoyama* approach to managing the landscape as a mosaic of forests, rice fields, grasslands, streams, ponds and reservoirs, thus meeting food, forest, water and energy needs harmoniously.

The forests of southern Asia, including those in Afghanistan, Bangladesh, Bhutan, India, Nepal and Pakistan, were cleared to provide cropland to support a rapidly expanding human population. In 1500, India's population of 100 million – more than twice that of Europe – required a steady expansion of the agricultural frontier. Deforestation accelerated during European colonization in the nineteenth and early twentieth centuries. During the most intense colonial exploitation of timber resources, from 1850 to 1920, as much as 33 million hectares of forest was cleared in India (Williams, 2002); today 68 million hectares of forest remains. When these losses are added to the deforestation to expand farming that occurred prior to colonization by the United Kingdom of Great Britain and Northern Ireland, it is probable that more than half of southern Asia's historic forest area has been lost in the last 500 years. Recent assessments suggest that the extent of forests is increasing in India, largely because of afforestation and reforestation and the expansion of tree planting on farms.

In most of southeastern Asia, shifting cultivation was the primary driver of forest clearing until the late eighteenth and early nineteenth centuries. Under colonization, commercial development, trade and population increased and the pace of deforestation increased steadily. Forests were exploited for selected tropical timbers, and cleared to plant a variety of crops such as oil-palm and rubber; between the late nineteenth and early twentieth centuries, nearly 40 million hectares of forest was cleared, mostly for commercial agriculture (Williams, 2002). Deforestation and forest degradation are continuing problems for many countries in southeastern Asia.

The Americas

In many parts of the Americas, including the eastern United States of America, Mexico, Central America, Peru and the coastal regions of Venezuela and Brazil, there is evidence that native cultures systematically used fire to clear forest or to create openings for growing crops or managing game. Archaeological evidence of pre-historic construction and charcoal remains in the Plurinational State of Bolivia and Brazil suggest that vast areas of the Amazon basin may have been cleared for

farming. The extensive forests of the western Amazon may have been significantly smaller than they are at present. Elsewhere in the Americas, there is abundant evidence of the extent to which the size and composition of forested landscapes have changed (Williams, 2002).

The Americas had an estimated population of 65 to 100 million people at the time of initial European contact in the late fifteenth century. Over 150 years, starting around 1500, the native populations were reduced to about 1 million in North America and 4 million in Central and South America (Williams, 2002). This unprecedented demographic collapse was largely the result of introduced pandemic diseases for which the native people had developed no immunity, including smallpox, measles, influenza, cholera, dysentery and yellow fever.

Initially, the population collapse in the Americas had the effect of allowing an increase in forest area, through natural regeneration in interior regions. This increase partly offset the clearing of forests that was taking place as European settlers increased the population in coastal areas. The European population in the Americas did not approach the levels reached by native populations prior to their collapse until the mid-eighteenth century. Latin America was probably about 75 percent forested before European settlement, although some studies suggest that it may have been less (see, for example, Sponsel, Headland and Bailey, 1996; Steen and Tucker, 1992). Today it is about 50 percent forested. Although some deforestation occurred in the eighteenth and nineteenth centuries, the pace more than doubled in the twentieth century (Williams, 2002).

In North America, as population increased and settlers pushed westwards in the nineteenth century, the rate of forest clearance increased rapidly. The immigrant population jumped from 2 million in 1750 to 23 million in 1850 and 75 million in 1900; the forest area of the United States of America fell from 450 million to less than 300 million hectares, with about half of total deforestation occurring between 1850 and 1900. By 1920, however, deforestation had largely stopped; today forests cover about 300 million hectares, roughly 33 percent of the land in the United States of America (McCleery, 1992). Canada also underwent a period of deforestation in the eighteenth and nineteenth centuries and has also been able to stabilize its forest area since the early twentieth century.

Africa

Forests in Africa are extremely diverse, ranging from the dry forests of the Sahel and eastern, southern and northern Africa, to the humid tropical forests of western and central Africa. Over the centuries, forests and wildlife in many parts of the continent were protected through rituals and sacred activities. Most of these attitudes were gradually abandoned during the period of European colonization, but many small, sacred forests have survived in western Africa and are still used for various rituals.

