Profitability of Forest Land Consolidation – a Finnish Case Study

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SUMMARY

In many places, the shape or size of forest properties leads to high harvest and management costs, which lowers the incentives to manage the forest. Forest land consolidation is carried out in parts of Finland to reduce the problems caused by forest properties that are long and narrow. To achieve the support of central stakeholders, it is, however, important to have knowledge on the profitability of the projects.

In this paper, a cost-benefit analysis of a Finnish forest land consolidation project is presented. The focus is on cost-savings in harvests and management, increased stumpage prices and on the increased activity of owners after land consolidation. Yearly benefits of the Pahkakoski forest land consolidation project are estimated, and the net present value of the project is calculated. A sensitivity analysis is carried out to analyse the effects on profitability of factors such as the discount rate.

The analysis shows that the forest land consolidation project was profitable. Central factors influencing the profitability of the project include cost savings due to economies of scale, increases in harvest activity and increased growth of the forests. Furthermore, the discount rate and time horizon, as well as the estimated future stumpage price, influence the overall result. The creation of jointly-owned forests, which is considered an important part of Finnish forest land consolidation, improves the profitability of the project, but is not a prerequisite for the project to be profitable. The results show that the profitability of land consolidation projects can be greatly increased by combining measures, such as the rearrangement of parcels, road construction and remedial drainage.

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1. INTRODUCTION

Finland is the most forested country in the European Union: 86 % of the land area is classified as forestry land. A majority of the forest land area is privately owned (60 %). Most privately owned forests are of small or medium size, with an average size of ca 30 hectares. (Finnish Statistical Yearbook of Forestry 2013.) Over the years, these family forests have been divided into smaller properties, mainly in connection to inheritance. In some parts of Finland this has led to parcels that are long and narrow, which impedes their use for timber production.

Land consolidation in Finland has, in recent decades, focused on agricultural land consolidation. Locally, the problems in forest areas are, however, large and a few forest land consolidation projects have been carried out (Airaksinen et al. 2006). In forest land consolidation projects long and narrow forest parcels are reshaped closer to square shapes, and the forest road and drainage networks are maintained or expanded.

As a part of recent forest land consolidation projects in Finland, jointly-owned forests have been created for part of the area. During the project, land owners are given the alternative to add their land, or part of it, to a jointly-owned forest, instead of getting their own parcel. Jointly-owned forests are managed as one unit, often by a forestry professional. The jointly-owned forests are expected to give larger economies of scale than private forests. Jointly-owned forests also follow a forest management plan, which is expected to increase harvests.

A requirement for carrying out land consolidation is that the benefits exceed the costs and hindrances (Real Estate Formation Act 554/1995). Cost-benefit analyses are also needed as a basis for decision making regarding the public funding of projects. Therefore it is necessary to carry out a cost-benefit analysis before the project, as well as after the project. Which impacts are included in the analysis depends on the country. Swedish studies on the profitability of forest land consolidation projects focus mainly on changes in harvest costs (Lantmäteriet 2012), while a German study (Hinz 2012) monetises all benefits, including environmental benefits and benefits to the local economy. Finnish studies, on the other hand, have focused mainly on the benefits to the forest owner (Airaksinen et al. 2007; Honkanen 2008).

This study focuses on the impacts of forest land consolidation on the costs and activity of harvests from forests of mainly private non-industrial owners. This ownership group is a major contributor to the Finnish forest economy: 77 % of commercial roundwood removals from Finnish forests are from private forests (Finnish Statistical Yearbook of Forestry 2013). A cost-benefit analysis of the Pahkakoski forest land consolidation project is carried out as a case study. Benefits to forest owners and harvest operators are calculated, and the net present value of the project at the time of implementation is calculated. Studies on individual impacts are not carried out, but the impacts are instead estimated based on previous research. Finally, a sensitivity analysis is carried out to determine which factors are central to the overall profitability of forest land consolidation projects.

