Nordic Journal of Surveying and Real Estate Research 11:1 (2016) 7–17
submitted on 5 May, 2015
revised on 9 June, 2015
accepted on 21 July, 2015

Jointly Owned Forests and Forest Land Consolidation – Increasing the Stand Size in Fragmented Areas

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Abstract. Private ownership has traditionally been considered superior to joint ownership. The creation of new jointly owned forests is, nevertheless, regarded as an integral part of Finnish forest land consolidation projects. The aim of these projects is to solve the challenge of increasingly small forest properties, which lead to higher harvest and maintenance costs, and lower incentives to manage the forests. In this article, a case study was carried out on the size of forest stands (compartments) before and a decade after the Pahkakoski land consolidation project. The stand sizes before and after land consolidation are compared both for areas that only underwent land consolidation and for areas that were merged into a jointly owned forest. The results indicate that land consolidation increases the stand sizes, especially for younger stands. For jointly owned forests, this increase is larger: in terms of forest land, the average stand size increased with between 1 and 1.8 hectares depending on the development class of the forest stand. While the results demonstrate that land consolidation on its own can increase the stand size, leading to lower management costs, jointly owned forests increase this effect considerably. As such, the creation of jointly owned forests presents clear benefits compared with pure land consolidation through economies of scale.

Keywords. *Land fragmentation, rural development, land tenure, forestry, private property, common property*

1 Introduction

Generally, property can be classified into open access, common, and private (Ekbäck 2009). The superiority of one property rights regime over another has long been a subject of debate, but economists have traditionally considered private property to be the most effective form of ownership. From that perspective, private ownership protects against the overuse of resources to which common property

has been thought to inevitably lead, especially after the publication of Hardin's *The Tragedy of the Commons* in 1968. Similar sentiments existed in Finland in the 19th century. Consequently, traditional forest commons in Finland were divided among shareholders to protect the forests from excessive use (Haataja 1949).

According to Liebcap (2002), on the other hand, common property does not necessarily lead to tragedy, but rather to the ineffective use of resources. Another view is, however, that common property can be considered an effective alternative in certain cases, such as when common property enables economies of scale or when resource usage requires cooperation (Feeny et al. 1990; Ekbäck 2009). In such situations, it would be expensive to divide the resource between users, and common property rights regimes may be the more efficient option (Ekbäck 2009).

The privately owned forests that were created in Finland during the 18th and 19th centuries have been further partitioned due to a lack of restrictions on the partitioning of properties since 1916 (Haataja 1949; Leppänen 2008). Despite ongoing concerns that free partitioning was leading to a fragmentation of forest ownership (e.g. Haataja 1935), the legislation has remained unchanged. In Finland today, inheritance continues to be a major force behind partitioning (Ripatti 1996), and 45% of all forest owners have obtained their forest through inheritance or as a gift (Hänninen et al. 2011). The size of forest properties in Finland have also been reduced due to political decisions to create new farms for the landless during the first half of the 20th century (Leppänen 2008). Consequently, the number of forest holdings more than doubled in Finland during the 20th century (Leppänen 2008), and the average size of forest holdings is currently 30 hectares (Finnish Statistical Yearbook of Forestry 2014). Additionally, the forest parcels that were created were often long and narrow in certain areas in western Finland. This is often the result of a combination of local geography and the equitable division of productive land, while keeping the number of parcels limited (Haataja 1949).

Harvesting and forest management display economies of scale, with reduced costs for larger entities. Conversely, fragmented ownership and small forest properties are associated with higher harvest costs, and as a consequence, small projects are typically less attractive to harvesting contractors (Moldenhauer & Bolding 2009; L'Roe & Broussard Allred 2012). Partly fixed costs in harvesting and management culminate in higher unit costs (Row 1978; Cubbage 1983). Higher harvest costs and less competition in turn result in lower timber prices for small timber sales (Brown et al. 2012; Kolis et al. 2014), affecting the potential income of small forest owners. Despite this, forest properties in many countries remain quite small with many European countries reporting problems with the fragmented ownership of forests (Hirsch et al. 2007).

