
Mit GOtt!
SYLVICVLTVRA OECONOMICA,
Oder
Haußwirthliche Nachricht und Naturmäßige
Anweisung
Zur
Wilden Baum-Zucht,
Nebst
Gründlicher Darstellung/
Wie zu förderst durch Göttliches Benedeyen dem allenthalben und insgemein einreissenden
Grossen Holtz-Mangel/
Vermittelst Säe- Pflantz- und Versetzung vielerhand Bäume zu prospiciren/
Alles zu nothdürfftiger Versorgung des Hauß- Bau- Brau- Berg- und Schmelz-Wesens/
Worbey zugleich eine gründliche Nachricht von den in Churfl. Sächß. Landen
Gefundenen Turff
Dessen Natürliche Beschaffenheit / grossen Nutzen / Gebrauch und nützlichen Verkohlung.
Von
Hannß Carl von Carlowitz/
Königl. Pohl. und Churfl. Sächß. Cammer-Rath/und Ober-Berg-Hauptmann.
Mit Königl. Pohl. und Churfürstl. Sächß. allergnädigsten PRIVILEGIO.
LEIPZIG/
verlegts Johann Friedrich Braun 1713.

***A facsimile of the front cover of the first edition of von Carlowitz's seminal work,* Silvicultura oeconomica**

Three hundred years of applied sustainability in forestry

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The scientific approach to forestry has evolved from sustainable wood production to multifunctional forest management.

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Today's guiding principle of sustainability has its origins in forestry. In 1713 – 300 years ago this year – Hans Carl von Carlowitz, a German, published his book *Silvicultura oeconomica*, which advocated the conservation, growing and use of wood in a continuing, stable and *sustained* manner. This was the first documented use of the German term for sustainability, *Nachhaltigkeit*. Arguably, it was also the start of a scientific approach to forestry, which ultimately expanded from Central Europe to the rest of the world. This article uses historical and contemporary sources to show how the principle of sustainability has permeated approaches to forestry beyond Europe and remains the guiding light of forestry today.

THE BEGINNING

Early reactions to forest overuse and degradation

Many early measures were taken to help conserve forests in Europe. In Germany, for example, common law as early as 1330 mentioned that woodcutting should be moderate and carried out without causing devastation (Mantel, 1990). Specific rules were adopted by villages, communal land associations, monasteries and towns. Measures included a ban on felling trees that yielded foods (e.g. fruits) and non-wood forest products. Forests near settlements were reserved for the use of local people and divided into coupes (rotation areas) to be harvested annually, after which such areas were to be protected from grazing until tree regeneration was assured.

In medieval France, the concept of sustainability appeared in the use of the Old French word *soustenir*, "to sustain", a technical term used in the *Ordonnance de Brunoy*, which is the first known French law dealing with the management of waterways and forests. Enacted in 1346 by King Philippe VI, the law stipulated that: "The owners of waterways and forests will make enquiries about and visit all forests and woods and will conduct sales that will allow the aforementioned forests to perpetually sustain themselves in good condition".

In Britain, John Evelyn's *Sylva: a discourse of forest-trees and the propagation of timber in His Majesty's dominions*, was presented to the King, the Royal Society and the public in 1664 (Grober, 2007). The book was reprinted several times during the seventeenth century and encouraged the planting of millions of trees, albeit in the parklands surrounding the country estates of landed gentry and the aristocracy.

Growing demand

Ultimately, though, such early efforts to ensure the conservation and management of forest resources were insufficient. The growing demand for wood in Europe in the seventeenth century for early industrial processing led to increasingly intensive prospecting for usable forests and the systematic exploitation of newly opened forest stands for wood (Mantel, 1990). In Germany, Austria and Switzerland, the need to supply the mining and salt production industries was urgent. In coastal countries such as Britain, France, Portugal, Spain and Sweden, maintaining a wood supply for shipbuilding was one

***An etching of woodcutters that appeared in von Carlowitz's* Silvicultura oeconomica**

of the main concerns. The push for wood and agricultural land led to large-scale tree-felling, complete forest clearance and inadequate regeneration. This had serious negative effects on forest condition, as evidenced by the contemporary reactions of independent observers and campaigns by local inhabitants, and by desperate descriptions of cleared areas and overused forests. Deciduous and mixed forests declined, and there were changes in the distribution of tree species such as beech, oak, pine and fir. By the beginning of the eighteenth century, the demand for wood could no longer be met by expansion into previously unused forests.