Sub-Saharan Africa consists largely of agrarian societies, primarily dependent on low-input agriculture and animal husbandry. Unlike Asia – where agricultural intensification through the green revolution helped to reduce the horizontal expansion of agriculture while assuring adequate food supplies for a growing population –

■ View of the Amazon forest, Brazil. Latin America was probably about 75 percent forested before European settlement



FAO/R. Faidutti/CFU000111

in sub-Saharan Africa, deforestation and population have gradually increased together, with the heaviest forest losses coming in areas where wood is needed for fuel or where forest land is needed for growing crops. The production of industrial crops for external markets – such as cotton, cocoa, coffee and tobacco – has also contributed to deforestation; large-scale land acquisitions by foreign investors have recently accelerated this process in some countries (Cotula *et al.*, 2009).

■ Springbok in Etosha Park, Namibia. Forests and wildlife in many parts of Africa were traditionally protected through rituals and sacred activities



FAO/M. France-Lanord/FO-5557

Agroforestry has been practised in Africa for centuries, and is the key to survival for many local communities throughout the continent. *Acacia albida*, for example, is known for its regenerative capacities on agricultural lands and as a livestock feed. The Senegalese Serer people combined cattle grazing on farmland and protection of young natural seedlings growing in cattle dunks. In the Niger, the Sultan of Zinder enacted laws punishing *A. albida* pruners with the amputation of limbs, and people convicted of felling the trees with decapitation.

In a few locations, deforestation in Africa increased during the colonial period, when trees were harvested and shipped to Europe. Forests were exploited to fuel steamboats and trains during the nineteenth century, opening up large areas of the continent for resource exploitation and agricultural development.

Agricultural technology was slow to develop in Africa, perpetuating systems that relied on slash-and-burn cultivation. Fallow periods became shorter as the human population increased, and forests were harvested for fuelwood and charcoal as cities grew. In some areas, industrial agriculture was introduced to supply export

markets, resulting in the clearing of large areas of forest and the introduction of intensive, often non-sustainable agricultural practices.

Is deforestation inevitable?

“The tragedy of deforestation in Amazonia as well as elsewhere in the tropics is that its costs, in both economic, social, cultural, and aesthetic terms, far outweigh its benefits.”

◆ Anderson, 1990

“Companies do not clear-cut forests out of wanton destructiveness or stupidity. On the whole, they do so because market signals – influenced by subsidies, taxation, pricing and state regulation, as well as land tenure and use rights – make it a logical and profitable thing to do. It is often profitable and logical because the costs of deforestation are generally not borne by companies clearing the land for agriculture or by companies logging and selling the timber. Rather, these costs tend to fall on society, on future generations, and often, on poor households in rural areas who frequently depend on the resources and services of the forest for their daily survival and security.”

◆ TEEB, 2010

As illustrated in the historical survey, although deforestation is a common pattern, about half of the world’s countries have halted or reversed forest loss. So the answer to the question of whether deforestation is inevitable must be “no”. Perhaps a more relevant, and in many ways more challenging, question would be: Are there circumstances under which deforestation is tolerable, or even desirable? Most deforestation is intentional and is not irrational. Rather, it represents a deliberate decision to convert land to a use that is perceived as having a higher value than retaining the land as forest would have. Forests have been cleared to make room for cities and farms and to produce timber, food and fuel for domestic and export markets, with the goal – if not always the result – of producing a higher standard of living for humans.

FAO’s Global Forest Resources Assessment 2010 (FRA 2010) (FAO, 2010b) estimated that the global forest area was 4.033 billion hectares, almost exactly the same as FAO’s first global estimate in 1948 (FAO, 1948; 2010b). However, the two reports are not directly comparable. Countries did not agree on a

standardized global definition of forest until 2000, so comparisons with previous assessments – many of which used a narrower definition of forest – require adjustments. Working backwards from deforestation rates found in recent assessments suggests that the global forest area in 1948 was about 4.4 billion hectares according to today's definition of forest.

FRA 2010 concludes that net deforestation at the global level occurred at the rate of 0.14 percent per year between 2005 and 2010. This compares with estimated net annual global deforestation rates of 0.20 percent between 1990 and 2000, and 0.12 percent between 2000 and 2005. The net rate is calculated by estimating the total forest area converted to other land uses, and adding back the area that is afforested plus any natural expansion of forests, for example on abandoned agricultural land.