The impacts of fragmented parcels are not only economical, but also ecological. The creation of larger ecological patches, such as continuous patches of old growth forest, is hindered threefold: the borders of forest properties often do not follow natural borders; landowners have various objectives; and forest management plans are drawn up without considering the plans of adjacent properties (Kurttila et al. 2002). Large patches can, however, also have negative consequences, such as increasing the time needed for pre-commercial thinning

(Uotila et al. 2014) or reducing the ecological or aesthetical values of the forest (e.g. Jokimäki et al. 1998; Koivula et al. 2002). To this latter point, Holmgren et al. (2010) found that Swedish forest commons were environmentally neither better nor worse than forests in other ownership categories.

From the beginning of the 20th century, jointly owned forests were sometimes formed instead of providing new farms with private forest land, especially in Northern Finland (Metsäpelto 1942). The success of these jointly owned forests depended on the use and management of the forest. Jointly owned forests that were partly used for firewood often led to problems and were sometimes divided, while larger, more professionally managed forests focusing on timber sales were more successful (Metsäpelto 1942).

In Finland, land consolidation and jointly owned forests are once again viewed as possible solutions to the difficulties associated with small private forest holdings. In Finnish legislation, a jointly owned forest is defined as an area that jointly belongs to several real properties and that is intended for practising sustainable forestry to the benefit of the shareholders (Act on jointly owned forests 109/2003). These forests are established through an agreement between the owners and are registered by a land surveyor. The practical operations thereof are managed by an administrative board or an agent. After a change in legislation in 2003, there has been an increasing interest in jointly owned forests. This shift has been supported by the Finnish state through lower taxes for jointly owned forests and no surveying fees for creating jointly owned forests (Viitala & Leppänen 2014a).

In recent forest land consolidation projects, at least some part of the project area has been converted into a jointly owned forest through an agreement between forest owners. Increasing the sizes of stands is seen as one of the benefits of forest land consolidation: with an improved property structure, natural stands are not divided between as many properties as before. There is, however, little research on the size of stands before and after land consolidation. A Swedish study showed that land consolidation increased the average size of regeneration fellings from 2 hectares to 4 hectares and for thinnings from 2 hectares to 6 hectares (Lantmäteriet 2012). It is, however, uncertain how this compares with Finnish circumstances. There are also no studies investigating if creating jointly owned forests is more effective than pure land consolidation in terms of creating larger stands, even though this is assumed both in current cost-benefit analyses and in the marketing of jointly owned forests.

In this article, the stand sizes before and after a land consolidation project are compared in a case study. The changes in stand sizes are also compared between the jointly owned forest and private forest areas, to investigate if there are benefits associated with jointly owned forests. The case study and the methods utilised are described in greater detail below, before reporting the results and drawing some final conclusions.