VON CARLOWITZ AND THE MOVE TO *NACHHALTIGKEIT*

In 1713, as head of the Saxon mining administration, Hans Carl von Carlowitz (1645–1714) published *Sylvicultura oeconomica, oder haußwirthliche Nachricht und Naturgemäße Anweisung zur Wilden Baum-Zucht* (in brief, *Economics of silviculture: instruction for cultivating wild trees*). In this 300-page treatise, von Carlowitz drew on his experiences, the written materials of others, international contacts and visits, and his own conviction that a new approach to using forests in a sustainable manner was required (see box). A second, augmented edition of the book, with a new section by the editor Julius Bernhard von Rohr, appeared in 1732, 18 years after von Carlowitz's death. The text became a must-read, not only for generations of foresters but also for state administrators and managers in the mining industry. *Sylvicultura oeconomica* can still be read without difficulty, and in many respects its content is as fresh and relevant today as it was when it was written.

In *Sylvicultura oeconomica*, von Carlowitz wrote about the lack of wood and its causes and noted "that, over time, many provinces of Europe will have great forests logged over and made thin". He not only set out a framework for a modern forest and wood-processing sector, he also created the term *Nachhaltigkeit* ("sustainability")

Hans Carl von Carlowitz

Hans Carl von Carlowitz, 1645–1714

The son of a forester, Hans Carl von Carlowitz was born in the Saxony town of Chemnitz, Germany, towards the end of the Thirty Years War. He studied law and public administration in Jena, learned foreign languages, and as a young man spent five years on a tour of Europe that spanned from Sweden to Malta and included lengthy study stays in Leyden, London and Paris (Grober, 2010, 2012). On his return to Germany, von Carlowitz entered the state service. In 1677, at the age of 32, he became the administrator of mining, and in 1711 he was put in charge of the mining industry at the court of the Electorate of Saxony. He lived in Freiberg, in the foothills of the Iron Mountains (*Erzgebirge*), known for their silver mines.

The Saxony mines were flourishing, employing about 10 000 miners. Their smelting furnaces devoured enormous quantities of charcoal, firewood and construction timber, and von Carlowitz was responsible for ensuring the wood supply. Thus, he was confronted with the industry's greatest problem at the time – a lack of wood. Large areas of forests had been exploited, and the devastated areas were unlikely to be productive again for many years. Trees had been cut-over for generations, old-growth forest had disappeared, and no effort was being made to regenerate the forests. The extensive grazing of cattle, pigs and goats, as well as subsistence agriculture, impeded forest recovery. In many cases these agricultural practices had long-lasting consequences for forest soil fertility, exacerbated by practices like litter-gathering.

DETLEV MÜLLER

Modern-day Freiberg, Germany

Von Carlowitz was strongly critical of the short-term thinking, driven by quick profits, that led to the ruthless exploitation of forests for their wood and then to their conversion to agriculture. He developed ideas intended to ensure a lasting supply of wood and to create a permanent economic resource. He suggested other measures that are still central to sustainability today, such as improving the insulation of houses, using energy-efficient smelting furnaces, and improving agricultural land management practices.

Most important was his forcefully argued and simple message that there would be no future wood supplies if the cut-over areas were not replanted systematically. This implied not just comprehensive legal and economic measures undertaken by the state, but a complete rethinking of the forestry problem and a major effort to persuade people

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to plant trees and maintain forest regrowth. It also required establishing a competent forest service with specialists who understood both the biological basis of tree-planting and the managerial tasks of developing a permanent wood production regime.

***Sylvicultura oeconomica* was written in the tradition of mercantilism, which was the prevailing economic theory of his times. It brought a new, rational approach to society and change as well as to humanity's understanding of nature and its relationship to it. It was conceived in the spirit of the Enlightenment and the Age of Reason, and marked the beginning of forest science and teaching.**

By no means does the work of von Carlowitz stand alone. He learnt from others and others came to learn from him. With his wide knowledge of the literature, he had the ability to compare the forest situation in Saxony with that in other European countries. He was well aware of innovative efforts undertaken elsewhere to develop new approaches and a more productive use of land in both agriculture and forestry. During his stay in France he became familiar with Colbert's legal reforms, which led to the Forestry Code of 1669. He quoted the new code extensively in his book, saying that it already contained most of his own work. He visited the forest of Montello in the Alto Adige, which was managed by the city of Venice for the supply of hardwoods for the Venetian fleet. And he likely knew John Evelyn's *Sylva* (see main text).

