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Economic Accessibility of Forest Resources in the Novgorod Region, Russia

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Abstract

The European part of Russia forms an important and growing part of total timber trade of Europe. While forest resources in the European part of Russia are vast, the accessibility of these resources limits their potential use. Economic accessibility of forest resources can be calculated based on forest inventory data as well as from satellite based forest resource information. The economic accessibility calculated in this study is based on the costs occurring from harvesting, forwarding, road side processing, transportation to lower landing or leskhoz center and reforestation. Comparing the two different forest resource information data there is only a slight difference in the results. It can be assumed that the forest resource data obtained from the satellite images is just as reliable as the traditional forest inventory data. In terms of western economics all forests in the seven leskhozes studied can be considered economically accessible. Further attention should be given to the accuracy of the harvesting costs and to costs occurring in different harvesting chains.

Keywords: forest inventory, GIS

Introduction

The European part of Russia forms an important and growing part of total timber trade of Europe. While forest resources in the European part of Russia are vast, the accessibility of these resources limits their potential use. Poor road conditions as a whole, frost damaged roads, lack of forest roads and large amounts of wetlands make it difficult to access these resources. Although, with modern methods, it is possible to harvest forests in remote, almost impassable areas, the costs of these operations can rise to a point where it is not economically feasible to harvest. Using highly detailed forest inventory data combined with road network and management unit map information it is possible to estimate the costs of harvesting timber in these areas. As an alternative to traditional inventory data, satellite based information can also be used. Currently, satellite based forest resource information is available for the entire European part of Russia. Accessibility measures, both economic and technical, are discussed in this study.

Background

Forestry in the Russian Federation

For European forest industry the most important and interesting part of Russia is the European part. The North and North-West districts of the Russian Federation (northwestern Russia) are especially important to forest industry in Scandinavia. The oblasts of Arkhangelsk, Vologda, Murmansk, and the Republics of Karelia and Komi form the North district, and Leningrad, Novgorod and Pskov make up North-West district.

The area of stocked forest lands under the authority of the Federal Forest Service of

Russia in the North district is 71,1 million ha and 6,8 million ha in the North-West district. In contrast, the area of forest land in Finland is 20 million ha, about a fourth of the area of forests in northwestern Russia. The total growing stock of these 8 oblasts is 8,3 billion m3 which is roughly four times as much as the total growing stock in Finland. In 1997 there were 26 National parks in the European part of Russia. Northwestern Russia contains 7 National Parks with a total area of 3 million hectares (Pisarenko, A. et al, 2001).

Russian forests are classified into three management groups. *Group I* forests are shelter belts along roads, railroads, rivers and lakes as well as protected forests and other forests outside of industrial use, where clear cuts are forbidden. *Group II* forests are located close to urban areas and industrial sites and only limited fellings are allowed. Forest regeneration is obligatory in these forests. *Group III* forests are intended solely for industrial use and are the main source of raw material for the industry. Clear cuts are allowed with a maximum size of 50 ha. Regions with a high population density and thus an extensive road system, such as Novgorod and Leningrad, and areas with a lot of wetlands have no Group III forests, but are made up mostly of Group II forests.

Novgorod Oblast

The case study of Novgorod region, located in the North-West district of the European part of Russia will be presented in this study. The region is 55,3 thousand square kilometres in size with a population of 751,5 thousand. 70% of the population is concentrated in the cities, with the biggest ones being Novgorod, Borovichy and Staraja Russa. Novgorod region is divided into 21 administrative districts and 24 state forest management enterprises (leskhozes).

The Novgorod region has a total of 4,1 million hectares of forest land of which 98,9 % is owned by the Committee of Novgorod Region. Dominant tree species in Novgorod (by area) are birch (40%), spruce (19%), pine (24%), aspen (11%) and other (6%). The annual allowable harvest has increased steadily since 1996, from 5,77 million cubic meters to 6,91 million cubic meters in 2001. The actual cutting is only a small share of the allowable cut. In 1996 the actual amount cut was 938 thousand cubic meters (16% of the allowable harvest) and in 2001 the actual amount cut was 2,86 million cubic meters (41% of the allowable harvest). The number of logging contracts in Novgorod varied between 24 in 1998 and 94 in 2001 (Lyubimov, 2002).

