

Short Communication

Sustainability in Managed Forests of Central Europe

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INTRODUCTION

The concept of sustainability has become established in scientific circles, but its practical implementation in politics and economics is difficult and has not been very successful. Here we are investigating the concept of sustainability for managed forests in Central Europe, where this term was initially generated in the 18th century. At that time, forests were mainly owned by the nobility, and they had been overexploited for centuries by multiple and overlapping rights of utilization. With increasing demands for wood in the early days of industrialization, wood was used above and beyond the needs of a farming society. Timber was used as ash for glass-production, as soot for printing, as charcoal for metalworking, as roundwood for mining, as sawn timber for construction and as bioenergy. Forests were used not only for wood production, but also for hunting by the nobility and for grazing of livestock. Taken together, the aforementioned demands exceeded the growth rate of the existing stands, and the result was a reduction of forest biomass stocks and a shortage of timber and wood products in the 18th century. The shortage of wood led to the development of forest sciences recommending to convert forests from “coppice with standards” into high forests with age class management [1]. This resulted in bigger trees and higher wood volumes per hectare, but it remains to be seen, whether this management has become sustainable in modern times.

In the following perspective article, we intend to evaluate modern forest management above and beyond the classic economic view of forest sustainability by following the Rio conventions [2]. We will investigate the economic sustainability in combination with the intended ecological and societal sustainability. The main objective is to view sustainability beyond the carbon balance.

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Submitted: 22 January, 2026**Accepted:** 18 February, 2026**Published:** 21 February, 2026**ISSN:** 2333-7141**Copyright**

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A Short History of Sustainable Forest Management

The situation was not new, when von Carlowitz wrote his book “*Sylvicultura Oeconomica*” (1713) [3] in order to convince the ruler of Saxony that a change in forest management was necessary. Carlowitz demanded that timber harvesting should not exceed the growth of wood in the forests of the ruler’s property. However, von Carlowitz did not define the timber stock, which is required to meet this condition. His aim was to produce round wood with small diameters for mining, which meant that this wood should be harvested at a time when the forests had not yet formed seeds, which would be unsustainable in the long term. The development of mining over the last 300 years resulted in a situation that there is not even a market for mining wood these days. Thus, only the idea remained after 300 years and not the desired product.

Wood shortage and attempts to manage forests sustainably are much older than von Carlowitz’s book. A written concept had already been developed in the 11th century by monks in Italian monasteries. At the monastery Eremo di Camaldoli near Florence the rule was simple: *You should not cut a tree before a new one is growing* [4]. However, the monks were very active in planting new trees. Thus, after 1000 years the region is covered with fir forests. The monks managed their forests beyond sustainability. A similar trend can be observed in Germany, where timber stocks have increased since the 1st National Forest Inventory in 1989. The timber stocks of Europe’s forests have increased by 50% over the last 30 years [5].

During the 19th century the pressure of utilization of Central European forests has lessened, when fossil energy and chemical processes were able to replace wood. The main uses of wood are now concentrated in construction, in pulp production (cellulose) and in heating of buildings. At the same time, the concept of sustainability has been

developed from using single trees or stands towards managing forests at landscape or even national scales. At a landscape level, young forests should balance the harvest of old forests. It was in 1915 in Germany that the first law was passed prescribing a 10-year management plan to prevent overexploitation [6]. In reality, however, forests were overused during wars. In addition, forests have been damaged locally, for example by bark beetles and by windthrow. Nevertheless, since World War II German forests increased in area and biomass stocks per ground area until today, mainly due to substitution of wood by other products and harvesting only 80% of the annual increment. With proper management, timber stocks of managed and unmanaged forests are not different [7]. Thus, there is no carbon debt at landscape nor national scale [8].

Problems of the Economic Concept of Sustainability

Economically, sustainability consists of two components, the capital one and the interest one. In forestry the capital is the timber stock per ground area, and the interest is the annual increment or the harvest. Von Carlowitz intended to attain a harvest that corresponded to the increment, thus keeping the volume of wood per area constant at the level of a forestry enterprise or a landscape. We do not know, if the ruler of Saxony agreed. As current growth fluctuates depending on the age of the forest stands and the weather conditions, the increment varies from year to year. Most likely the ruler would have preferred to see a constant increment, i.e. a constant harvest to maintain his ore mines. As Luther said in his translation of the bible: "you cannot be servant of two lords". In other words: no one can serve two masters (Matthew 6; 24, Luke 16:13).