2. PAHKAKOSKI LAND CONSOLIDATION PROJECT

The Pahkakoski forest land consolidation project was carried out from 1990 to 1997. Pahkakoski is situated in Oulu in Northern Finland, ca 600 km north of Helsinki. Basic information on the project is presented in table 1. There are large mire areas and other wetlands in the project area, which leads to a considerably lower forested area than the total project area. Due to the northern location and large peatlands, the growth of timber in the area is relatively low: the annual increment of growing stock in the area is 3.2 m^3/ha and the annual sustainable roundwood removal 1.6 m^3/ha (Honkanen 2008).

Table 1. Details of Pahkakoski forest land consolidation (Airaksinen et al. 2007; Uimonen 2010)

Total area	4892 ha
Forested area	3500 ha
New jointly-owned forest	1874 ha
Parcels before land consolidation	232 parcels
Parcels after land consolidation	130 parcels

Before land consolidation Pahkakoski was characterised by long, narrow properties: some up to 12 km long and less than 100 metres wide. The smallest properties were less than 1000 m^2. There was also a very limited road network in the area, and 56 km of forest roads were built during the project. The shape of the properties and the lack of a road network meant that large areas had been left unmanaged. It has been estimated that ca 69 % of the possible harvests would have been done without the land consolidation project (Honkanen 2008).

The costs of the Pahkakoski land consolidation project were 721 081 euros. Additionally, road construction costs were 472 092 euros and the costs of drainage works 300 259 euros. (Honkanen 2008.)

3. BENEFITS OF FOREST LAND CONSOLIDATION

Cost-benefit analysis is used to calculate the net-benefits of an investment project. It is an economic evaluation of the costs and benefits under different scenarios. The different scenarios include, at the very least, a comparison of the costs and benefits when implementing and not implementing a project or an investment. This can be done either by comparing the net-income with and without the project, or by calculating the change in costs and income if the project is implemented. The second approach is followed here. (Campbell & Brown 2003.)

A cost-benefit analysis consists of several steps: identifying the costs and benefits, valuating them and finally comparing the costs and benefits (Campbell & Brown 2003). This can often be a complex issue. Benefits can be valuated through cost savings or at market prices where these are available and they correspond to the real benefits of the project. Where this is not the case, shadow prices may be used. Benefits for goods not available in the market may be valuated through non-market valuation. A cost-benefit analysis can be purely financial, which takes into account only monetary benefits and costs to those involved in implementing the project, or economical and take all benefits and costs to the whole economy into account (Campbell & Brown 2003).

This study consists of valuating and comparing costs and benefits that have been identified in previous studies of Finnish forest land consolidation projects. The referent group, i.e. the stakeholders that are considered to be important for the study (Campbell & Brown 2003), consists mainly of the land owners. The total costs of the project are however included, including the share that is financed by state support, as are taxes. For the reduction in harvest costs the whole reduction is included, but the part of this that benefits the land owner through higher stumpage prices is also calculated separately.

There are likely to be other beneficiaries of land consolidation than those included in this referent group. Land consolidation can affect local employment and industry, and the environment and society at large (Hinz 2012). Hinz (2012) carries out an economic cost-benefit analysis of German forest land consolidation projects, which identifies and quantifies 32 different benefits of forest land consolidation. Apart from benefits to the economy of forestry, these include benefits to the climate, recreation, cultural landscapes, nature protection, flood protection, land value, increased safety and increased employment. These impacts often do not have a market value, but need to be estimated through non-market valuation methods, usually through willingness to pay. An estimation of these is, however, not within the scope of this study.