If the world's net forest area continues to decline by 5.2 million hectares per year (the average net annual loss between 2000 and 2010), it will take 775 years to lose all of the world's forests. This would seem to provide enough time for actions to slow or stop global deforestation.

FRA reports make an important distinction between the total forest area lost in a given period and changes in net forest area. Between 2000 and 2010, the world lost about 130 million hectares of forest (about 3.2 percent of the total forest area in 2000), but gained back about 78 million hectares, mainly as planted forests and natural forest expansion. The net loss of forest area was 1.3 percent over the ten-year period.

It is not easy to generalize about the differences between losses and gains in forest area: there are many differences between a mature forest and a young forest; and the term "plantation" generates confusion and dispute, with some observers considering that planted forests do not compensate for the loss of natural or primary forests, especially considering the impact on biodiversity. However, planted forests vary widely, in both objectives and composition, while only a relatively small portion of the world's plantations are managed intensively for timber production. It must also be noted that primary forests account for only a share of current deforestation; in some regions, semi-natural and degraded forests account for the majority of forest loss. In addition, most forest loss now takes place in the tropics, while most net gains in forest area occur in the temperate and boreal zones, in very different types of forests.

Factors affecting deforestation vary widely, within and among countries; deforestation phenomena are therefore always local – deforestation has never taken place at the same rate in all parts of the world. Between 100 and 200 years ago, deforestation was a significant process in Europe and North America, but not in the tropics; today this pattern is reversed.

At the United Nations Intergovernmental Forum on Forests (IFF, 1998 to 2000), countries debated the underlying causes of deforestation (Box 2). It was agreed that the deforestation problem cannot be solved within the forest sector alone. As the underlying causes are spread throughout the economy, the solutions must be too.

A comprehensive study of the history of forests in the United States of America confirms the suggestion that macroeconomic forces often hold the key to halting deforestation. From 1700 to 1900, about half the forest area in the United States of America was converted to agricultural use. However, in the last 100 years, forest area has increased, even though population growth and urban development have continued, and have even accelerated. The explanation is that advances in agriculture – including fertilizers, intensified grazing, and technical innovations such as refrigeration and freezing – have made it possible to grow more food on less land. As a result, farms in marginal growing areas have been abandoned, and the farmland has been replaced by forest through natural regeneration or programmes for planting trees (McCleery, 1992).

At the other end of the spectrum, nine countries are currently experiencing net deforestation rates of more than 2 percent per year. This trajectory would result in the loss of most – if not all – of their forests within this century. Most of these countries or territories have low forest cover (so a small change in absolute value can produce a large percentage change). Twenty more countries or territories have net deforestation rates exceeding 1 percent per year, and another 30 have rates of more than 0.5 percent. All of these countries will face serious ecological and economic challenges if they do not slow or reverse these trends.

In Latin America, there was a net loss of 88 million hectares of forest (9 percent of the total forest area) during the 20 years from 1990 to 2010 (FAO, 2010b). This is an understatement of the actual deforestation over this period because it takes afforestation into account. The leading cause of deforestation was conversion of

forests to grazing and cropland. For the first time in history, the region's forest area fell to less than 50 percent of the total land area. If this rate of forest loss were to continue, Latin America would be without forest in about 220 years.

In Africa, forests currently cover about 23 percent of the land; African countries reported that 75 million hectares of forest land (10 percent of the total forest area) was converted to other uses between 1990 and 2010. As in Latin America, deforestation in Africa is driven by the demand for land for growing a variety of crops and for grazing. An added pressure on forest resources in Africa is that wood is the main source of fuel; about 80 percent of all wood used in the region is for fuel. An acute fuelwood shortage affects large areas of eastern Africa.

