Sustainability issues in Switzerland's forests

WOLFGANG ORTLOFF

Swiss Federal Institute for Forest, Snow and Landscape Research, Birmensdorf, Switzerland

Key words: age structure, consumption, forest functions, forest history, regeneration

Abstract. Basically there are three methods of regenerating a forest: sowing, planting, and natural regeneration. In the eighteenth and nineteenth centuries, large forested areas of Switzerland were devastated by exploitation and grazing within the forest borders. A significant percentage of these areas was regenerated by planting seedlings. Thus, the Swiss landscape is the result of both land use and cultural history. Today practically no old virgin forests remain.

Forests in Switzerland are required to meet diverse expectations. They function as a means of protection against avalanches, rock falls, and landslides; a source of wood; a natural habitat for animals and plants; and areas for recreation and tourism. Forest management aims to ensure all of these functions on a long-term, sustainable basis. Several problems exist with regard to sustainability in Swiss forests. Data from the Swiss National Forest Inventory reveal that the age structure is off balance, i.e., that there are too many old and not enough young forests. In addition, only two-thirds of the potential Swiss timber yield is harvested, whereas wood is imported from foreign regions where no control over the type of forest management is possible. Without a reduction in the demand for and consumption of wood, this practice, over the long term, is not a sustainable management option. The matter also raises ethical questions, e.g., is it correct to practice nature conservation in your own country while at the same time using wood produced under unsustainable conditions elsewhere?

Introduction

This paper gives a short overview of issues in Switzerland's forests which in one way or another relate to sustainability. In order to prevent the term sustainability from becoming an empty formula, a word without a concrete meaning, I have associated it with some forestry issues. It is not my objective, however, to ultimately define sustainability. Switzerland, in this case, merely serves as an example; most of the points mentioned can also be found in or applied to many other countries.

Planted

I refer to “planted” as one possible form of forest regeneration. To my understanding – and I am sure there are many formal definitions to distinguish between them – a planted forest and a plantation are two very different things. The major difference, in my opinion, is that the main purpose of a plantation is to produce biomass, whereas a planted forest can fulfill a number of different functions, which I will demonstrate with examples from Switzerland.

Basically there are three methods of regenerating a forest: natural regeneration, sowing, and planting. Because natural regeneration has both ecological as well as economic advantages, it is the management measure of choice under certain circumstances. These circumstances include seed trees that are autochthonous or at least highly adapted to the site, and seed trees that are of the desired species for the future stand at the respective site. If these prerequisites are not met or if areas without forest are to be afforested, active management measures are needed for regeneration. These measures include either sowing or planting. Sowing on a larger scale took place as early as the thirteenth century in the forests around the city of Nuremberg (Germany) in order to reafforest the vastly exploited area. Planting has some advantages over sowing. For example, germination and seedling growth take place under controlled conditions in nurseries, weed and pest (insects, fungi) controls are easier and more cost efficient in a nursery than in the field, and seedlings, once planted, have a competitive advantage against weeds and grasses. Regeneration can also take place in a combined pattern, with high-density plantations created on the best sites and the poorer soils colonized by natural regeneration (Combe 1994). An often neglected, but very important, prerequisite is that the planted trees match the site – not only in terms of the right species, but also in terms of genetic constitution.

Sustainable

One of the most frequently cited definitions of sustainable development is that given in the report of the World Commission on Environment and Development (WCED 1987), known as the Brundtland Report: “Sustainable development is development which meets the needs of the present without compromising the ability of future generations to meet their own needs.”

A point often neglected is how very important it is to distinguish between sustainable development and sustainability. This is clearly expressed in a definition by Dovers and Handmer (1992): “Sustainability is the ability of a human, natural or mixed system to withstand or adapt to endogenous or exogenous change indefinitely. Sustainable development is therefore a path-

way of deliberate change and improvement which maintains or enhances this attribute of the system, while answering the needs of the present population An important aspect here is the explicit separation of sustainability as a difficult and distant goal, and sustainable development as a variable process of moving toward that goal. They are not the same thing.” Therefore, a sustainable society would be a society which is in such a process of moving toward sustainability.