by referring to the concept of *nachhaltige Nutzung* ("sustained use"). He provided a definition for what became, in following decades, the basic concept of forest management:

> *The greatest art, science, diligence and institution of these countries will rely on the manner in which such conservation and growing of wood is to be undertaken in order to have a continuing, stable and sustained use, as this is an indispensable cause, without which the country in its essence cannot remain.*[*]

Von Carlowitz's concept of sustainability was further developed by others. In his book *Grundsätze der Forst-Ökonomie* (*principles of forest economics*), Wilhelm Gottfried Moser (1757), an administrator and forester, referred to the intragenerational and intergenerational elements of *Nachhaltigkeit*: "A sustainable economy is as reasonable, just and wise as it is certain that man must not live only for himself, but also for others and for posterity". Georg-Ludwig Hartig (1795) formulated the principle of sustainability from an intergenerational perspective, remarking in his textbook *Anweisung zur Taxation der Forste oder zur Bestimmung des Holzertrags der Wälder* (*Taxation of forests*) that:

> *It is not possible to think about and expect sustained forestry if the wood allocation from the forests is not calculated according to sustainability … Any wise forest direction consequently needs to tax (assess) the woods as high as possible, but aiming at using them in a way that the descendants can draw at least as many advantages as the now-living generation appropriates.*

In this last phrase it is possible to see the seeds of the modern concept of sustainable development, which the World Commission on Environment and Development (1987) defined as "development which meets the needs of the present without compromising the ability of future generations to meet their own needs".

In 1841, Carl Heyer referred to the sustainability of wood production when he remarked that a forest could be considered to be "managed in a sustainable manner if one takes care of the regeneration of all logged stands in order to maintain the soil that is destined for forest production". The Swiss forester Karl Albrecht Kasthofer, who had studied in Heidelberg and Göttingen, translated the meaning of *Nachhaltigkeit* as the "sustained and equal product of a forest".

THE PRINCIPLE OF *NACHHALTIGKEIT* SPREADS

Europe

Nachhaltigkeit started to become a reality in science-based forest research and education in the early 1800s (Grober, 2007). The first privately run schools to teach practical forestry were founded in the Harz Mountains and Thuringia (Germany). Heinrich von Cotta established a school in Tharandt (in Saxony, Germany) in 1811. There were strong professional relations between Germany and France: Bernhard Lorentz, a native of Alsace in France and a life-long friend of Georg Ludwig Hartig, became the founder and first director of the French National Forestry School in Nancy. This school was established in 1824, followed quickly by the enactment of the French Forestry Code in 1827.

Step by step in Europe, policies and laws introduced and normalized principles of renewable natural resource use. Silvicultural models of wood production were developed, adapting wood harvesting to the long-term productive capacity of forest stands. European forestry professionals and scientists became well known, and technical schools and academies gained reputations and attracted foreign students. Graduates from these schools travelled to other countries and spread the idea of sustainable wood production. Johann Georg von Langen, an influential German forester, for example, worked for many years as an adviser to the Danish court, helping to build principles for forest resource management in Denmark and Norway.

Tsar Peter the First ("Peter the Great") and Tsarina Katharina ("Catherine the Great") used German experts when establishing

[*] Translations are by the author.

a forestry profession in Russia. Peter the Great visited Saxony in 1698 and returned to see von Carlowitz in 1711 and to visit one of the salt mines. Later, he recruited miners from Saxony to build up the mining industry in Russia (Grober 2010, 2012). The oldest forest education institution still in operation today is the St Petersburg Forest Academy, which was established in 1803. In the mid-nineteenth century, Spanish and Portuguese students received grants to study forestry in Germany and were critical in the establishment of the first forest schools and modern forest administrations and forest codes in their native countries (Rojas-Briales, 1992).

Below, the examples of India and the United States of America illustrate the spread of the principle of *Nachhaltigkeit* beyond Europe.

India and Burma

In British-ruled India, the felling of trees was unregulated in the first half of the nineteenth century. In 1850, at the initiative of Hugh Cleghorn, the British Association in Edinburgh formed a committee to study forest destruction. In 1855, Lord Dalhousie, governor-general of India, issued a memorandum calling for forest management.