Data

Inventory data

Forest inventory data in Russia is gathered as a compartment based assessment. Inventory work starts with the acquisition of aerial photographs on which the borders of compartments are delimited. The compartments are visited and the following variables, by forest group are measured:

- kvartal area, hectares (estimated by measuring the area enclosed within kvartal boundaries)
- total growing stock, cubic meters
- pre-merchantable stand area, hectares
- pre-merchantable volume, 10s of cubic meters
- merchantable stand area , hectares
- merchantable volume by tree species, 10s of cubic meters

Compartments are organised into kvartals, with an average of 100-200 ha each, kvartals are grouped into forest districts, lesnichestvos of appr. 20 000 ha and forest districts are grouped into forest management units, leskhozes. The leskhozes in the Nogorod region are approximately 100 000 ha in size. When talking about inventory data a question on the reliability of the data is taken up. Despite the large size of the Russian Federation and the vastness of its forest resources, errors in forest resource estimates are not that much larger than those normally found in western European countries. A recent study (Kinnunen, J. et al, 2003) has shown that stand volumes in the Novgorod region have been underestimated by 13.4%, on average. The biggest differences occurred when comparing inventory data in larger volume classes. An overestimate of 12% was observed in the small volume class (<200m^3/ha) while an underestimate of 28% was observed in the large volume class (>400 m^3/ha). The data used for this study are kvartal (management unit) level volume estimates which have been derived from detailed compartment level data.

Map data

The map data included in this study includes the general layers of kvartal, leskhoz (24 in the Novgorod region), parks, wildlife reserve boundaries, relief, roads and railroads, urban areas, leskhoz centres, management units not controlled by forestry authorities, forests, non-forest and marsh areas, lakes and rivers.

The road network of the Novgorod region is rather comprehensive and increases the industrial attractiveness of the region. With an average amount of 17 km of roads per 100 km^2, a total of 1147 km of railroad and more than 300 km of open waterways for navigation, cargo can be carried effectively and with ease to the Baltic states, other regions of the Russian Federation, Scandinavia, and CIS countries. The road network crosses the region and leads to major cities such as St. Petersburg, and from there onwards to Finland and the Baltic Sea as well as through Moscow to other areas of eastern Europe. The railroads cross the region in practically all directions and, in addition to main line railroads, there are some narrow guage railroads, which can be used locally. Waterways make it possible to carry cargo in vessels and boats from Lake Illmen, to the Baltic and White seas and then onwards to other regions in Europe and countries outside of Europe, such as Turkey. The forest road network in the Novgorod region forms a less comprehensive network, with an average of 4,5 km of forest roads per 1000 ha, and will, hopefully, be improved within 10 years as a result of new forest legislation. The current amount of forest roads is only a third of the recommended amount.

Methods

The economic accessibility of forest resources is measured in this study, using costs occurring between harvesting and delivery to a lower landing. Stumpage is not included in the method as the stumpage value can be either evaluated with this method (by way of assessing the ability to pay for wood at the lower landing/mill gate and deducting the costs from that) or by using the (minimum) stumpage price given by the authorities. This method has been derived from an earlier study by Niskanen, et al (2002, 2003) where the method was slightly different in that forest inventory data was not used. The basic idea is the same, but a different view on economic accessibility is obtained. The costs calculated are felling, forwarding, roadside processing, forest road transportation, road transportation and regeneration (Table 1). The parameters used for cost calculations were obtained from the Russian partners but it should be noted that these parameters are from one forest management enterprise, and thus, cannot be

considered to represent the whole area.

Table 1. The harvesting costs used for assessing the economic accessibility

Activity	Setup Costs (per kvartal)	Variable Costs	
Final Cuts	380,0	32,1	Rubles/m3
Forwarding	290,0	6,2	Rubles/m3/km
Roadside Processing	125,0	0,4	Rubles/m3/km
Forest Road Transport	125,0	7,1	Rubles/m3
Road Transport		0,2	Rubles/m3/km
Total Fixed Setup Costs	920,0		Rubles/kvartal
Planting		1850,0	Rubles/ha
Sowing		572,0	Rubles/ha
		Revenue	
Conifer Mill Gate Price		650,0	Rubles/m3
Soft Hardwood Mill Gate Price		480,0	Rubles/m3
Hard Hardwood Mill Gate Price		750,0	Rubles/m3

In this study it is assumed that all roads are accessible all year around, so no periodic frost damage or wet seasons were taken into account. Although it is obvious that many roads, especially forest roads, are not drivable in the wettest spring and summer months, it was not possible to examine the effect of these factors on the accessibility of forests at this time. For this kind of examination more detailed road network data as well as data on relief of the region is necessary.