Modern tropical deforestation has been the subject of considerable academic study, much of it concluding that "policy failure is usually a more important driver of tropical deforestation than market failure" (Folmer and van Kooten, 2007). Many governments encourage deforestation by providing direct or indirect subsidies and incentives for agriculture and by failing to recognize the importance of the non-timber benefits of forests and the external costs associated with forest clearing. Folmer and van Kooten (2007) suggest that deforestation is justified when there are important opportunities for agriculture and ecosystem values are low: "Countries with tropical forests might well be reducing their stocks of forest because they are going through development stages similar to

those experienced by developed countries". A recent statistical analysis of deforestation in 59 developing countries from 1972 to 1994 confirmed that the failure of political institutions plays a significant role in deforestation, but found no conclusive evidence – in the sample – to suggest that progress in development is associated with a slowing of the rate of deforestation (Van and Azomahou, 2007).⁵

However, from a global perspective, the good news is that many countries have been able to stabilize their forest areas. During the period 2005–2010, about 80 countries reported either an increase or no change in forest area. Countries reporting increased forest area include several of the world's largest forested countries: the Russian Federation, the United States of America, China and India. In Europe, 27 countries reported increases in forest area, led by Spain, Italy, Norway, Bulgaria and France; Asian countries with significant increases, in addition to China and India, include Viet Nam, the Philippines and Turkey; Latin American countries posting increases include Uruguay, Chile, Cuba and Costa Rica; and in Africa, Tunisia, Morocco and Rwanda report the largest increases in forest area.

Although there are many underlying causes (Box 2), deforestation and forest degradation are fundamentally driven by two realities:

⁵ However, using a sample that included developed countries, Kauppi *et al.* (2006) conclude that forest area and density are positively related to economic development.

Box 2: Underlying causes of deforestation and forest degradation

During the deliberations of the United Nations Intergovernmental Forum on Forests, the global community agreed that the underlying causes of deforestation and forest degradation are interrelated and are often socio-economic in nature. Both the causes and the approaches to dealing with them are often country-specific and therefore vary among countries. The underlying causes include:

- poverty;
- lack of secure land tenure patterns;
- inadequate recognition within national laws and jurisdiction of the rights and needs of forest-dependent indigenous and local communities;
- inadequate cross-sectoral policies;
- undervaluation of forest products and ecosystem services;
- lack of participation;
- lack of good governance;
- absence of a supportive economic climate that facilitates sustainable forest management;
- illegal trade;
- lack of capacity;
- lack of an enabling environment, at both the national and international levels;
- national policies that distort markets and encourage the conversion of forest land to other uses.

Source: IFF, 2000.

- Natural forest cleared for agriculture in Aceh Province, Indonesia. Tropical deforestation has been the subject of considerable academic study



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- It takes many years to grow trees. In many parts of the world, fertile land is scarce and, compared with long-term forest management, more money can be made from growing and harvesting crops that mature more quickly and require another land use, such as farming, grazing or orchards. It is a widely observed – and ethically debated – tendency of human beings to give higher value to the needs of the current generation than to those of future generations.
- Many forest benefits are not valued by markets. There are no markets – places to sell or buy – for most of the ecosystem services provided by forests, such as sequestering carbon and helping to provide clean water. In addition, many of the negative consequences (or costs) of deforestation, such as greenhouse gas (GHG) emissions and soil erosion, are not assigned financial values or paid for through markets or other mechanisms. These positive and negative market externalities play a significant part in decisions about forests, but they are notoriously

difficult to quantify, and people seldom agree on their values.

Although oversimplifying the problem can make the solutions appear to be easier than they really are, simplification can also help clarify the type and focus of appropriate policy responses.

In the first comprehensive book on forest economics, written in 1902, Bernhard Fernow observed that “the exploitation of the forest resource for private gain is apt to lead to its deterioration or eventual destruction” because “the private individual can hardly be expected to appreciate distant interests of his own motion in the management of his forest property, hence the state must guard them” (Fernow, 1902). These arguments gained considerable attention, leading to the establishment of national forests in Europe and North America and the development of public regulation of private forest practices.

In 1976, Nobel laureate economist Paul Samuelson noted that “applying what is sound commercial practice to government’s own utilization of public forests ... is a sure prescription for future chopping down of trees”. He observed that “everybody loves a tree and hates a businessman”, and “indeed, if the externalities involved could be shown to be sufficiently important, I am naïve enough to believe that all economists would be found on the side of the angels, sitting thigh next to thigh with the foresters” (Samuelson, 1976).