It is therefore crucial to define the desired goal. Von Carlowitz did not define the expected volume of timber neither per hectare nor in total. In modern management plans the owner defines the management goal and thus the expected volume of timber that should be maintained over time [9,10]. However, this target can however be changed with repeated management plans.

Sustainability in Modern Times

The Rio Conventions of 1992 changed the definition of sustainability to cover not only the quantitative and economic aspect of harvesting wood, but also the environmental impacts of forest management (mainly biodiversity, water supply, and filtering of air) and the demands by society (mainly recreation) [2,11]. In recent times, climate protection through forests, in particular carbon storage, and the substitution effects of wood use, has been at the center of the political debate [7,12].

Meanwhile, not wood production nor wood volumes are the target of sustainability but climate protection is the top priority among the six pan-European criteria for forest sustainability. These are: Forest resources and their contribution to the global carbon cycle, health and vitality of forest ecosystems, productive functions of forests, biological diversity in forest ecosystems, protective functions of forests and other socio-economic functions [13].

The **economic sustainability** of forests in Germany is defined as maintaining wood volumes at landscape scale. Wood volumes have been monitored by national, grid-based inventories since 1986 [14]. After post-war cuttings, German and European Forests have increased wood volumes continually until 2022, since when climate change and associated biological factors lead to stagnating timber stocks. This development shows that the expectations of sustainable growth cannot be maintained if the environmental conditions change. In the past, the constant growth of timber stocks per ground area was politically promoted to balance fossil CO₂-emissions. But this approach has proven to be risky and unsustainable, because when forest stands became older, they become increasingly vulnerable to environmental stress at the risk of losing biomass. Apparently German forests have reached the limits of sustainability in this respect. However, the effects of over-aging were already predicted decades ago by management models [15]. In addition, because the age class distribution of German forests has been distorted by wars, and there is no management tool that could avoid a decrease of wood volumes in the future. Even sustainable forest management cannot prevent timber stocks from future declining [16].

Ecological sustainability has been defined as the maintenance of ecological functions over time, whereby the functions are mainly defined by human needs: Water supply, filtering of air, and biodiversity. In present days the focus of ecological sustainability is primarily on the preservation of biodiversity. Water supply and atmospheric interactions (e.g. carbon storage) have been considered as secondary effects. It has been shown that managed forests in Germany have not lost a single plant species during the last decades, which distinguishes them from in agriculture [17-19]. Some tree genera have even seen an increase in species numbers. An example is the tree genus *Sorbus*, which had 19 species according to the red list of plant species published in 1996, but 40 species according to the red list of 2018. This could be attributed to a more careful taxonomy, but it is also a result of forest management. Because forest management allows species that normally grow in geographically separate locations, to

grow in close proximity. This has led to the formation of hybrids [20]. An increase in species numbers has not been considered in the concept of sustainability. Will forests therefore become ecologically unsustainable in the future? We do not think so, because hybrid formation may become an important feature under conditions of global climate change. It shows that the concept of sustainability does not actually include future evolution.

More difficult is the situation with large properties (including state owned forests) where monocultures were cultivated on large areas, which are at risk under climatic change. However, some organisms may require a minimum area for development, and thus the classic age-class forestry where clearcut is part of the management scheme may fulfill an important ecological function. Final harvest by clearcut is not deforestation, as in land use change. An alternative management scheme would be single tree harvest, as in Plenterwald management or in permanent forest cover schemes. Here only few tall growing late successional and shade tolerant species are promoted, leading to a loss of species. Thus, the ecological sustainability for forests in Germany results from the mixture of management that is driven by a heterogeneity of land owners [21].