Dietrich Brandis was born in Bonn, Germany, and studied at the universities of Copenhagen, Göttingen, Nancy and Bonn; he became a lecturer in botany in the latter. He joined the British Imperial Forest Service in 1856 as superintendent of the teak forests in eastern Burma. After seven years in Burma, he was appointed inspector-general of forests in India and held that position for 20 years. He promoted the "taungya system", an early form of agrosilviculture: villagers provided labour for clearing, planting and weeding teak plantations and in return were allowed to plant food crops between the teak saplings in the early years of the cycle before the tree canopy closed. As the distance between the village and each newly established forest area grew, however, the plantations became increasingly difficult to maintain and later there was local resistance to them (Gadgil and Guha, 2006).

Brandis developed teak growth-and-yield tables as a reliable basis for determining allowable annual cutting volumes under a sustainable management regime. Forest protection plans against tree disease and fire were drawn up, timber purchasing rules were formulated, and extensive teak plantation schemes were planned and implemented. The Indian Forest Service, with administrative and operational districts under the responsibility of forest conservators, was established, with Brandis at its head. Brandis also prepared new forest legislation and helped establish forest research and training institutions – in particular, the Imperial Forest Research Institute at Dehra Dun in 1906. Many of the accomplishments of Brandis were of interest in other countries in Asia and Africa and contributed to the spread of sustainable forestry practices.

TONYNIRAPPATHU

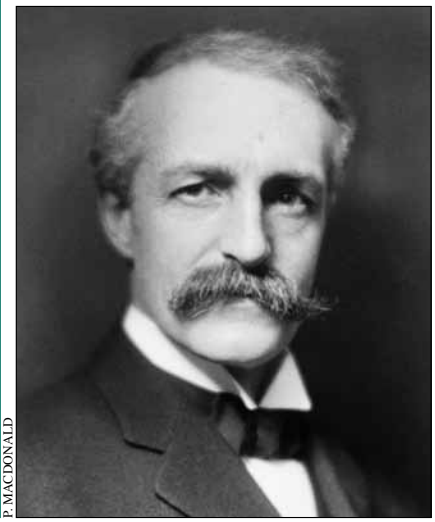
The world's largest teak tree, Parambikulam forest, Kerala, India

The United States of America

The concept of *Nachhaltigkeit* reached the United States of America through several channels. One was Bernhard Fernow (1851–1923), who studied forestry at the University of Königsberg and the Forest Academy in Münden before marrying an American woman and settling in the United States. As chief of the Division of Forestry in the United States Department of Agriculture from 1886 to 1898, Fernow's focus was on establishing a national forest system, introducing science-based forest management, and protecting forested watersheds. From 1898 to 1903 Fernow was the first dean of the New York State College of Forestry at Cornell, and in 1907 he became the founding dean of the University of Toronto's Faculty of Forestry in Canada. He established the *Forest Quarterly* (which later became the *Journal of Forestry*) at Cornell in 1902 and was that publication's editor-in-chief until his death.

Scientific and professional ties between the United States and Europe strengthened during the career of Gifford Pinchot (1865–1946). After graduating from Yale University in 1889, Pinchot followed the advice of Dietrich Brandis, at the time a professor in Bonn, and enrolled in a one-year forestry course for senior officials specializing in forest management at the French National Forestry School in Nancy. During his time in Europe, Pinchot became familiar with the work of high-level scientists and researchers, both through personal contact and from reading the literature, and he also learned from experienced forest practitioners and from forest excursions he made in France and Germany. In his later career in the United States, Pinchot returned several times to Europe to visit scientists and colleagues he had met during his stay in Nancy. In 1898 he succeeded Fernow as head of the Division of Forestry. In 1905 Pinchot was appointed chief of the newly established United States Forest Service, of which he was in charge until 1910.

Gifford Pinchot in 1909. At the time of this photo he was the first Chief of the United States Forest Service



P. MACDONALD

Pinchot understood that if they were to engage in tree-planting as an economic venture, Americans needed clear and convincing evidence that sustainable forestry by private landowners would repay the funds invested by generating income – in the short term as well as the distant future. Pinchot also believed that the system on which European *Nachhaltigkeit* was based was not the way to proceed in the United States. In much of Europe at the time, the general citizenry was little involved in the use and management of state and communal forests, and decision-making was left to an admittedly competent and dedicated state forest administration. During his stay abroad, however, Pinchot had noticed that the Sihlwald of Zurich was an exception – an example of *Nachhaltigkeit* in which local people had a direct say. Pinchot believed that the United States, with its democratic political system, would not achieve a shift to sustainable forestry without the consent and active participation of its citizens. A comprehensive policy of natural resource conservation and preservation required the understanding and support of the American public, private landowners and policy-makers.