For the calculation of the net present value (NPV), the benefits are discounted to the end of the land consolidation project (1997), which also is the year when the benefits start taking place and the costs are determined. The benefits are first calculated as yearly benefits to forestry in this chapter, and the yearly benefits are then in the results chapter discounted and the net present value is calculated as:

$$NPV = B \cdot \frac{1-(1+i)^{-n}}{i} - C$$

where n is the number of years, i the discount rate, B the annual benefits and C the project costs. Benefits are calculated at market prices, because land consolidation projects are carried out at as local projects in specific problem areas. Therefore it is not expected that the project would have such a large impact on the local economy and the supply and demand of timber in the area as to change prices.

The long time scale of forestry is one of the major difficulties in calculating the benefits of forest land consolidation. Unlike agriculture, where most of the benefits either take place once or every year, the time scale in boreal forestry can be up to 100 years, or more. As such, there are two possibilities: calculating all future benefits by comparing the present value of the land before and after, or calculating costs and benefits encountered during a certain number of years, and disregarding all possible benefits after that. Because of the uncertainty of future conditions and to increase the comparability to cost-benefit analyses carried out in agricultural areas, the second option is chosen here, with benefits over 30 years being taken into account.

The impacts of forest land consolidation on productive forestry can roughly be divided into two categories: 1) changes in management and harvest costs, which may or may not be transferred into prices, and 2) increases in the production through an increase in growth and in managed forest area. To some extent these may also be linked: an increase in stumpage prices is likely to increase the incentives to manage forests and to harvest (Bolkesjø & Baardsen 2002; Favada et al. 2009). Changes in timber prices also have an impact on the optimal management options and rotation periods (Tahvonen et al. 2013).

3.1 Impacts on costs and prices

The impacts on harvest costs are calculated below for the estimated yearly 3870 m³ (69 % of sustainable roundwood removal) that would have been harvested from the area even without land consolidation, as this is the portion of the harvests that are affected by a reduction in costs. In Finland 82 % of timber from private forests is sold in standing timber sales, where the buyer of timber is responsible for harvesting (Finnish Statistical Yearbook of Forestry 2013). Therefore, the harvest costs savings affect the buyers directly, and the forest owners indirectly through changes in the stumpage prices that buyers are willing to pay. As such, the share of the overall cost savings that get transferred into stumpage prices is also estimated.

3.1.1 Road construction

New forest roads can be built as part of a forest land consolidation project, or existing roads can be improved. In Pahkakoski, 56 km of new roads were constructed. The average forest haulage distance was estimated to decrease from above 1000 metres before to ca 300 metres after (Airaksinen et al. 2007). The construction of forest roads decreases harvest and management costs, and increases the area that can be harvested in summer (Saarinen et al. 2001).

The construction of new roads decreases the forest haulage distance - that is the distance from where timber is harvested to the roadside where it can be loaded for long-distance transportation. A decrease in the forest haulage distance reduces the harvest costs (Kuitto et al. 1994; Väätäinen et al. 2007), and at least part of this reduction is transferred to stumpage prices as higher prices paid for timber from transactions with short average forest haulage distances (Kolis et al. 2014). Väätäinen et al. (2007) calculated that an increase of the forest haulage distance with 1000 m increased harvest costs with 3 €/m³. Here, the reduction is approximately 700 metres, which would lead to a 2.1 €/m³ reduction in harvest costs, or a total of 8295 €/year. Out of the reduction ca 1.4 €/m³ would be seen as changes in stumpage prices, based on Kolis et al. (2015).

Bad-quality roads in many areas mean that timber can only be transported in winter, when the terrain is frozen. New or improved roads increase the area that can be harvested in summer. The possibility to harvest in summer reduces the costs to buyers of timber, because the stands can be harvested when there is demand, regardless of weather conditions (Saarinen et al. 2001). Timber buyers pay a premium of ca 0.9 €/m³ for tracts that can be harvested in summer or all year long (Kolis et al. 2014). In Pahkakoski, the area affected by this was estimated to be 1120 hectares (Airaksinen et al. 2007), leading to a total increase in stumpage prices of 1613 €/year with 1.6 m^3/ha/year harvests.