Several initiatives evolved in the aftermath of the United Nations Conference on Environment and Development (UNCED or “Earth Summit”) in Rio de Janeiro in 1992; they aimed at reaching an agreement on how sustainable management or sustainability should be defined. One of these initiatives was the Helsinki Ministerial Conference on the Protection of Forests in Europe in 1993, which provided the definition: “Sustainable management means the stewardship and use of forests in a way, and a rate, that maintains their biodiversity, productivity, regeneration capacity, vitality and their potential to fulfill, now and in the future, relevant ecological, economic and social functions, at local, national, and global levels, and that does not cause damage to other ecosystems.”

This emphasizes that the objective of the UNCED conference, and of other international initiatives, is ecological sustainability. Over the past years there have been a number of initiatives aimed at defining criteria for sustainable forest management, and several *measurable* indicators for each of these criteria (Forest Stewardship Council 1994; Hahn-Schilling et al. 1994; IWGF 1994). The most comprehensive so far is the recently published report of The Montreal Process (1995).

Forest history

Over the centuries Switzerland has witnessed several phases of extensive forest exploitation. The reasons, among others, were usage of wood for construction material, for fuel, and for railroad ties; extensive grazing within forest borders; nutrient export through litter raking; and, in the eighteenth and nineteenth centuries, urban growth and the boom of such industries as iron, brick, glass, and charcoal works. These exploitations resulted in increasing resource damage through erosion, landslides, avalanches, and flooding, events often referred to as “natural hazards.” The Swiss realized that domestic supplies of timber could be improved only if size, condition, and yield capacity of the forests were known, and if the forests received proper treatment. Early forest regulations recognized the threats posed to people by overexploitation of natural resources. The Zurich Forest Decree of 1702 mentioned the risk caused to future generations by excess cutting, and this forced many citizens to leave the country because of timber shortage. Other regulations

and decrees recommended that the forests be treated more appropriately, i.e., more in line with forest science. Another publication called for proper planting, treatment, and utilization of forests “for their own and their successors’ welfare” (Schuler 1984).

At the beginning of the nineteenth century, academically trained foresters (mainly in German forestry schools) initially influenced Switzerland’s forestry. “They were convinced that forests and their management should not be looked at separately from anything else happening in the country. They were further sure that plans for forest tending and utilization were necessary if forests were to fulfill their functions and purpose to the profit of the whole country over a long period of time and therefore on a sustained basis” (Schuler 1984). Knowing the German and French schools of thought, Swiss foresters critically adapted these theories to the special conditions of Switzerland. The desire to systematically study and, thus, better understand the processes within forest ecosystems led to the establishment of a forestry school at the Federal Polytechnikum in Zurich in 1855.

As mentioned, the number of catastrophic events, e.g., floodings, avalanches, and rock falls, peaked in the mid-nineteenth century. Around that time a report was compiled to document the often poor state and exploitative utilization of the Swiss forests, especially those with a protective function, and the relation between forest exploitation and these catastrophic events (Landolt 1862). As a result, the first Swiss Forest Law was established in 1876, and set the foundation for a nationwide forest policy. It called for the conservation of existing forest area and the reafforestation of areas without sufficient forest cover. It must be stated, however, that these goals would not have been reached if the railway system had not been established at that time. This made it possible to import large amounts of coal from Germany and, thus, to reduce the demand for wood. Because there were no systematic forest inventories in those days, no exact data exist regarding the proportion of reafforestation carried out by planting trees. The exploited status of vast areas suggests that regenerating the forests by planting must have taken up a large proportion.