There is, however, a counterpoint to these observations of the tendency towards, and consequences of, narrow, short-term thinking: in several countries, privately owned forests are among the best-managed and most productive. In many major timber-producing countries – including those in Scandinavia and central Europe, and Australia, Brazil, Chile, Japan, New Zealand and the United States of America – privately owned and, in some cases, intensively managed forests provide timber raw material for competitive forest industries. The motivation of ensuring a reliable supply of timber has been a basis for maintaining or even expanding the area of forests.

Forestry

“Planting a tree is one of the very few human actions which can really be called altruistic. A person plants a tree for his children, his grandchildren, or even for their children, but not for himself.”

◆ Seymour, 1983

↳ *Multi-purpose plantations, designed to meet a wide variety of social, economic, and environmental objectives, can provide key ecosystem services, help preserve the world's remaining primary forests, and sequester an important proportion of the atmospheric carbon released by humans over the past 300 years.*

◆ Paquette and Messier, 2010

For hundreds if not thousands of years, humans have practised forestry with the main goal of providing a steady, reliable supply of wood and other forest products and ecosystem services. Although forestry has been recognized as a science and a profession in only the last 300 years, methods for allocating and attempting to conserve forest resources have been implemented in one society after another and in different regions of the world for far longer.

Forestry: looking back

Forest policies have evolved since the Bronze Age. The Code of Hammurabi in Babylon included government regulations for felling and distributing timber. The Han Dynasty in China had similar laws about 2 000 years ago. Conservation of forests formed an integral part of the Vedic tradition of India: as early as 300 BCE, the Maurya kingdom recognized the importance of forests, and the first emperor of the dynasty, Chandragupta, appointed an officer to look after the forests. The concept of sacred groves is deeply ingrained in Indian religious beliefs, and thousands of such protected areas still conserve trees and biodiversity. There is evidence that during the Middle Ages in Europe, many kingdoms had local laws to govern the allocation and use of wood, which was recognized as a valuable resource. The objective of such laws was usually to stop harvesting rather than to encourage reforestation. In general, however, laws had little effect against the inexorable demand for land and timber.⁶ In Africa, where oral culture is strong, most clans or tribes developed codes that were handed down through the generations as tales and legends.

By the seventeenth century, forests were becoming so scarce in populated areas of France and Germany that they were eventually perceived as having a value that justified their conservation and replenishment. Human intervention was required to ensure that not all the wood was used by current generations, and that there would be sufficient wood for the future; communities in central Europe began to plant trees as well as felling

them. This simple step marks the advent of modern scientific forestry.

Hans Carl von Carlowitz published the first comprehensive book about forestry, in Germany in 1713; he became known as the father of sustained-yield forestry. His particular concern was to ensure a steady supply of timber for the mining industry where he was employed. Forestry evolved as the science and practice of managing forests and trees, and by the eighteenth century the deforestation of Europe was increasingly viewed as an economic crisis. The teaching of forestry as an applied science spread through universities in France and Germany, and systematic reforestation programmes were started in both countries.

By the late nineteenth century, the practice of forestry as a scientific discipline and a profession was spreading to all corners of the world. Colonizers from the United Kingdom of Great Britain and Northern Ireland recognized the need to conserve forests in southern Asia, where they hired a German forester, Dietrich Brandis, who became known as the father of tropical forestry for his work in what was then known as Burma and in India. Future forestry leaders travelled from North America to France and Germany to study forestry; among these future leaders was Gifford Pinchot, who established the United States Forest Service in the early twentieth century.

In Chile, laws to protect forests date back to 1872, and the first national forest reserves were established in 1907. All over South America – in Argentina, Brazil and Peru – the economic value of forests gained increased attention. Throughout the twentieth century, forestry schools were established, and new policies and laws for conserving and managing forest resources were enacted in countries across Latin America.

In Japan, a complex series of forest customs and laws evolved over several centuries, exerting effective controls on the harvesting of trees and resulting in the protection of forests and a system for allocating forest products. Private citizens did not own the forest but had rights to controlled harvesting, which were similar to the concessions in modern public forests in Western countries. The result was the conservation of a much higher percentage of forest than in other densely populated societies.

By the end of the First World War, widespread deforestation was coming to a halt in eastern Asia,

⁶ A similar failure can be noted in efforts to repress forest fires.