A decrease in the length of extraction routes due to an improved shape of properties (see 3.2.1 below) decreases the distance the harvest operator is required to drive while harvesting. This reduces harvest costs further (Kuitto et al. 1994; Väätäinen et al. 2007). Calculated with a change from 500 metres of roads per hectare to 400 metres (estimated based on the theoretical model in Honkanen 2008), cost-savings in harvests are ca 0.3 €/m^3 according to the regression model by Väätäinen et al. (2007), or a total of 1139 €/year.

3.1.2 Size of sales

Partly fixed costs in harvests lead to higher per unit harvest costs for small harvest volumes (Väätäinen et al. 2007). For Pahkakoski it has been estimated that the average harvest size before land consolidation was 100 m^3 and after land consolidation 200 m^3 (Honkanen 2008). This change is used in calculations for private forests. For jointly-owned forests 300 m^3 is used, corresponding to a larger increase in stand size (Kolis 2015). On the other hand, Finnish jointly-owned forests sell, on average, ca 2000 m^3 per sale (Kärhä et al. 2014), making this a careful estimate. An increase from 100 m^3 to 200 m^3 reduces harvest costs with ca 1.5 €/m^3 and to 300 m^3 with 1.9 €/m^3 (Väätäinen et al. 2007). The total reduction in harvest costs in the area is 6340 €/year.

The economies of scale of harvests get, at least partly, transferred to stumpage prices (Brown et al. 2012; Kolis et al. 2014). Based on Kolis et al. (2014), it is estimated that changes in the average volume of sales increase the stumpage prices with at least 0.7 €/m^3 for private forests and 1.1 €/m^3 for the jointly-owned forest. If the sales from the jointly-owned forest increase to 2000 m^3, the reduction in costs would be 2.8 €/m^3 and the increase in stumpage prices ca 3 €/m^3. This would, however, increase the overall profitability of the project with only 6 €/ha.

Furthermore, some other costs of timber sales and forest management are fixed and do not vary with size. Such mainly fixed costs are the transfer of equipment and staff between assignments, and the time that sellers, buyers and the local Forest Management Association, spend on preparing the sale. Making a very cautious estimate of administration costs of 150 euros per sale, this corresponds to 1.5 €/m^3 for a 100 m^3 sale, 0.75 €/m^3 for 200 m^3 and 0.5 €/m^3 for 300 m^3, leading to a 3270 €/year reduction in costs for the land consolidation area.

3.1.3 Stand size

The stand size affects costs also during other stages of the forest rotation than during harvests. Larger stands mean less separate objects that need to be planted and maintained. The cost-savings for managing the stands are difficult to estimate. A survey on how many times supervising employees from the local Forest Management Association visit objects at different stages is, however, available (Seppänen et al. 2008). Depending on the stage, on average 1 to 2 visits were required. The average time consumption and costs of visiting the objects is calculated and included in the analysis as a rough estimate of the benefits of increasing the average size of stands. The increase in the average stand size is calculated separately for private forests and the jointly-owned forest, based on the average real growth in stand size in Pahkakoski over ten years (Kolis 2015). The rotation period is calculated at 100 years, but for more southern locations this could be considerably shorter. The yearly reduction in costs is 9708 €/year, when only calculated for 50 % of the area due to low levels of management before land consolidation.

3.2 Increase in production

The increase in production after land consolidation, and the benefits of this are estimated based on previous studies and on the average annual growth and harvest possibilities in the Pahkakoski area. The income effects could be estimated in greater detail by applying growth and harvest models at a stand level, but this requires a detailed analysis using input data at a stand level, which is often not available at an early stage of land consolidation projects.

The value of the increase in forest production depends heavily on the price of timber. Due to a large difference between the price of sawlogs and pulpwood, the average timber price is largely affected by the share of sawlogs in harvests. For Pahkakoski, the sawlog percentage in sales has been calculated as relatively low (ca 10 %), which gives an average estimated timber price of 20 €/m³ (Honkanen 2008; Finnish Forest Research Institute 2014). For timber from the jointly-owned forest the prices may be expected to be slightly higher than average, but this is not included at this stage.