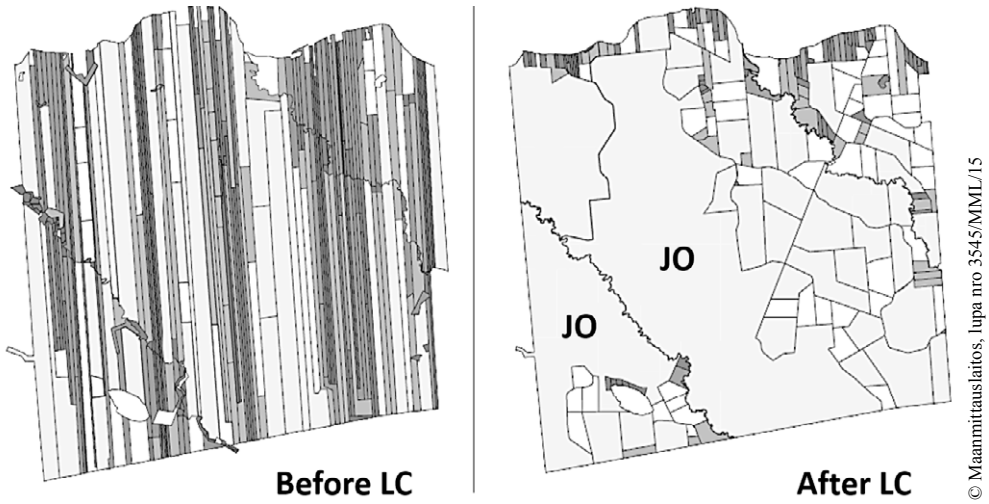

Figure 1. *Pahkakoski land consolidation project before and after land consolidation, with darker colours showing the lower suitability of parcels for forestry (Uimonen 2010). The two parcels of the new jointly owned forest are marked with JO. (Map © National Land Survey of Finland / Uimonen 2010).*

2 Pahkakoski Land Consolidation Project

The Pahkakoski forest land consolidation project (Fig. 1) was carried out between 1990 and 1997. Pahkakoski is situated in northwestern Finland, approximately 35 km north of the city of Oulu. The project covered 4900 hectares of forest land, and 83% of the land area changed ownership during the project (Uimonen 2010). The average parcel size in the project was relatively large in comparison with the size of forest holdings in Europe (Hirsch et al. 2007); however, the growth of the forest at northern latitudes is slow along and the parcels are containing impractically shaped parcels. Prior to the land consolidation project, the area consisted of up to 8 km long properties that in some places were less than 30 metres wide with some uncertain property borders.

In the land consolidation project, the shape of the properties was improved. Before land consolidation, the area lacked a proper forest road network, which was built during the project. The forest drainage was also maintained and supplementary drains were added. As part of the land consolidation project, a