Thanks to the “pioneer” foresters of the nineteenth century, a formal forestry organization has developed, thus allowing Swiss forests to be managed on a sustainable basis and causing a boom in reafforestation. Of course a comprehensive ecological sustainability has not yet been achieved because it is not comprehensively defined. In comparing the time span of development of this “controlled forestry” to that of a tree, one recognizes that this development has to be looked at as a historical process which is still evolving. Although many ideas proposed by foresters in the nineteenth century were not realized at the time, and might not even be today, one has to

acknowledge their broad perspective on long-term forest management. They pertained, not only to timber production, but also to the important role that the many functions of forests play for a society. In conclusion, it can be expected that the change in paradigms from sustainable multipurpose forestry as practiced today to true ecological sustainability will promote an explosion in knowledge similar to that promoted by the principle of sustained-yield forestry two centuries ago (Glück 1994).

Sustainability and sustained yield

When studying the term “sustainability” in connection with forestry, one always encounters the concept of “sustained yield.” Yield is an obvious criterion for ecosystem productivity and has several indicators, e.g., standing volume and annual increment, which are relatively easy to measure. The idea of sustainability was developed very early. In Germany, the first written source of the term “Nachhaltigkeit”, generally used as the synonym for “sustainability”, dates back to 1713. In a book from 1806 by Zschokke on the Swiss mountain forests, the concept of sustained yield was considered to be the “first main principle of forestry”, i.e., the forest itself was the capital which should not be reduced (Zschokke 1806; after Schuler 1984). Yet a fundamental problem existed: the volume of sustained yield was unknown. Therefore, fellings were often excessive or insufficient, and, thus, one way or the other, ruined the forests. Another early forester with an academic education was Kasthofer, who also attributed the devastation of the mountain forests to the fact that no forestry rules were applied. He understood sustained-yield management to be “felling not more per annum, but also not less, than nature produced annually ...” (Kasthofer 1818; after Schuler 1984).

Kasthofer was the first forester in Switzerland to use the term “Nachhalt”, an abridged form of the German term “Nachhaltigkeit.” In this context, he spoke explicitly of the different functions of the various forests and emphasized the importance of forests in keeping the country heritable and fertile. Consequently, he saw selection forestry as a proper silvicultural method to be practiced in mountain forests because the most important forest function there is that of protection. Only in forests treated in such a manner is a permanent forest cover and, therefore, the maximum protective function guaranteed. In his opinion, any attempts to regulate on the basis of formula and normal conditions were, especially in the mountain forests, “useless, costly, and sometimes even ridiculous.” This makes clear that the term “Nachhaltigkeit” not only pertains to timber production but also includes other values and relevant forest functions which are to be provided on a long-term, sustained basis.

Several centuries ago, in the early stages of forestry science, models were developed to help determine the use of forests on a sustained yield basis. The first models predicted that the same area be cut yearly in a certain sequence, given by the predominant wind direction (Schuler 1984); later models determined that a certain timber volume be cut each year, because growth, and therefore yield, might be different on different plots. Both models can be seen as attempts to secure a steady supply of wood. For a respective forest area, the total standing stock divided by the rotation period (in years) results in a volume to be cut each year. If the total forest area being managed is big enough, clearcutting may be used to provide the sustained yield of timber. However, this does not take into account the effects of this type of forest management on the ecosystem. On the other hand, the management system in which sustained yield is realized on the smallest spatial extent is “Plenterung”, which can be translated as selection cutting. Thus, when talking about sustainability, it is necessary to give the spatial extent referred to, as will be shown in a later section.

The Swiss forest today

Current data

The data on Swiss forests were provided by the National Forest Inventory section at the Swiss Federal Institute for Forest, Snow and Landscape Research. The forest cover in Switzerland is 29 percent of the total surface area and 37 percent of the total stockable area, i.e., excluding glaciers, high mountain areas, and so forth. Spruce is the dominant species (Table 1), although it is claimed that its proportion would be considerably smaller if left to nature. The proportions of the different methods used for regenerating the forests are different in the five main regions (Figure 1). For example, planting is used more often in the Central Plateau, whereas natural regeneration predominates in the mountainous regions. The age structure is off balance (Table 2), with too many old and not enough young forests.