3.2.1 Increase in area for forestry

Forest land consolidation can reduce the length of property boundaries in the area. The benefits of reducing the length can be seen either as a reduction of work needed to keep these borders maintained, as is done in Sweden (Lantmäteriet 2012), or through the reduction of productive forest area due to borders being kept open. This second approach is followed here, as this has been previously employed in Finland (eg. Airaksinen et al. 2007). This reduces the need to estimate the time consumption and cost of border maintenance, as well as having to estimate to what extent maintenance work would have been carried out without the project.

The improved shape of properties also reduces the need for extraction routes. In harvests, there is a need for ca 4.5 m wide routes every 20 m. If properties are narrow, it is usually not possible to get an optimal number of routes in comparison to the width of the property. The area under these routes is also outside forestry use.

The area of land affected by property boundaries and extraction routes is estimated with GIS. For Pahkakoski land consolidation, the reduction in boundaries and roads has been calculated to correspond to a circa 4 % increase in the productive forest area (Airaksinen et al. 2007). With an average annual growth of 3.2 m³, this corresponds to an increase of 12524 €/year.

3.2.2 Remedial drainage

A third of the forestry land in Finland is mires, and half of these have been drained (Finnish Statistical Yearbook of Forestry 2013). Drainage and remedial drainage increases the growth of the trees in the area (eg. Sarkkola et al. 2008). Drainage works usually needs to be carried out collectively for a large area, and land consolidation projects offer an opportunity for this. In Pahkakoski, 675 ha were drained and the drainage was improved for 2372 ha (Airaksinen et al. 2007). As a result, the overall area of drained peatland forest has increased with 520 ha and transformed mires with 302 ha between 1995 and the 2000's. The annual increase in growth varies between locations and studies between 0.2 and 1.5 m³/ha/year (Sarkkola et al. 2008). The estimation 0.8 m³/ha/year used by Honkanen (2008) is used here, and the benefits of this were calculated as 48752 €/year.

3.2.3 Areas where management neglected

Forest land consolidation projects have tended to lead to a higher level of management and harvest activities among forest owners. The increase may be due to a combination of factors, such as higher stumpage prices and lower costs, forest management plans and a higher interest in the forest. For Pahkakoski, it has been estimated that the project led to an increase in harvests of 4762 m³ between 1997 and 2007, corresponding to increase in yearly harvests of ca 476 m³ (Honkanen 2008). With an average stumpage price of 20 €/m³ this increases the overall yearly income from the project area with ca 9520 €. For jointly-owned forests the increase may be larger than in private forests, considering that Finnish jointly-owned forests used, on average, 92 % of the harvest possibilities during 2012 (Kärhä et al. 2014).

Managing forests and tending young stands also increases the growth of young trees and increases the share of high-quality timber (Hynynen et al. 2005; Huuskonen et al. 2008). The work consumption also grows over time if tending is postponed: Kaila and Liikkanen (2004) showed that postponing maintenance with two years increased the time consumption with ca 0.3 working days/ha. In Pahkakoski it has been estimated that 1507 ha of young stands would not have been tended without land consolidation (Airaksinen et al. 2007). Losses from ignoring the maintenance have been estimated to ca 300 €/ha for one rotation period at a 5 % discount rate, or ca 3 €/ha/year (Ahtikoski 2002; Hynynen et al. 2004; Airaksinen et al. 2007), leading to a total of 4521 €/year.

3.2.4 Former meadows and commons

Some areas, such as former meadows and commons, may be considered to have been outside of economic use before the land consolidation project. These areas are often small, separate properties or commons, and have irregular shapes. The benefits of getting these areas into forestry could be considered to be at least the value of future growth, and at most the value of future harvests, including the value of the timber at the time of the project. This is due to the expectation that a large part of these areas would not be harvested at any point without land consolidation and as such had very little value before the project. Here, the benefits of getting these areas into productive forestry are calculated as the value of annual sustainable roundwood removal.

