EVALUATION OF THE SOCIAL AND ECONOMIC BENEFITS OF SUBSIDIZED FOREST ROAD DEVELOPMENTS IN AUSTRIA

Thomas Steinmüller
Institute of Forest and Mountain Risk Engineering
University of Natural Resources and Applied Life Sciences Vienna
Peter-Jordan-Strasse 70/2, A-1190 Vienna, Austria
thomas.steinmueller@boku.ac.at

Keywords: forest engineering, forest road construction, forest subsidies

Abstract: *Forest road construction influences economical, ecological and social benefits of the forests. The goal of this project is to set up a auditing protocol that addresses the compliance of road constructions. It is to facilitate the mid-term evaluation of the EU framework of "rural development". 57% of subsidies have been spent on forest road network planning. By using a Delphi opinion poll, criteria and indicators for the evaluation of 48 Austrian forest roads (built between 1995 and 1999) have been defined.*

After analyzing the forest road construction projects, we have developed some important observations. Major results from the subsidies are improved work conditions and safety, a change in silvicultural strategies, increased forest tending operations and income realization due to rationalization effects. Additionally it is now possible to manage forests in isolated areas.

1. Introduction

Forest road construction is of economical importance to the forest owners (e.g. Trzesniowski, 1993; Wolf, 1994; Peichl, 1998). Furthermore forest roads are generally not only used for forestry but also for a number of other purposes (like tourism and as an integral element of the development of agriculture in general and alpine agriculture in particular). In addition to that it facilitates services such as the public use of the forest for recreation purposes (Tamme, 2001). The construction of forest roads, using the latest technical developments, is very costly. Therefore the construction of forest roads is being subsidized by the EU.

In the course of a mid-term evaluation of the EU-subsidy programme "development of rural areas" the effective use of the subsidies will be looked at. The question focuses on the actual extent of the effects of forest road construction on forestry and rural development. Especially with regard to the continuous reduction of subsidies and the resulting need of operational and target orientated allocation of these subsidies by the decision makers. There are only few indicators and criteria to facilitate this type of evaluation and those have to be further developed. The targets of this study are defined as follows:

- Developing a catalogue of criteria and indicators for the assessment of the effects of forest development measures according to economical, ecological and socio-economical aspects;
- Evaluation of tangible forest road projects based on the catalogue of criteria and indicators;
- Implementation of the results in a web-based database.

2. Methodology

2.1 Delphi Opinion Poll

Delphi opinion polls have frequently been applied to the evaluation of complex ecological connections (e.g. Bardecki, 1984; Schuster, 1985; Lehmann, 1998; Wilhelm, 1999). Therefore this method was used to find economical, ecological and socio-economical criteria and indicators for the evaluation. Participants in the survey came from the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management (BMLFUW); the Austrian Federal Office and Research Centre for Forests (BFW); the University of Natural Resources and Applied Life Sciences Vienna (BOKU) and the State governments of the federal states.

Figure 1 shows the procedure of the Delphi opinion poll. The first draft of the catalogue has been set up by members of the University of Natural Resources and Applied Life Sciences Vienna. The experts had three opportunities to participate in the set up of the catalogue. One of these three opportunities was a joint expert workshop. After the final suggestions were included, the final version of the catalogue of criteria and indicators was ready by mid October 2002.