Old growth/virgin forests

There are areas, especially in the mountains, where the last direct disturbance by humans took place several decades ago. These forests could, therefore, be called “old growth” if one allows the definition of old growth to include human disturbances. “Virgin” or “primeval” forests, i.e., forests without any human influence, do not exist in Switzerland because of the very intensive land use of the last few centuries. Depending on how strict the definition

Table 1. Tree species in Switzerland's forests (Source: EAFV 1988).

Common name	Species	Standing volume (%)
Conifers		
Spruce	<i>Picea abies</i> (L.) Karst.	49
Silver Fir	<i>Abies alba</i> Mill.	15
Larch	<i>Larix decidua</i> Mill.	5
Scots Pine	<i>Pinus sylvestris</i> L.	3
Cembra and Mountain Pine	<i>Pinus cembra</i> L., <i>P. mugo</i> Turra	1
Other conifers		0
Broadleaved trees		
Beech	<i>Fagus sylvatica</i> L.	16
Sycamore Maple	<i>Acer pseudoplatanus</i> L.	2
Ash	<i>Fraxinus excelsior</i> L.	3
Sessile and Pedunculate Oak	<i>Quercus petraea</i> Liebl., <i>Q. robur</i> L.	2
Chestnut	<i>Castanea sativa</i> L.	1
Other broadleaved trees		3

of "human influence" is, one could make the assumption that there are no virgin forests left on the earth because human influence exists even in the most remote areas, e.g., through anthropogenically elevated atmospheric concentrations of CO₂.

Forest functions

Forests in Switzerland have to fulfill a variety of different functions, and a general overview of the environmental functions of forests is given in Table 3. Because of the rough topography in Switzerland, especially in the mountainous regions of the Alps, forests are relied on as a means of protection against avalanches, rock falls, and erosion, and they also prevent flooding in the lower parts of the country. Forests are a source of wood and many other, non-timber resources (e.g., mushrooms, berries, and game). Furthermore, the forests themselves, as well as in combination with such other elements of the landscape as meadows, agricultural lands, and rivers and creeks, offer possibilities for recreation and tourism which are major components of the Swiss economy. Studies in landscape aesthetics reveal interesting insights into the expectations of people (locals, as well as tourists) concerning preferred landscapes.

Figure 1. Methods of regeneration in the five main regions of Switzerland.
(Source: EAFV 1988).

Another increasingly important aspect of forests is their ability to provide natural habitat for animals and plants. Biodiversity, similar to sustainability, is a term often used in the recent scientific literature and in political statements (e.g., the CIA World Factbook 1994 on the Internet informs us that a current environmental issue in Switzerland is “loss of biodiversity”). Without any parameters, this type of information is useless. The usage of the term “biodiversity” is often inadequate, i.e., it is often used only in the sense of

Table 2. Actual and modeled (economic ideal) age structure of Switzerland's forests (*Source:* EAFV 1988).

Age class	Forest area (%)		Difference
	Actual	Model	
Uneven-aged	25	25	
0–30	12	15	–3
31–60	10	15	–5
61–90	18	15	+3
91–120	17	15	+2
121–150	9	10	–1
151–180	5	5	0
over 180	4	0	+4

Table 3. Environmental functions of forests (*Source:* Pearce and Moran 1994).

Sources of materials and services	Sink for wastes	General and life support
Timber	Absorption of waste	Genetic pool
Fuelwood	Recycling nutrients	Climate regulation
Other business products	Watershed protection	Carbon fixing
Non-wood products	Protecting soil quality	Habitat for people, flora,
Agricultural production	and erosion resistance	and fauna
Recreation and tourism		Aesthetic, cultural and
		spiritual source
		Scientific data

species diversity. But biodiversity also includes the diversity of landscapes (i.e., the pattern or mosaic of different ecosystem and land-use types), as well as the genetic diversity within species. This point was clearly emphasized in the Helsinki process and also in the Rio conference. In Switzerland the obligation of maintaining genetic diversity is fulfilled by several genetic inventory projects which provide valuable information about where and how to install genetic reserves. The principle underlying these activities is that of conservation of genetic reserves in situ.