Societal sustainability has not been clearly defined. Social obligations of land properties have been written into the German constitution in 1949 (long before Rio Conventions) as article 14, sentence 2: "Property obliges. Its use should also serve the public". In Germany, the forest-law from 1975 allows free access for the public to all forests, even to private forests [22]. On the basis of this law, the constitutional "obligation" changed into a public "right of use". Until now, the law does not regulate sustainable public use of forests as major goal. This brings us back to the days of Carlowitz (see above) of sustainable use versus sustainable resource. A legal regulation becomes complicated because recreational needs have changed over time. In 1975, when public access was regulated by law, public use meant hiking. In the following years, cycling became accepted as a leisure activity. Now there are electric bikes, which are battery powered and allow cyclists to reach forest areas that they would not be able to reach under their own steam. In addition, extreme sports such as downhill cycling, searching for nature, or enjoyment by lighting fires have become established. As a consequence, more than 90% of forest fires are man-made [23,24]. In a visitor's book we found the inscription: "Forests are owned by the public". Thus, there remains the conflict of ownership. In addition, for certain members of the public, there is apparently the need to vent their

frustration in the forest and forests without rules are particularly suitable for this purpose. Thus, one result of the public activity is vandalism.

Clearly, the constantly increasing public demand for recreation in forests is no longer sustainable. The forest as an economic resource is increasingly being destroyed by public use. Public vandalism is not well documented in scientific literature but reported in the local public press. The authors of this perspective article are in possession of hundreds of such reports, but it is not possible in this short communication to evaluate the public use of forests. Forest-owner associations hesitate to address the societal problems, because the public opinion is helpful in political debates. In Europe, the owner has very limited legal possibilities to prevent public use [25]. It becomes increasingly obvious, that without further legal regulation public use of forests is unsustainable.

The Future

After a century in which alternative products replaced wood, demand for forest products has risen again. The initiative to use more wood in construction and the increasing chemical use of wood have increased demand for wood, especially of conifers [26,27]. This contrasts governmental regulations recommending broadleaves instead of conifers for replanting after harvest or after pests. The government has so far failed to recognize, that managed forests in Germany have not lost but increased biodiversity. There is still the public demand for more protection with free access to conservation areas, because this creates areas with fewer regulations. Presently there is a major debate about the fact that environmental groups buy forest land at inflated prices. These groups are governmentally supported by tax payers' money to buy forest land with the declared objective of taking this land out of management. Non-management has led to unexpected calamities, such as outbreaks of pest infestation [28], and nature conservation measures have not yet been shown to have a positive impact on biodiversity beyond that of managed stands. The "Nature Restoration Law" of the EU is likely to fail because the targets are defined for the past but not for the future [29]. In Europe, nature conservation without management may be necessary in certain situations or for certain species, but not as a general large-scale concept. The biology of European forests has adapted to 1000 years of management. However, since protected areas remain accessible to the public and due to the recreational demands, the public supports nature conservation. Societal demands remain unlimited, and pose a threat to forest land as has already been mentioned, for example, the thread of forest fires. In the future a legal

definition and limitation of public use will be necessary in order to remain within the bounds of sustainability.

In the past, the concept of forest sustainability has suffered from ambiguous usage and definitions, where it is unclear whether the timber stock or the increment should be sustainable. However, the main problem of the concept is the static perspective. In times of climate change, for example, timber stocks as well as the increment may decline due to increasing drought. For the same reason, the range and types of tree species may change in future, but forest management can still be sustainable. The concept of sustainability currently allows for neither for evolution nor for technical development. The classic definitions of sustainability are based on conservation of historic conditions. But framework conditions change over time, therefore the sustainability goals must be formulated more dynamically. Sustainability aims at a moving target. Basic conditions change over time. This includes climate change (temperature and rainfall) as well as the human needs (chemical use of wood) and the demands by the society (various types of sports rather than relaxation). All of this requires a re-definition of the concept that also takes into account the possibility of overachieving the target as for instance seen by the increase in biodiversity. Certainly, sustainable forest management cannot be used to reach other objectives, such as mitigation of CO₂ emissions without considering the risk of failure. Our assessment is mainly based on German examples, but we think, that it holds for Western Europe. Despite all worries, forests of Western Europe appear still to be sustainable in terms of economy, ecology and public needs, and it differs significantly from exploitation forestry that is still in use for most parts of the globe.

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