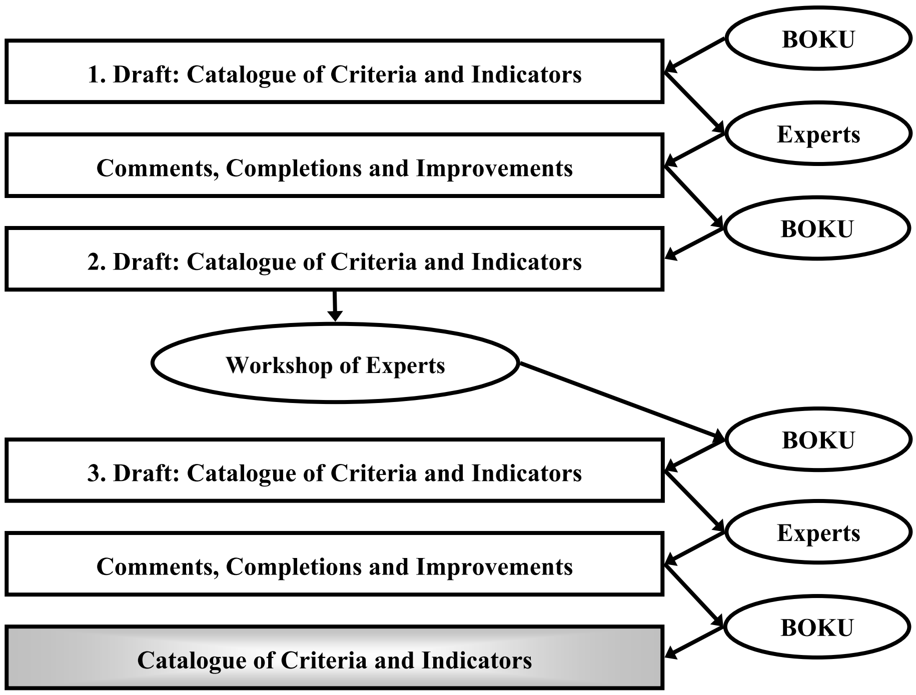

Figure 1: Procedure of the Delphi opinion poll

2.2 Case Studies and Interviews

The selection of the 48 Austrian forest roads to be evaluated has been carried out based on the following criteria (Table 1):

- according to the proportion of subsidies received by each federal state;
- according to the diversity of natural conditions of environment within each federal state (growth areas, altitudinal belts and geological aspects).

Table 1: Distribution of the case studies

Federal state	n projects
Burgenland	4
Carinthia	6
Lower Austria	11
Upper Austria	7
Salzburg	4
Styria	5
Tyrol	10
Vorarlberg	1
Total	**48**

3. Results and Discussion

More than 147 km of forest roads in eight federal states have been evaluated. The length of the different forest road projects ranges from 350 to 13,340 running meters; the average of all of the 48 projects amounts to 3,064 running meters. The roads facilitate access to forest areas between 7 and 220 hectares; the average area is 65 ha. This results in a density of roads of 17 to 100 (average 51) running meters/ha. The areas made accessible per kilometer of forest road range from 10 to 56 (average 23) ha/km; the volume of timber made accessible is between 1.8 and 23.4 (average 7.6) Vfm/lfm[1]. For the purpose of planning, submission, construction and maintenance of the forest roads 29 co-operatives have been established. 38 projects are carried out in small forest units with operational sizes of up to 200 hectares.

3.1 Forest stands examined

In the course of the evaluation 14 inventory sample points have been analyzed in each area of the 48 forest roads. Table 2 shows a description of the examined stands:

- **Vertical structures:** The bulk of the spot checks (53%) were carried out in even-aged stands. 38% of the spots were selected in uneven-aged forest stands with two layers and 9% were referring to multi-layered stands.
- The **number of stems** vary according to a number of different factors (especially age and stock density). The average of all trial areas is 626 stems/ha. The 14 projects serving the „protection from falling rocks“ have a number of stems ranging from 159 to 1,268 (average 650) stems/ha.
- **Standing timber:** The economic values figured out are the result of demanding a balance between the economical optimum on one hand and a highest possible degree of protective function of the forest stands on the other. The average of all case studies lies at 338 Vfm/ha[2]. For small forests this figure is 349 Vfm/ha², for large forests it is 297 Vfm/ha².

  The forest report 1996 indicates a volume of 295 +/-2.7 Vfm/ha² of productive forests in Austria (small forests 290 +/-3.4 Vfm/ha² and companies without the ÖBf AG[3] 296 +/-5,1 Vfm/ha²) (BMLFUW, 1998).
- **h/d-values:** The analysis of the h/d-values (heights/diameter) is vital for the evaluation of the degree of protective function. The average on all projects is 66; 90% of all projects show an h/d-value below 80.

---

[1] Vfm/lfm[1] cubic meter of standing timber per running meter forest road
[2] Vfm/ha² cubic meter of standing timber per hectare

[3] ÖBF AG³ Austrian Federal Forests

Abetz (1976) has analysed snow break areas and has found a stability index for firs by considering the thickness ratio (heights/diameter). He considers h/d-values < 60 as highly stable, h/d-values of 60 to 80 as stable, h/d-values of 80 to 100 as unstable and h/d-values > 100 as highly unstable (Mayer, 1992).