Another function that forests fulfill worldwide is that of carbon sequestration and storage. The national balance for CO₂ and other greenhouse gases reveals that forestry in Switzerland is the only branch acting as a sink for these

Figure 2. Greenhouse-gas balance emissions of Switzerland for 1990 in CO₂-equivalents (Source: after Federal Office of Environment, Forests and Landscape 1995).

gases (Figure 2). In this context, it is also worth mentioning that using wood for energy production and for heating of buildings has advantages over fossil fuels because wood is CO₂-neutral. The use of forests for these purposes is widespread in Switzerland. Nevertheless, various assessments show that 40–70 percent of the potential yield of wood for energy is not used (Brändli 1994). The federal program “Energy 2000” aims at doubling the country’s consumption of wood for energy by the year 2000. Using wood for construction purposes is also a good option because the CO₂ fixed in the wood is stored in the buildings for decades.

Issues for consideration

Insufficient fellings

The annual yield in Swiss forests is about 7–8 million m³, but only 4.5 million m³ are harvested. Nevertheless, total wood consumption is about 7 million m³, i.e., about one-third of the wood consumed in Switzerland is imported from foreign countries.

Figure 3. The natural cycles in forests and the influence of silvicultural practices in order to Ensure the Protective Function of Mountain Forests (After: Combe 1994).

There are several reasons for the insufficient fellings in Switzerland, and among the most important are the high costs for harvesting (Brändli 1994) and the setting aside of forested areas for conservation. The primary reason for high harvesting costs are high wages. Often, the price for timber is too low to even cover the harvesting costs. This leads to a reduction in such management actions as thinning and regeneration, which might, in the longer term, have negative implications for the stability (e.g., storm events) and the protective function of some forests, as well as the future wood supply. Very little information exists on whether or not the protective function can be maintained in mountain forests which are allowed to enter the natural decay phase (Figure 3).

When discussing sustainability, the spatial context has to be made clear. At first glance, it might seem sustainable to conserve forests in a country and not use them anymore. Without a reduction in the demand for and consumption of wood, this practice of chronic insufficient fellings while importing wood from countries where no control of the method of forest management is possible is, over the long term, not a sustainable management option. The matter also raises ethical questions, e.g., is it correct to practice nature conservation in your own country and at the same time use wood produced under unsustainable conditions?

Unbalanced age structure

Data from the Swiss National Forest Inventory (EAFV 1988) reveal that the age structure is off balance, i.e., there are too many old and not enough young forests (Table 2). Forest management can deal with such a situation by means of careful planning. In the long term, however, this situation poses a serious threat to sustainability, e.g., through lack or scarcity of habitat for species depending on early-stage succession forests. In addition, a steady supply of wood for different kinds of uses, such as energy, construction material, and pulp and paper, is not guaranteed.

Tree species not matching the site

There are debates in progress on what the proportions of different tree species would be if forest development had not been anthropogenically influenced after the last ice age. Today almost 50 percent of the standing volume in Swiss forests is made up of spruce (*Picea abies* [L.] Karst.). Spruce is not an exotic tree species to Switzerland, but some claim that many stands of spruce are located on unsuitable sites. It is not known if this will, over the long term, have detrimental effects, e.g., on soil and groundwater.

Besides soil, geologic substrate, and water availability, the term “site” in forestry also includes the influences of weather and climate. These latter influences underlie a constant change, i.e., it is impossible to define normality for these factors. Nevertheless, the ongoing discussion and the majority of the scientists in the field of global change predict a general warming during the coming decades as a result of the anthropogenically altered composition of the atmosphere. The regional effects of this predicted global warming are not yet clearly understood.

What does this expected global warming mean for forest management and silviculture? Should only warm-tolerant species which are more adapted to water stress be planted? According to a number of Central European forestry scientists (see Sperber 1994), the main goal of forest management should be to maintain structurally, biologically, and genetically diverse forests, because they are the most apt to have the capacity to deal with change, be it biotic or abiotic, climatic, or anthropogenic. There is no justification for the use of genetically altered plant material. Nature develops under constantly changing conditions, thus genetically rich species which match the respective site are the best guarantee of tolerance against any kind of stress.