Pinchot's book, *Breaking new ground*, published posthumously in 1947 (Pinchot, 1947), provides a breathtaking insight into the origins of sustainable forestry in the United States. Pinchot was able to combine his knowledge of forestry with a profound understanding of the political, economic and social circumstances determining the development of sustainability in his country. The book remains relevant today because it addresses many issues that are fundamental to forest development in modern societies.

BUILDING A MULTIFUNCTIONAL FOREST SECTOR IN EUROPE

The process of building a productive forest sector in Europe during the nineteenth and twentieth centuries is a model for promoting the sustainable management of renewable resources in other sectors. The decisive aspect during the transition from local forest management regulations to the implementation of the *Nachhaltigkeit* principle was the recognition that forests could be used permanently as renewable resources for profitable and efficient commercial and industrial activities while maintaining and even increasing their productive capacity. In Europe, growing stock and annual increment have both increased since the beginning of the nineteenth century, thanks to highly developed silvicultural practices that conform to the *Nachhaltigkeit* principle. Considerably larger volumes of roundwood can be harvested sustainably today than were available two hundred years ago.

During the nineteenth century there was a separation of the agricultural and forestry production systems as efforts were made to intensify the production of arable land and pasture on the one hand and to limit damage to forest stands and establish the conditions for increased wood production on the other. This led to important landscape changes: for example, many biodiversity-rich biotopes that had developed under less intensive land management systems disappeared or were reduced in size.

By the mid-nineteeth century, the sustainability of wood production had become a major consideration for foresters,

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Natural beech forest, Germany

both public and private, who calculated allowable annual wood harvest quantities in relation to the growth and yield of the available forest stands. One of the methods for regulating the rate of wood-harvesting was an area allotment system (*Flächenfachwerk*) that divided forest into annual harvest sections. The volume allotment method (*Massenfachwerk*) was later introduced to account for differing wood-supply capacities, by area. In this latter method, the usable total growing stock was divided according to the planned rotation period. More recent methods include management regulations based on the annual increment of forest stands, and the control method, in which the sustainability adjustment is based on a periodic assessment of the development of the growing stock.

The widespread use of coal and oil, improvements in infrastructure and the intensification of agricultural production based on mechanization and fertilizers reduced pressure on forests to produce wood as an energy source and created conditions under which forests could be used as a lasting supply base for industrial wood-processing. Putting the *Nachhaltigkeit* principle into practice meant adjusting the intensity of felling to the long-term production potential of forest stands and sites. Silvicultural techniques were developed for regeneration, the tending and thinning of young stands, and matching species to site conditions and end uses. Forest ecology became an important discipline in forestry research and development (Dupuy, 2005).

The importance of tenure

Ensuring the continuity of and increasing the wood supply required considerable private and public investment, but this could not be obtained without secure forest tenure. The current property rights structure in European forests was established largely in the nineteenth century. Forest lands were surveyed, mapped and entered into land registries. Defining, clarifying and formalizing forest ownership rights, and physically marking ownership boundaries on the ground, were among the most significant contributions made by forest laws during the nineteenth and twentieth centuries.

The first generation of forest laws in Europe tended to restrict or abolish usufruct rights and transform collective tenure into clearly defined private, communal and state landownership. Customary private and collective use rights were legally registered, or forests still under collective tenure were divided among users and became private forests. In other cases, communal and state forests were confirmed or created. Quite often, a combination of private and public forest tenure developed. More recently, the distribution of property and use rights has changed as a result of the sale of forest land, the afforestation of former agricultural areas, and political and constitutional changes.

Legal requirements usually focus on protecting forest cover, setting minimum standards for sustainable management, and ensuring increased productivity. New forest laws generally aim to protect

landowners' wood production and their right to use their forestland as a productive asset for generating income and profit. The laws also determine landowners' responsibilities for serving certain purposes in the public interest, such as watershed protection, by stipulating the maintenance of permanent forest cover.