- Native forest of *Araucaria spp.* in the Andes Mountains, Chile. In Chile, laws to protect forests date back to 1872, and the first national forest reserves were established in 1907



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Europe and North America. The most important reasons were economic, as discussed earlier, but an important complementary factor was the spread of forestry as a science and profession, resulting in new laws, policies and government agencies in countries around the world.

In most countries, the majority of timber was harvested from natural forests, and the primary thrust of forest management was to regulate the pattern and rate of exploitation. However, as forests were cleared for use in agriculture, and timber stocks declined, it became necessary to make deliberate efforts to restore and rebuild forests through afforestation and reforestation, sometimes using methods that closely followed natural systems of disturbance and regrowth. Nevertheless, the transition from a hunter-gatherer approach to systematic cultivation is more recent for forestry than for agriculture. The hunter-gatherer approach to forestry still persists in many countries, even though planted and managed forests account for more than half of the world's timber production, and supply all of the timber raw material in several important timber-producing countries.

Forestry today

By the middle of the twentieth century, many countries recognized that forests need to be managed for more than timber. Laws were enacted mandating multiple uses of forests for recreation, wildlife and water, in addition to timber. Forest management practices, including sustained yields of timber, were codified as public policy throughout Europe and North America, and in colonial territories. In Europe, the multi-functionality of forests gained prominence in the late twentieth century.

Forests were increasingly valued for soil protection, watershed management, protection against avalanches and provision of biodiversity. When combined with economic forces that reduced the incentive to convert forest land to other uses, changes in policy helped to bring deforestation to a halt in most of the temperate world.

In many developing countries that used to be European colonies, attempts were made to duplicate the forest laws and practices of the colonizing power. Towards the end of the colonial period, several European countries made efforts to introduce good forest practices in their colonies, such as the United Kingdom of Great Britain and Northern Ireland in southern Asia, and France in western Africa and the Maghreb countries.

However, the end of colonial rule often left a country without the technology, human capacity and financial resources to manage its forest resources effectively. Governments of newly independent countries had to pay increased attention to economic and social development, and forests were often seen – and used – as a resource and asset to support these efforts. In many instances, poor governance and corruption resulted in the rapid depletion of forests, without any concomitant benefits to society. FAO and a number of bilateral aid organizations have focused energy and resources on capacity building in developing countries in all regions, enhancing institutions and technical capacity, including by supporting education, research, extension and local community involvement.

During the 1970s, advances in the study of ecology influenced forestry practitioners in expanding their focus from the sustainable management of forests primarily for a single product (timber) to a broader emphasis on ecosystem and social services in addition to wood and non-wood products. Education and practice gave increasing attention to the importance of forests in providing clean water and biodiversity. By the 1990s, concepts of “ecosystem management” were replacing “sustained-yield forestry” as organizing principles, especially in developed countries.⁷

At the same time, the idea of “putting people first” was coming to the forefront in many developing countries.

⁷ It has been argued that the recognition of forests as complex systems with broad, tangible and intangible benefits has precursors in the beliefs and practices of ancient societies and indigenous peoples (see, for example, Banuri and Appfel-Marglin, 1993).

It was increasingly clear that top-down solutions were not very effective. The theme of the World Forestry Congress in Indonesia in 1978 was “Forests for People”; the congress helped to provide impetus to a movement variously known as “social forestry”, “community forestry” and “participatory forestry”. The basic idea is summed up in the name of a field-oriented programme coordinated by FAO in the 1980s and 1990s: “forests, trees and people”.

- Primary forest of the Tailândia region of Brazil, site of a sustainable forest harvesting project. Sustainable forest management is understood as being the cornerstone of good forest policy



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As recently as the late twentieth century, there were heated debates within and among countries regarding the meaning and wisdom of sustainable forest management. Today, the concept is broadly accepted and understood as being the cornerstone of good forest policy. Sustainable forest management has evolved to recognize the importance of adopting a broad, multidisciplinary approach to managing forests in ways that sustain a variety of forest goods and ecosystem services, while explicitly taking into account the role of forests in relation to other sectors, based on the three interdependent pillars of sustainable development: economy, society and environment.