Damage by deer and other ungulates

Damage by deer and other ungulates is a widespread problem in Central Europe, and represents “an unholy alliance between hunters and misguided animal lovers” (Giordano et al. 1993). Hunters want more game to shoot, and animal lovers with their “bambi-mentality” refuse to accept that natural predators, such as wolves and bears, have become extinct over large areas of Europe. Depending on the point of view, the latter can be seen as positive or negative, but it is the reality today and needs to be dealt with – no matter what its cause.

Excessive deer populations to a large degree hinder regeneration, be it natural or planted. The problem exists in many European countries and is not a new one. Aldo Leopold visited Germany in 1935 and was shocked by the damaging effect deer had on the forests there (Leopold 1936a,b). Because regeneration by planting involves a considerable investment, the forest owner must fence the regenerated plots for several years at considerable expense in order to keep the deer out. This issue is a serious one which, in my opinion, will, in the long term, have effects more detrimental than such other factors as air pollution and climatic stress.

Conclusions

- Natural regeneration is the method of choice wherever certain prerequisites are met: the seed trees are autochthonous or at least highly adapted to the site, and the seed trees are of the desired species for the future stand at the respective site. Because of the long history of exploitation and the following boom of reforestation in the nineteenth century, a significant proportion of the forests stocking Switzerland today were planted. One has to always bear in mind that today’s forests and the landscape in general are shaped by a long history of anthropogenic land use. These processes are still going on, i.e., forests are not static, although in many discussions on sustainability this seems to be implied. Forests are, on the contrary, always changing, and any discussion on sustainability has to realize this aspect of constant change (Dovers and Handmer 1992).
- Forests in Switzerland are required to meet many diverse expectations. They function as a means of protection against avalanches, rock falls, and landslides; a source of wood; a natural habitat for animals and plants; and an area for recreation and tourism. Sustainable forest management in the broadest sense is apt to ensure that all of these and maybe additional functions are met on a long-term sustainable basis.

- Chronic insufficient harvest levels threaten the principle of sustainability if at the same time wood is being imported from foreign countries where no control over the harvesting methods is possible. Rich countries can afford nature conservation, and buy parts of the timber resources they need from other countries, which might be financially dependent on the exploitation of their natural resources. By importing wood, environmental problems are exported. Sustainability not only implies *intergenerational equity*, as it is called, e.g., in the Brundtland Report, but also *intragenerational equity*, i.e., “justice within the current world population” (Dovers and Handmer 1993).
- One of the main tasks of forest policy is the promotion of sustainable forest management in accordance with UNCED principles. This should not cause major problems because these principles are very much in line with those already accepted and established in Swiss forestry (Combe 1994).
- Ecological sustainability has yet to be well defined. We need better criteria and, even more importantly, measurable indicators in order to decide if forest ecosystems are moving toward or away from what we define as sustainability. Moreover, forestry needs to use public relation mediums more effectively (Halder 1992) in order to gain publicity for the principle of sustainability in natural resource management. Surveys in Germany have shown that most people do not even know what the term “sustainable forest management” means (Schanz 1995).
- One of the major contributions of forestry to society is that, centuries ago, forestry was the first field to attempt to implement the principle of sustainable action. The principle of acting on a sustainable basis originates from forest management and forestry sciences. This is a result of the long-term nature of any forestry management action. Whatever is done in the forest will most probably affect succeeding generations more than it does the present generation. In my opinion, this fact must always be kept in mind when discussing sustainability.

References

- Brändli, U.B. 1994. Swiss forests and their potential for energy wood on the basis of data from the National Forest Inventory, pp. 1–9. In: Richardson, J. (Ed.) *Silviculture Tuned to Nature and Wood Energy Production*. Natural Resources Canada, Canadian Forest Service, Ottawa.
- Combe, J. 1994. Silvicultural practice in Switzerland – a nature-tuned philosophy, pp. 10–12. In: Richardson, J. (Ed.) *Silviculture Tuned to Nature and Wood Energy Production*. Natural Resources Canada, Canadian Forest Service, Ottawa.