In Spain, two main historical events were of particular importance for the distribution of land use and tenure. The first was the *Reconquista* (the reconquest of Moorish Spain in the Middle Ages), which had significant consequences for land development in the pre-industrialization period of the late eighteenth century. The second was the forced sale of church, municipal and crown forests in the nineteenth century, known as *desamortización*. This process, affecting at least 4.5 million hectares of forest (18 percent of the total forest area), was in line with liberal post-French Revolution thinking but was applied in Spain in an exceptionally unstable political environment. The expected advantages were very limited, and many authors identify it as a cause of the country's last deforestation wave (Rojas-Briales, 1996).

FOREST MANAGEMENT IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

Today, silviculturists in Europe use a range of harvesting techniques and regeneration methods to achieve stable and sustainable forest production. Efforts to promote natural regeneration and a proportion of deciduous trees in planted coniferous stands have intensified, especially in Central Europe. The conservation of genetic resources and landscape features while maintaining the capacity of forests to adapt to changing environmental conditions is now a major silvicultural goal in most European countries. Close-to-nature forest practices (Küchli, 2013) help maintain the diversity of forest stands while providing flexibility in production and creating attractive, varied landscapes.

What forests mean today to people living in largely urbanized European societies is an interesting subject of debate and social research. The findings of such research confirm, first of all, that forests continue to be seen as a usable and productive part of the human environment, and that their management is conditioned by economic and social preferences and competition with other materials. Because wood is a renewable resource that can be managed sustainably, and because forests have a largely carbon-neutral life cycle, the production and use of wood is an essential political option in efforts to protect the environment and mitigate climate change.

At the same time, empirical studies show that forests have acquired new meaning and significance in society. The aesthetic values of trees and forests were already acknowledged at the turn of the twentieth century (von Salisch, 1902). For a growing part of the population today, the forest represents a space for recreation that is different from more intensively used areas. Increasingly, Europe's forests are seen as natural; people perceive them as representing the free interplay of natural forces, in contrast with inhabited areas and land exploited intensively for agriculture. This perception reflects the needs and preferences of a growing part of contemporary society and the desire of urban populations for relaxation in natural surroundings. Forests address a need brought on by growing threats to the

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Mixed broadleaf forest, Germany

global environment, including the loss of biodiversity. For a large number of people, forests are places for meditation, reflection and personal freedom.

Under *Nachhaltigkeit* today, forest practices address a range of forest uses, societal values and management systems. The concept of priority functions allows approaches that determine which management priorities are assigned in a given forest stand. Accordingly, managers prioritize their objectives and the measures that must be taken to achieve them, and they limit or avoid uses and interventions that are incompatible with priority forest functions. Such a process-steered approach provides, for example, transparent evidence of performance in preserving the stability and productivity of protected forests. Distinguishing priority functions in given forest areas is useful whenever divergent interests lead to conflicting goals in natural resource management. Priority functions may relate to entire geographically delimited landscapes and watersheds or to units such as forest stands and biotopes.

Balancing private and public interests in management planning, seeking agreement among stakeholders with divergent interests in preparing national forest programmes, and creating workable arrangements for landowners facing public demands for the services provided by their forests have all become important forest-policy objectives. Such requirements are the result of a major shift from governmental and hierarchical regulatory systems to formalized negotiation procedures, public process steering, and joint management responsibilities. Close-to-nature forest management systems allow managers to adapt their strategies to meet changing societal values, leaving options open for alternative uses and new developments.

CONCLUSION

In the face of pressing demands for environmental protection and the conservation of biodiversity on a large scale, it is not the principle of *Nachhaltigkeit* that is in question today, but certain forest practices that are deemed incompatible with sustainable development. The legacy of von Carlowitz and his approach to forest management is capable of taking into account profound currents of opinion in society. Multifunctional forest management can react flexibly to diverse social interests and adapt forest management to local social and environmental conditions. It provides multiple options for responding to market trends and the changing needs and values of society, while not precluding options for future generations.

Sustainable forest practices have developed steadily since von Carlowitz's day. His central idea formed the basis of the long subsequent history of forestry development. But the goals of sustainable forestry – nowadays called sustainable forest management – and the strategies to achieve them have been adapted over time as environmental and socio-economic conditions have changed. The secret for achieving sustainable forest management is to maintain the principle of sustainability while adapting forest management strategies to changing circumstances. In this, forestry has shown the way for other natural resource management sectors. ◆

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