Table 1. *Pahkakoski before and after land consolidation (Uimonen 2010).*

	Before	**After**
Number of parcels	232	130
Average size of parcels*	15 ha	23 ha

* Excluding jointly owned forest

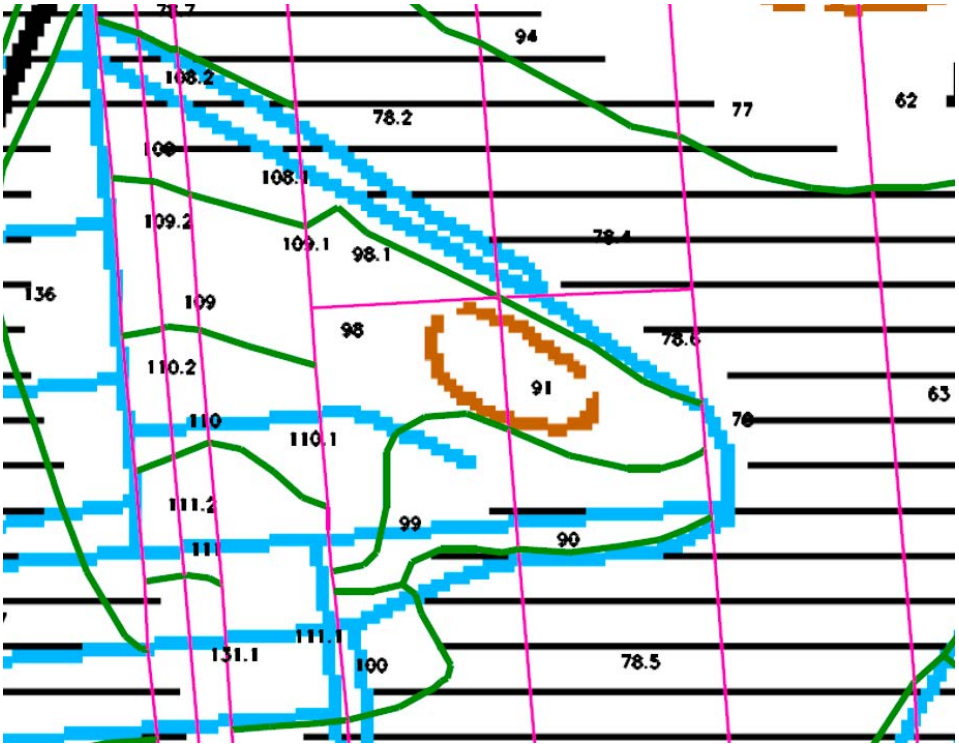

Figure 2. *The property boundaries (pink) split the natural stands (numbered, stand edges in green) into substands – an example from Pahkakoski before land consolidation. Ruled area is mires and wetlands. (Background map © National Land Survey of Finland).*

jointly owned forest covering 1874 hectares was created. During the project, all land owners were offered the possibility to join the jointly owned forest. The resulting forest has 149 shareholding real estates and is managed as one unit. This greatly reduced the number of parcels (Table 1) in the area.

Pahkakoski was selected for the case study, because it was the oldest forest land consolidation project in Finland where the pre-land consolidation forest management plans were available electronically. This made a GIS analysis possible while also providing the longest possible time scale for the analysis. Moreover, Pahkakoski was also the first Finnish land consolidation project, where a jointly owned forest was formed from privately owned forest holdings.

Figure 2 shows an example area from Pahkakoski before land consolidation, with the stands numbered and separated by green lines. The natural stands were split into substands due to property boundaries (pink lines). After land consolidation, part of the boundaries were removed. In addition, stands were combined so that stands sharing the same first number were merged (e.g. 109, 109.1, and 109.2 were combined).

3 Data Analysis

For the study, the stand sizes in Pahkakoski before and after land consolidation were compared. A computerised forest management plan from 1995 was available for the whole area. During this time, the land consolidation project was already in progress. This meant that some stands had already been merged to correspond to the situation after the change of property boundaries; thus, the old property boundaries were not available in the data. Property boundaries were, therefore, redrawn based on paper maps of the area and stands were split along property boundaries (Fig. 2). The boundaries were created to follow stand edges wherever it was obvious that the stands had followed the old boundaries.

Three different databases were then created: one for the whole area, one for the area that formed the jointly owned forest, and one for the areas that did not join the jointly owned forest. In the north, the area is limited by the Ii River, so parcels for summer houses were left along the river for the previous owners. These were not included in the forest management plans, and they were also excluded from the analysis. The data in the forest management plans include stand area, development class, and land class.

Data on the stands before land consolidation were compared with data from the new forest management plans. This comparison was undertaken to investigate how the stand size has developed after land consolidation. For the area of the jointly owned forest, the forest management plan was last updated in 2006. For the other areas, plans have been updated during various years, and for a large part of the area, no newer plans exist. As a result, 2090 hectares out of 4900 hectares were excluded, because the forest management plans had not been updated since 2000. Areas that were marked as brooks and other areas marked as protected according to nature conservation or forest legislation were likewise excluded, because these were usually relatively small areas that are not used for active forestry. This removed 98 stands from the data.

The hypothesis was that the average stand size would increase in all land classes, but that the increase would be larger for scrub and wasteland. The focus was, however, mainly on the productive land. Therefore, the average stand sizes were calculated separately for forest land, scrubland, and wasteland[1]. In order to be able to estimate when the benefits would accrue, the changes in stand size were also estimated separately for each development class, with the assumption that younger stands can more easily be combined into larger areas than mature stands. The statistical significances of the changes were tested through t-tests of independent samples.

4 Results

In Table 2, the average stand size in Pahkakoski before and after land consolidation is presented, separately for the area where a jointly owned forest was created and separately for the area where only the shape of the properties was improved

[1] Forest land: annual increment over 1.0 m³/ha, scrubland: 0.1–1.0 m³/ha, wasteland: less than 0.1 m³/ha.