- Dovers, S.R. and Handmer, J.W. 1992. Uncertainty, sustainability and change. *Glob. Environ. Chang.* 2(4): 262–276.
- Dovers, S.R. and Handmer, J.W. 1993. Contradictions in sustainability. *Environ. Conserv.* 20(3): 217–222.
- EAFV (Swiss Federal Forestry Research Organisation). 1988. Schweizerisches Landesforstinventar: Ergebnisse der Erstaufnahme 1982–1986 (Swiss National Forest Inventory: Results from the First Survey 1982–1986). Eidgenoessische Anstalt fuer das Forstliche Versuchswesen, Report No. 305. Flück-Wirth, Teufen.
- Federal Office of Environment, Forests and Landscape. 1995. Klimapolitik der Schweiz. Informational brochure.
- Forest Stewardship Council. 1994. Forest Stewardship Principles and Criteria for Natural Forest Management. Forest Stewardship Council, Oaxaca, Mexico.
- Giordano, E., Glück, P., Hummel, F., Kurth, H. and Kuusela, K. 1993. Policy implications of the UN-ECE/FAO 1990 Forest Resource Assessment. European Forest Institute Working Paper 1. European Forest Institute, Joensuu, Finland.
- Glück, P. 1994. Von der ökonomischen zur ökologischen Nachhaltigkeit (From economic to ecological sustainability). *Österreichische Forstzeitung* 8: 24–28.
- Hahn-Schilling, B., Heuvelink, J. and Palmer, J. 1994. A Comparative Study of Evaluation Systems for Sustainable Forest Management (including principles, criteria, and indicators). Bundesforschungsanstalt für Forst- und Holzwirtschaft, Hamburg.
- Halder, F. (Ed.). 1992. Public relations fuer den Wald (public relations for the forest): ein Workshop mit Diskussionsbeitraegen aus Wissenschaft und Praxis. Fischer, Munich.
- IWGF (Inter-Governmental Working Group on Forests). 1994. Final Report. Second Meeting. Ottawa/Hull, Canada, October 10–14, 1994. Ottawa/Hull.
- Landolt, E. 1862. Bericht an den hohen schweizerischen Bundesrat über die Untersuchung der schweizerischen Hochgebirgswaldungen (Report to the honored Swiss Federal Council on the study of the Swiss mountain forests undertaken in the years 1858, 1859 and 1860). Weingart, Bern.
- Leopold, A. 1936a. Deer and Dauerwald in Germany I. History. *J. For.* 36(4): 366–375.
- Leopold, A. 1936b. Deer and Dauerwald in Germany II. History. *J. For.* 36(5): 460–466.
- Montreal Process. 1995. Criteria and Indicators for the Conservation and Sustainable Management of Temperate and Boreal Forests. Canadian Forest Service, Hull, Quebec.
- Pearce D. and Moran, D. 1994. The Economic Value of Biodiversity. IUCN, London.
- Schanz, H. 1995. Zur Bedeutung von “Nachhaltigkeit” in der Forstwirtschaft (The importance of “sustainability” in forestry). *Der Wald Berlin* 45: 114–117.
- Schuler, A. 1984. Sustained-yield forestry and forest functions, as seen by Swiss foresters in the nineteenth century, pp. 192–201. In: Steen, H.K. (Ed.) *History of Sustained-yield Forestry: A Symposium*. Forest History Society, Santa Cruz, California.
- Sperber, G. 1994. Das Klima ändert sich – was können wir Förster tun? (The climate is changing – what can we foresters do?), pp. 115. In: Verband Weihenstephaner Forstingenieure (Ed.) *Waldökosysteme im globalen Klimawandel* (Forest ecosystems and global climate change). Economica Verlag, Bonn.
- WCED (World Commission on Environment and Development. 1987. *Our Common Future*. Oxford University Press, Oxford.