In Pahkakoski, 11 % of the total area (538 ha) were commons that have become forested over the years, and 70 % of these were estimated to have been outside any economic use before land consolidation. Land consolidation reduced this area with 369 ha. Calculated with average annual harvests of 1.6 m³/ha, 70 % of 369 ha and an average stumpage price of 20 €/m³, the value of getting these lands into use is 8266 €/year. (Airaksinen et al. 2007.)

4. PROFITABILITY OF FOREST LAND CONSOLIDATION

4.1 Results of cost-benefit analysis

The yearly benefits described above were discounted at a 5 % discount rate and over a 30-year horizon and compared to the costs. The results show that the land consolidation project was profitable with these input factors (table 2). Major contributors to the overall profitability were: increased growth through remedial drainage, reduced in harvest costs and lower maintenance costs due to larger stands and units (table 3).

Table 2. Cost-benefit analysis of the Pahkakoski land consolidation project (5 % discount rate, 30 years)

	€	**€/ha**
Benefits	1 759 667	358
Costs	1 493 432	305
Profitability	258 235	53

Table 3. Distribution of the benefits of forest land consolidation

Benefits (subchapter where presented)	**Annuity** (€, chapter 3)	**Discounted total benefits** (€)
Reduced harvest costs (3.1.1, 3.1.2)	15 778	242 540
(of which transferred to stumpage prices)	11 519	177 073
Increased summer harvests (3.1.1)	1 613	24 793
Reduced transaction costs (3.1.2)	3 268	50 238
Reduced costs of regeneration (3.1.3)	9 708	149 234
Former meadows and commons (3.2.4)	8 266	127 063
Increased area (3.2.1)	12 524	192 517
Increased harvests (3.2.3)	9 520	146 346
Increased productivity of forestry (3.2.3)	4 521	69 499
Remedial drainage (3.2.2)	48 752	749 438
Total benefits	**113 948**	**1 751 667**

4.2 Discount rate and time

The discount rate was set at 5%, which is the rate commonly used for public cost-benefit analyses in Finland, and also currently used for agricultural land consolidation. From a forestry point-of-view the discount rate is relatively high. A comparison of the productive value and transaction prices of forest properties suggested a 2.6 % discount rate was included in transaction prices (Hyytiäinen et al. 2007), and discount rates above 5 % make many forestry related investments unprofitable (cf. Saarinen et al. 2001; Ahtikoski 2002). For forest land consolidation, Lantmäteriet (2012) uses 3 - 4 % discount rates and Hinz (2012) uses 4 %.

The used time horizon of 30 years corresponds to only one third of the rotation period of the forest. It is, however, close to the time the average Finnish forest owner who inherits the forest property is likely to own the forest. Currently, 45 % of Finnish forest owners have inherited or been given the property as a gift, and a further 41 % have bought it from parents or other relatives (Hänninen et al. 2011). For small properties the share of inherited properties is even larger.

To test the sensitivity of the calculations, the profitability was calculated at different discount rates and discount times. Fig. 1 shows that the project would be profitable with a discount rate up to 7% (30 years) and with discount horizons down to 20 years (5% discount rate). Reducing the discount rate to 4% or increasing the discount time to 40 years would roughly double the profitability of the project.

4.3 Sensitivity analysis

Sensitivity analysis was also carried out on other variables, to inspect which variables cause the largest changes in the profitability of the project. The sensitivity analysis was carried out as partial sensitivity analysis: input data was changed for one input variable at the time. Graphs for the profitability with different input data are shown in fig. 1 for those input variables that had the largest effects on the overall profitability.