Table 2. *Average stand size before and after land consolidation in Pahkakoski.*

	Land consolidation area			Jointly owned forest		
	Before (1995)	**After* (2000–)**	**Change**	**Before (1995)**	**After (2006)**	**Change**
All land classes	0.57 ha	1.25 ha	119%	0.70 ha	2.37 ha	239%
Forest land	0.48 ha	1.07 ha	123%	0.67 ha	2.26 ha	237%
Scrubland	0.55 ha	0.85 ha	55%	0.69 ha	2.25 ha	226%
Wasteland	1.45 ha	5.26 ha	263%	1.16 ha	6.47 ha	458%
Number of stands	4,736	448	–91%	2,622	762	–71%
Total area	2,678 ha	562 ha		1,829 ha	1,809 ha	

*Includes only the area where forest management plans have been updated since 2000.

Table 3. *Average stand size in different development classes before and after land consolidation in Pahkakoski.*

Development class	**Land consolidation area**			**Jointly owned forest**		
	Before (1995)	**After* (2000-)**	**Total area in development class (2000-)**	**Before (1995)**	**After (2006)**	**Total area in development class (2006)**
Young seedling stand	0.80	0.93	9 ha	0.60	2.14	49 ha
Advanced seedling stand	0.41	1.23	81 ha	0.68	2.10	334 ha
Young thinning stand	0.50	1.20	205 ha	0.69	2.40	833 ha
Advanced thinning stand	0.48	0.89	60 ha	0.60	2.35	298 ha
Mature stand	0.49	0.67	36 ha	0.60	1.60	50 ha
Scrub and wasteland	0.83	2.17	158 ha	0.81	3.52	240 ha

*Includes only the area where forest management plans have been updated since 2000.

(referred to as the land consolidation area). The results indicate that the average stand size before land consolidation was small, both in the land consolidation area and in the area for the jointly owned forest. The differences between the two areas in 1995 are purely incidental.

Land consolidation increased the stand size in both areas. The average stand size of forest land had approximately doubled during the decade, while the jointly owned forest tripled the average stand size. The increase is considerably larger for wasteland, but this increase has little significance for forestry as this land class remains outside of the traditional economic use of forests (e.g. cuttings). The

increase in the average size of wasteland under unified ownership could, however, be significant if creating environmental protection schemes for mires.

Table 3 details the increase in the average tract size in different development classes of the forest land. The results indicate that those stands that are still developing (advanced seedling stands and young/advanced thinning stands) have been merged to form larger stands, while enlarging the size of mature stands has been more difficult, at least over this time frame. On the other hand, the area covered by mature stands and young seedling stands is quite small. For the land consolidation area, there has mainly been an increase in the average size of advanced seedling stands, while the jointly owned forest shows an increase in all development classes. It is, therefore, possible that over time the benefits will be larger even in the land consolidation area.

The significance of the changes in stand size was tested by independent sample t-tests. The stand sizes were not normally distributed, with a strong focus on smaller stand sizes, but the robustness of the t-test does not require normality (Schmider et al. 2010). The t-tests were calculated based on the assumptions of equal and non-equal variances and samples sizes (Welsh test). The assumption of equal variances was rejected in most cases, but both an assumption of equal and non-equal variances led to the same result in most cases. The stand sizes were statistically significantly larger after the project, except for young seedling stands in the land consolidation area. The average stand size after land consolidation was also significantly larger in the jointly owned forest than in the land consolidation area (p-value < 0.05) for forest land, scrubland, and for all development classes.

5 Discussion

This case study demonstrates that over the course of a decade the stand size increased both after land consolidation and after creating a jointly owned forest. On this account, there was an increase in all classes of land and in all development classes. The results also show that the creation of a jointly owned forest led to a considerably larger increase in the average stand size than mere land consolidation. This suggests that from the viewpoint of stand size at least, it is beneficial to create jointly owned forests through land consolidation.