In the past ten years, the importance of forests in mitigating climate change through carbon sequestration has become widely understood and accepted. By the 2000s, it was increasingly clear that deforestation and forest degradation were major contributors to global climate change. In response, and to halt the conversion of primary forests to other land uses, several developing countries have pioneered new approaches to forest management, including the use of payments for ecosystem services as a financial tool.

An emerging challenge is reaching consensus on how to use the concepts and methods of sustainable forest management to integrate forest products and services into a green economy for the future, in which economic growth is based on sustainably managed natural systems. Important and immediate consequences would be to stabilize, or in some circumstances increase, the area of forests, and to increase the quality of forests – their ability to provide goods and ecosystem services sustainably. The net loss of forests would be reversed. However, forest management, science and policy face challenges in reaching this result, not the least being the need for a broader and deeper knowledge of the importance of forests and forest products. For years, foresters and forest policy-makers have recognized the need to deal more effectively with forces outside the forest sector – that is, forces outside their own sphere of influence. As this chapter has shown, deforestation is almost always the result of such forces.

Unfortunately, in contemporary discussions of the green economy, foresters may find themselves on the periphery, apparently with limited relevant experience and therefore little influence. Climate change, globalization and unknown future changes in technology are among the factors that complicate the already complex interactions of forests and forest management with other sectors, giving rise to daunting policy problems. One of the biggest challenges for forestry professionals is therefore building on and extending their expertise to demonstrate their ability to help solve these problems; find ways of ensuring that the full range of forest functions is recognized and valued by society and reflected in the global political economy; and ensure that forests play an integral role in the future green economy.

Sustainability: an enduring value

“Sustainable management is a beguiling term and open to many interpretations. It contains many uncertainties and ambiguities.”

◆ Poore, 2003

Sustainability requires the making of decisions that take into consideration the needs of future generations as well as present needs. Although the future, including the needs of future generations, cannot be known, the lessons of history and of contemporary earth sciences and ecology underscore the importance of forests and the need to ensure that future generations

- Baskets for sale at a market, Plurinational State of Bolivia. On balance, the demand for goods and services from forests has contributed to forest conservation by sustaining the perception of forests as valuable assets



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can enjoy and use forests' many benefits. The resilience and productivity of well-managed forests provide an opportunity for meeting the needs of many generations.

The idea of sustainable output, which is a core concept of scientific forestry, dates back about 300 years. In the past 40 years, this concept, and forestry itself, have deepened and broadened to encompass the ecosystem services provided by forests and their critical role in sustaining life on earth. As a consequence, the social and economic functions of forests are better understood, and the role of people and communities that directly depend on these ecosystem services is increasingly appreciated and used in the management of forests.

Transformation of the environment has been a feature of human history for thousands of years, and can be expected to continue. When applied to forests or other resources, the concept of sustainability links consideration of the interests of future generations to actions for meeting the needs of today. Inevitably, perspectives on environmental transformation, including deforestation, are influenced by people's direct experience of the costs

or benefits of these changes; perspectives can also be expected to change over time: sustainability is a dynamic rather than an absolute concept.

This diversity of perspectives should not lead to the conclusion that there are no bad choices or bad outcomes – an environmental equivalent of moral relativism. Instead, it argues for the need to understand the lessons of history, including the lesson that not all deforestation is bad, but some deforestation is catastrophic. Another lesson is that the long-term effects of forest use, including deforestation, are typically determined by a combination of factors, such as subsequent patterns of land use and accompanying patterns of weather and climate. In the past, where population pressure continued unabated and soils were degraded, forests did not return; however, there are also examples from many continents and cultures where – given the opportunity, including the right policies – forests have recovered.

On balance, the demand for goods and ecosystem services from forests (including wood products) has contributed to forest conservation by sustaining the perception of forests as valuable assets. The science of sustainable forest management will play an important supporting role, but it is the perception of forests' role – immediate or potential – that is the critical element. When considering the importance of forests and their role in a sustainable future, discussed in detail elsewhere in this volume, it is important to understand the central role that forests and their products have played in the economy in the past. Looking ahead, forests should be seen as an increasingly valuable asset – for example, as a source of renewable energy and as a natural system providing multiple services, including the capture and storage of carbon created by the use of fossil fuels. Forestry must therefore continue to evolve and, in doing so, will have a profound impact on the future global economy and environment.