The sensitivity analysis shows that the average stumpage price has a large effect on the profitability. The stumpage price level has, however, remained relatively stable in the region over the past decade (Finnish Forest Research Institute 2014), and a decrease to prices below 15 €/m³ seems unlikely. On the other hand, factors such as the transaction costs and the increase in the area that can be harvested all year did not change the profitability considerably (changes ca 5 €/ha). Neither did a change in the reduction of forest haulage distance.

Because the analysis was carried out as a partial sensitivity analysis, it is possible that some scenarios are not taken into account. This includes scenarios where several variables are changed at the same time. A worst-case scenario would inevitably lead to the project not being profitable, as very low stumpage prices alone could cause this. The partial sensitivity analysis does, also, not take correlated inputs into account. A correlation between inputs is most likely to be present between stumpage price and harvest intensity.

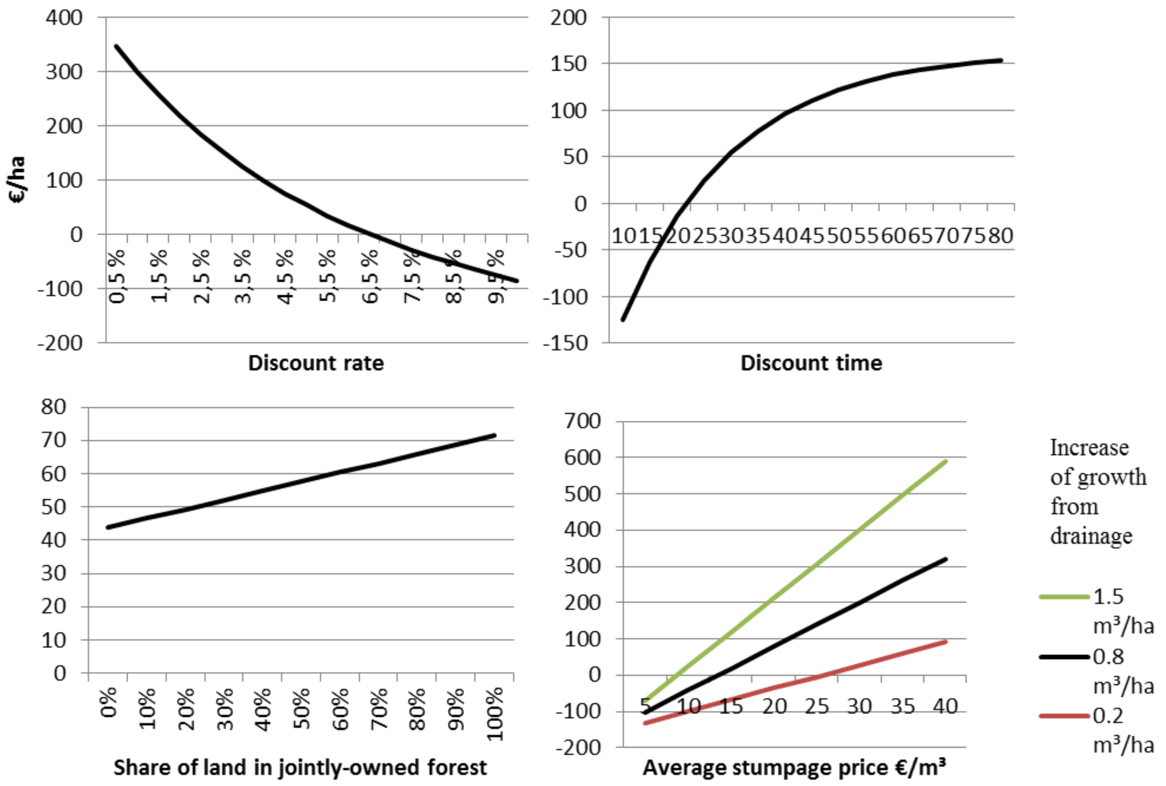

Figure 1. A sensitivity analysis of the profitability (€/ha) of the Pahkakoski land consolidation project, at different estimated increases of annual growth due to remedial drainage