The jointly owned forest also displays a larger increase in all development classes, including mature stands. Considering that the main part of the income from forestry comes from the regeneration felling of mature stands, this means that the jointly owned forest achieves these benefits sooner. The small total area of mature stands in Pahkakoski, however, reveals that a large part of those benefits from land consolidation related to regeneration felling will only be realised after several decades. This includes a large share of the increase in timber prices, as well as benefits when planting new trees after regeneration felling.

The smaller increase in the stand size for mature stands suggests that it is difficult to remove old treatment patterns over a short period of time. For younger stands, on the other hand, thinnings that are carried out after land consolidation make it possible to quickly combine stands that have been under different ownership and have slightly different ages. Thinnings have often been neglected

before land consolidation, so it is usually possible to carry out thinnings shortly after land consolidation (Airaksinen et al. 2007).

Larger stands bring economies of scale into harvesting and forest management. Considering the results of this study, it seems that jointly owned forests can offer benefits compared with private ownership through economies of scale. This confirms the findings of previous studies on common property, such as Ekbäck (2009). The significant interest in joining jointly owned forests also shows that the development does not necessarily only move unidirectionally from common property to private property, but also in the opposite direction, as suggested by Field (1989). Under the right circumstances, common property may well be the effective solution.

The increased size could in some cases also increase the labour consumption. Based on the model by Uotila et al. (2014), the increased size of stands could increase the labour consumption for motor-manual pre-commercial thinning at sites that have not previously been thinned. Larger sites had a larger stump diameter and a larger density of removal at pre-commercial thinning. Applying the model to the stand sizes of seedling stands in Pahkakoski provides an increase in the labour consumption of between 0.0 and 0.1 days/ha. For sites that have been previously thinned, the area does not significantly change the labour consumption. This increase in labour consumption could, however, be compensated through a smaller number of independent stands that need to be visited and thinned.

The aforementioned Swedish study (Lantmäteriet 2012) compared the sizes of timber transactions before and after land consolidation. Their results are similar to the results for stand sizes in jointly owned forests in this study. In Sweden, the area in regeneration fellings was doubled, as was the average stand size for mature stands in this study. With regards to thinnings, the area grew by a factor of three in both the Swedish study and this study. The results are, however, difficult to compare in greater detail, because of differences in geography and at the level of fragmentation before and after land consolidation.

This paper presented a case study of one forest land consolidation project over the time frame of approximately ten years. There is need for further studies to investigate how this case study compares with other land consolidation areas and how the stand size develops over a longer period of time, such as 20 or 30 years. However, there have not been many pure forest land consolidation projects in Finland in recent years, due to a strong focus on agricultural lands. As such, further comparison at this time is not possible.

Jointly owned forests may also have additional benefits, such as offering an ease of ownership to those who do not wish to manage their forests independently. There are management costs incurred in both private and jointly owned forests—whether this includes the owner's time, the appointment of a professional to manage the forest, or the co-ordination and decision-making within the jointly owned forest. However, a comparison of these costs is quite difficult, as is placing a value on the time that private owners dedicate to managing their forests and keeping up to date with current developments in forestry. Furthermore, the economies of scale of creating jointly owned forests outside land consolidation projects is more difficult

to estimate, because the parcels that are voluntarily merged are rarely next to each other. Therefore, it is possible that creating jointly owned forests through land consolidation offers benefits that may not be achieved otherwise. There has always been insufficient evidence of the economic superiority of private forests or jointly owned forests (Haataja 1949; Viitala & Leppänen 2014b), due to the large number of factors that affect both the cost and income side of forestry, and the large variety in the size and management of jointly owned forests. This study, however, offers some insights into the situation, at least in a land consolidation context.

Acknowledgements. I wish to thank Esa Ärölä for his help in data collection and the use of the software, as well as for his comments on this paper. I also wish to thank the jointly owned forest, Pahkakosken yhteismetsä, and the Finnish Forest Centre for providing the post-land consolidation stand data. This research was funded by the Finnish Ministry of Agriculture and Forestry and the National Land Survey of Finland.

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