Table 2: Description of the examined forest stands

Criterion	Description	Value	Unit
Vertical structures	even-aged stands	53	[%]
	uneven-aged stands (2 layers)	38	
	multi-layered stands	9	
Number of stems	Average	626	[n/ha]
	Minimum	96	
	Maximum	1,550	
Standing timber	Average	338	[Vfm/ha²]
	Minimum	112	
	Maximum	650	
h/d-values	Average	66	[h/d]
	Minimum	21	
	Maximum	93	

3.2 Forest tending operations

Figure 2 shows forest tending operations that were carried out since the completion of the forest roads. Thinning operations, young growth tending and tending of thickets have been given priority and can be carried out at lower cost since the completion of the forest roads. In only 5% of the projects life branches were pruned. In 10 of the projects only one tending measure was applied, in 7 projects two, in 18 cases three, in 7 cases four and in 2 cases five forest tending operations were carried out.

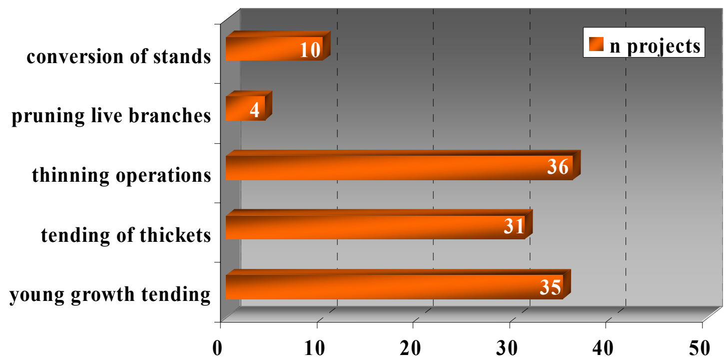

Figure 2: Forest tending operations

3.3 Forest Regeneration

A total of 594 ha of forest areas (19% of all evaluated areas) were found to having been subjected to forest regeneration. In the case of about three quarters (74%) of these areas this was done through natural regeneration. The remaining quarter (26%) is relating to areas with artificial regeneration and the share of tree species of the natural habitat amounts to 80% of the total number of trees planted. The forest report 1996 shows for all of the mountain forests that 14.8% of the area needs to be regenerated and is regenerating (BMLFUW, 1998).

3.4 Final Opening Up

Figure 3 indicates the situation of the examined forest road projects with regard to the final opening up. In almost all of the cases the construction of forest roads led to the set up and/or the extension of facilities for final opening up.

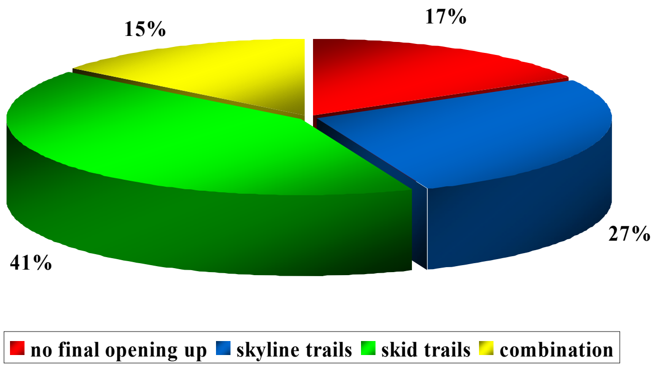

Figure 3: Final opening up

Presently only 8 projects (17%) did not have any skid trails, skid tracks or skyline trails. In the case of one of these projects there was no harvesting operation since the completion of the forest road. In 13 opened up areas (27%) the skidding is exclusively accomplished on skyline trails; 20 projects (41%) use skid trails and/or skid tracks. And the graphical segment „combination“ stands for 7 areas (15%) that are only partially drivable (this is where skyline trails as well as skid trails are being used).

3.5 Self-employment or contractors

Especially with regard to the assessment of the securing of income by means of opening up forests the question of forest management through self-employment or contractors is of great importance. This was the focus of the analysis of the latest thinning operations and final cuts of all forest road projects.

The results give a clear indication as to the ambition of using mechanized harvesting systems even in small forests. In 25 of the projects forest management co-operatives have been established in order to optimise the operational capacity of the used machines. For this reason the share of harvesting operations by contractors dominates in all cases (thinning operations, final cuts and utilization in connection with catastrophes). This becomes most evident in the case of utilization after catastrophes where the share of operations carried out by contractors makes up roughly two thirds of the total amount of timber. Apparently, in these cases those administering and managing forests depend on the experience and machinery of specialized timber harvesting enterprises. With regard to the final cuts the proportions are similar. In the case of thinning operations the external does only slightly dominate (Figure 4).