Maintaining the drainage during the project proved to be an important part of the project. If the benefits and costs of drainage had not been included, the benefits of the project would have been reduced considerably. Without drainage works the project in Pahkakoski would, in fact, have been unprofitable (-191 000 €). This suggests that remedial drainage also on its own would have been profitable in the area, but with the fragmented ownership in the area it is unlikely that a large-scale project could have been carried out, particularly at the current costs, and that the increased growth would actually have been harvested. The impact of ditch network maintenance depends, however, largely on the estimated increase in growth. Any estimates below 0.5 m³/ha/year make the project unprofitable, while using 1.5 m³/ha/year increases the project benefits with ca 700 000 euros.

The northern location of the Pahkakoski land consolidation area plays a role in the overall benefits: if the average annual increment and the sustainable roundwood removal had been 70 % higher and the rotation period 80 years, as could be expected in Southern Finland (average annual increment 4.6 m³/ha), the profitability of the project would be 152 €/ha with remedial drainage and 60 €/ha without. Higher stumpage prices than those included in this study would lead to an even larger profitability. As such, a similar project further south would have been profitable even without remedial drainage.

The effect of the area that joined the jointly-owned forest on the overall profitability was also studied separately. As fig. 1 shows, the total area of the jointly-owned forest affects the overall profitability of forest land consolidation, but keeping other factors set the project would have been profitable even without the jointly-owned forest. It is, however, possible that the costs of the project would have been affected if a considerably smaller or larger area joined the jointly-owned forest, but this could not be estimated. The impacts of the jointly-owned forest also include other factors that are difficult to estimate, such as the management costs of the jointly-owned forest in comparison to the management costs of private forests (cf. Viitala & Leppänen 2014).

5. CONCLUSIONS

In projects it is usually relatively easy to estimate the costs, and in studies carried out after the project the costs are usually known. Estimating the benefits and possible hindrances is, however, more difficult. In this paper, the profitability of a forest land consolidation project was calculated. While the article focuses on the situation in Finland, the property structure of forests is problematic in many countries. The basics of modern forestry are also relatively similar between countries. As such, the results and calculation methods can be applied, with necessary modifications, elsewhere. The results show that forest land consolidation can be profitable to forest owners, even in boreal areas with a slow growth of timber. Information on the profitability is important for the decision-making in land consolidation projects, and difficulties to show stakeholders that projects are beneficial can lead to difficulties in reaching good results in land consolidation projects (Hartvigsen 2014).

The creation of jointly-owned forests is seen as a major part of current forest land consolidation projects in Finland. The results show that creating jointly-owned forests increases the benefits of the project, but that the project would have been profitable even without the jointly-owned forest. As such, jointly-owned forests can be seen as a profitable addition to the project, but an interest among land owners for jointly-owned forests does not need to be a prerequisite for carrying out land consolidation.

The increase in the profitability of the project when including not only the rearrangement of parcels, but also road construction, jointly-owned forests and drainage works, shows the benefits of combining all these into the same project. On their own, each measure would have been difficult to implement, especially at the current costs. Combining different measures into a comprehensive land consolidation project may prolong the process, but gives access to benefits that otherwise could not have been achieved.

This article focuses on the benefits of forest land consolidation to the economic use of forests, and the main beneficiaries are land owners and the local forest industry. Forest land consolidation can, however, also have impacts on society at large. Projects can improve the local economy, facilitate landscape measures, afforestation and the creation of protected areas or other public projects (Thomas 2006; Hinz 2012). Projects may also have an impact of nature (Thomas 2006), which has to be taken into account when planning and implementing projects. Further studies are required to analyse which further benefits apply in Finnish circumstances, and what their monetary value is. This was not possible within the scope of this study, and therefore this study sets a lower limit for the overall profitability of the project. This study, however, shows that the forest land consolidation project was profitable even without taking these into account.

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