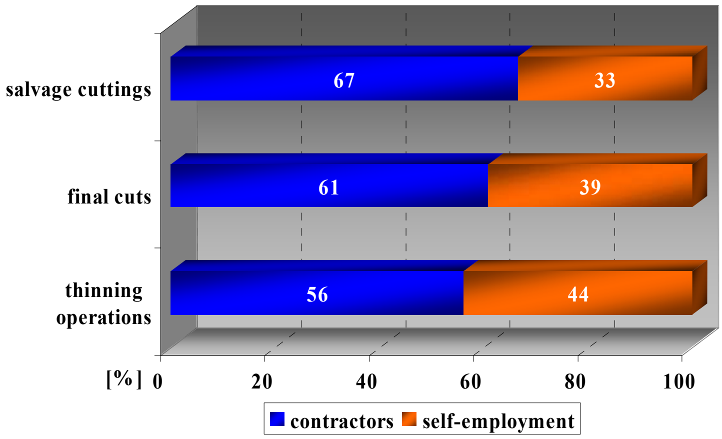

Figure 4: Management structure

Stampfer and Moser (2002) showed by the means of the forest economic community Leoben the attitude of the forest owners. 77% of all interviewed persons want to use their forest by self-employment in the next three years. The result of the present study concerning small forests shows a similar situation with regard to thinning operations (66%).

3.6 Timber harvesting costs

The reduction of harvesting costs is an argument frequently heard in the course of discussions about new opening up projects. In 30 of 48 case studies thinning operations were carried out after completion of the forest roads. However, in 10 cases there aren't any indications as to timber harvesting costs because the respective stands have not been cultivated before roads were constructed. The results in all other cases show a considerable reduction of cost. The average timber harvesting costs of the zero option (situation before forest roads) add up to 44.1 €/Efm[4]. The comparative figure for the latest operations in all of the 30 regions adds up to 26.6 €/Efm[4]. This comes up to a reduction of the timber harvesting costs of an average of 40% or 17.5 €/Efm[4] (Figure 5).

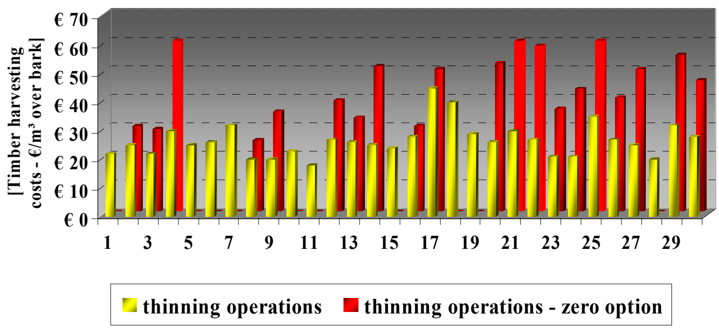

Figure 5: timber harvesting costs – thinning operations

[4] €/Efm[4] Euro per cubic meter harvested timber

In the latest carried out final cuts the situation is a similar one. There are comparative figures for 31 of 38 cuts, in 7 of the cases the forest was not cultivated before the construction of forest roads. The records of the forest owners indicate average timber harvesting costs of 41.5 €/Efm[4] for the zero option. This compares with the figure of 22.7 €/Efm[4] for 38 most recently carried out operations. The difference averaged 18.8 €/Efm[4] which equals a reduction of 45% (Figure 6).

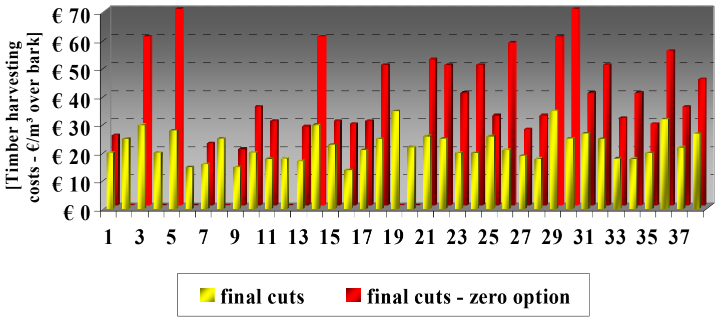

Figure 6: timber harvesting costs – final cuts

According to forest owners all thinning operations and final cuts were carried out profitably (logging-cost-free profit). The comparison with a survey on a small forest carried out by Sekot (2000) proves this point. For the period from 1991 to 2000 the trial operation network has delivered average figures of € 3.51 for a profit margin I including wages of management and € 8.14 for the profit margin I excluding wages of management.

Comparing the figures with the average prices of round timber stated in the forest report 2002 shows that in the years from 1990 until 2001 the average figures for mechanical-, pulp- and logwood have been above the timber harvesting costs from this study (BMLFUW, 2003a).

3.7 Work Safety

The evaluation of all forest road projects showed that work safety could be increased after completion of the roads. In 64% of the cases a rescue chain can reach the location of the accident within 16 to 30 minutes after the accident has been reported. Considering the high number of working accidents related to forestry this result is of major importance. In the year 2001 there have been 957 registered working accidents including 15 casualties among the group of self-employed persons and 757 registered accidents including 5 casualties among employed persons. Most of the accidents were relating to the felling, processing, transportation and manipulation of timber (BMLFUW, 2003a).

3.8 Environmental Compatibility

- There was a total of 5,448 trees that were considered by the angle-count methods. From those trees 4,505 were undamaged (= 82.7%), from the remaining 943 trees 908 (= 16.7%) suffered damage by one and 35 (= 0.6%) by more than one cause.

---

[4] €/Efm[4] Euro per cubic meter harvested timber

The **stem damages** have mainly been caused by harvesting operations (31%), by game animals (22%), falling rocks (13%) and damaged tree tops (8%). All other kinds of damages (mainly caused by road construction and climate) are included in the category „other damages“ (26%).
The comparatively small number of damaged trees is pleasing, especially when considering the fact that according to the 2001-report on damages caused by game animals (BMLFUW, 2003b) 24% of the pole stands in the field of productive forestry and 22% of the pole stands in the field of protective forestry have suffered bark damages from these animals.

- **Soil damages** (depth of trail tread > 15 cm) have only been found on 8% of all areas utilized. This is connected with the minor degree of passage in the stands and with existing facilities of structured opening up (Table 3).

Table 3: Environmental Compatibility

Criterion	Description	Value	Unit
Stem damages	undamaged trees	82,7	[%]
	damaged trees: 1 cause	16,7	
	damaged trees: more than 1 cause	0,6	
Soil damages	latest utilized areas with soil damage	4	[%]

3.9 Additional Value Added

To make forests accessible does evidently generate additional value for the rural forest owner. On one hand this is facilitated by the reduction of logging costs and on the other by an increase of profit due to timber assortments of improved quality. And there is additional value as a result of selling timber chippings and earnings from tourism (rent of mountain-bike routes) and hunting.

- In the survey at hand the provision of **chipping material** has mostly been carried out in a semi-mechanical manner in the course of thinning farmers' forests; thereafter the material was chipped in the forest or at the farm by small or medium sized chipping machines and finally it was transported by agricultural tractors. About half of the forest owners are in position to store and to dry chipping material. The common form of marketing was direct marketing. Sales based on agency contracts (machine co-operatives, district farmers' chambers etc.) as well as sales involving purchasing and selling organizations (especially co-operatives) have played a minor role in this case. In the federal states Carinthia, Lower Austria, Upper Austria, Styria, Tyrol and Vorarlberg forest chipping material has been produced and sold in 20 of the projects (19 of them relate to small forests).
  The takings and quantities sold are averaged across the federal states and vary between 12.40 and 17.25 €/Srm[5]. These earnings are the result of selling quantities between 92 and 400 Srm[6].

- The **tourism** related income predominantly derives from the lease of mountain-bike routes and ski-slopes: 21.8 of the slightly more than 147 evaluated forest road kilometers (15%) were officially classified as mountain-bike roads and 6.4 km (4%) of forest roads are part of either ski slopes, cross-country slopes or of a toboggan run.

- The income from the lease of **hunting rights** have varied tremendously depending on the basic conditions (self-owned hunting grounds or share of co-operative hunting grounds). The forest owners were stating annual revenues between 2 and 105 (average 16.30) €/ha.

[5] €/Srm[5] Euro per piled cubic meter
[6] Srm[6] piled cubic meter

3.10 Rural Development

One major goal in connection with the allocation of forestry subsidies is the increase of income and job opportunities in rural areas. This is why a lot of attention has been paid to the actual local situation. According to beneficiaries the rural income has risen in 39 of the projects (81% of all cases). To them the measures to open up the forest facilitate an (efficient) utilization; in 15 cases (31% of all cases) the forest has only been cultivated since the road was constructed.

An increase in employment possibilities could be evidenced in 30 of the cases (63%). In these cases the forest owners themselves, their family members and employed persons as well as self-employed persons that were not family members have been working in the forest. The economical sector directly related would also profit from this improvement.

4. Summary

Forest road constructions are influencing economical, ecological and social effects of the forests. The complexity of impacts, connections and correlations are often difficult to identify. Therefore open questions have to be clarified, concerning silvicultural, timber harvesting and socio-economic topics.

After the analysis of 48 Austrian forest roads (built between 1995 and 1999), the construction of forest road networks leads to some important results: Silvicultural strategies have changed (less clear cuts) and forest regeneration is realised in 74% by natural regeneration. In the case of artificial regeneration the share of tree species of the natural habit amounts to 80% of all planted trees. The number of forest tending operations in the areas has increased since completion of the forest roads. The founded situation of stem and soil damage is also passable.

Work conditions and safety have been improved as well as rationalization effects have lead to income realization. The opening up does evidently generate additional values for the forest owners. On one side there is a reduction of harvesting costs and an increase of revenues due to timber assortments of improved quality. On the other side there is additional value as a result of selling timber chippings and earnings form tourism and hunting. In a final step the increase of income and job opportunities in rural areas could be observed.

The founded criteria and indicators turned out to be operational and relatively easy to elevate. One major problem of this study is, that the situation before the construction of the road is unknown. This is the reason for estimating some criteria and indicators. Further explorations in a few years will be necessary to make statements about long-term effects of forest road construction.

5. Acknowledgements

The author wants to thank the Austrian Federal Ministry of Agriculture, Forestry, Environment and Water Management as well as the Austrian Federal Office and Research Centre for Forests for the financial support and the cooperation.

6. References

Abetz, P. (1976) Beiträge zum Baumwachstum. Der h/d-Wert mehr als ein Schlankheitsgrad, Der Forst- und Holzwirt, 31.

Bardecki, M.-J. (1984) Wetland Conservation Policies in Southern Ontario – A Delphi Approach, Geographical Monographs, no. 16, York University.

BMFLUW (2003a) Nachhaltige Waldwirtschaft in Österreich. Österreichischer Waldbericht – Datensammlung 2002, electronic document: http://www.lebensministerium.at

BMLFUW (2003b) Wildschadensbericht 2001, electronic document: http://www.lebensministerium.at

BMLFUW (1998) Österreichischer Waldbericht 1996. Bundesministerium für Land- und Forstwirtschaft. Wien. 89 S.

Lehmann, B. (1998) Umweltindikatoren – Scharnier zwischen Ökonomie und Ökologie. Eignungsbewertung von Indikatoren für ein Umweltmonitoring und Evaluation der Umweltwirkung agrarökologischer Erlasse – Resultate einer Delphi-Studie. vdf Hochschulverlag AG an der ETH Zürich. 164 S.

Mayer, H. (1992) Waldbau auf soziologisch-ökologischer Grundlage. 4. Auflage. Gustav Fischer Verlag, Stuttgart. 522 S.

Peichl, B. (1998) Hochwasser, Erosion und Waldstraßenbau, Allgemeine Forstzeitschrift/Der Wald, 53, 19: 992-994.

Schuster, G. (1985) The Delphi Method – Application to Elk Habitat Quality. United States Department of Agriculture, Research Paper INT-353.

Sekot, W. (2000) Betriebsabrechnung für den Kleinprivatwald, Österreichische Forstzeitung, 111, 10: 10-11.

Stampfer, K. and Moser, A. (2002) Gibt es im Kleinwald auch in Zukunft Eigenbewirtschaftung?, Österreichische Forstzeitung (Arbeit im Wald), 113, 1: 1-3.

Tamme, O. (2001) Beschäftigungseffekte der forstlichen Förderungen, Ländlicher Raum Ausgabe 2/2001. Bundesministerium für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft, Wien: 11-20.

Trzesniowski, A. (1993) Wozu Walderschließung in Österreich?, Österreichische Forstzeitung, 104, 7: 5-7.

Wilhelm, J. (1999) Ökologische und ökonomische Bewertung von Agrarumweltprogrammen. Delphi-Studie, Kosten-Wirksamkeits-Analyse und Nutzen-Kosten-Betrachtung, Europäische Hochschulschriften: Reihe 5, Volks- und Betriebswirtschaft; Bd. 2542. Peter Lang GmbH. Europäischer Verlag der Wissenschaften, Frankfurt am Main. 284 S.

Wolf, W. (1994) Variantenvergleich im Forststraßenbau unter besonderer Berücksichtigung der Belange des Natur- und Landschaftschutzes. Dissertation, durchgeführt am Institut für Forsttechnik der Universität für Bodenkultur Wien. 124 S.