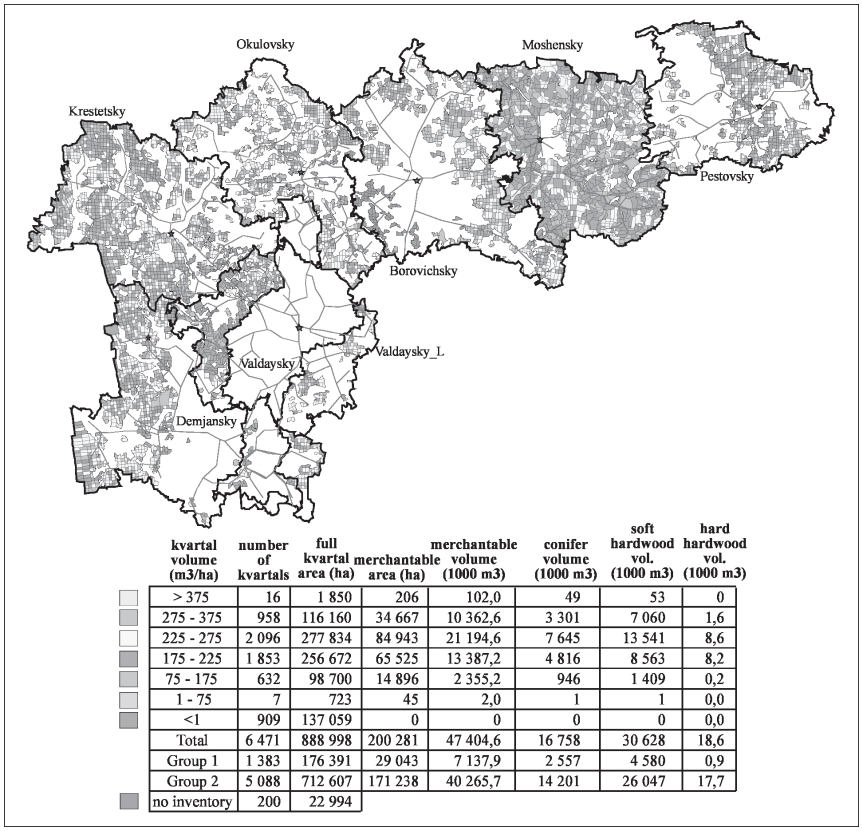
The information for each inventory block is linked to the respective map kvartals after which costs associated with harvesting and hauling harvested timber to lower landings near the leskhoz centres are calculated. The distance from a kvartal to the leskhoz center is calculated by calculating the shortest distance from the kvartal center to the nearest road segment after which the length of the path along road network segments to the leskhoz center can be added to that.

Satellite based information

Detailed enough forest inventory data in the Russian Federation, or elsewhere for that matter, is not easy to acquire. An extensive project developing satellite based measurements of forest resources in Europe has been conducted as a joint project by the European Forest Institute, the Joint Research Center of the European Commission, the European Space Agency and VTT. The resulting maps indicate the amount forest coverage as a percent of land area over most of Europe and in European part of Russia (Päivinen et al, 2001; Schuck et al, 2002).

Results

The map data is combined with the inventory data in seven leskhozes (figure 1). As usual in Russia, the timber is assumed to be transported to the lower landing near or in the leskhoz centre. From there, the timber can be forwarded to long distance transportation by trucks or railroad. The costs occurring after delivery to the landing site are not taken into consideration.



kvartal volume (m3/ha)	number of kvartals	full kvartal area (ha)	merchantable area (ha)	merchantable volume (1000 m3)	conifer volume (1000 m3)	soft hardwood vol. (1000 m3)	hard hardwood vol. (1000 m3)
> 375	16	1 850	206	102,0	49	53	0
275 - 375	958	116 160	34 667	10 362,6	3 301	7 060	1,6
225 - 275	2 096	277 834	84 943	21 194,6	7 645	13 541	8,6
175 - 225	1 853	256 672	65 525	13 387,2	4 816	8 563	8,2
75 - 175	632	98 700	14 896	2 355,2	946	1 409	0,2
1 - 75	7	723	45	2,0	1	1	0,0
<1	909	137 059	0	0	0	0	0,0
Total	6 471	888 998	200 281	47 404,6	16 758	30 628	18,6
Group 1	1 383	176 391	29 043	7 137,9	2 557	4 580	0,9
Group 2	5 088	712 607	171 238	40 265,7	14 201	26 047	17,7
no inventory	200	22 994					

Figure 1. Merchantable volume of kvartals (m^3/ha)

The conifer volume by distance to the nearest road (along the forest road) is in general less than 7,5km (figure 2) and no timber has to be transported on these forest roads beyond 12,5 km. The distance from kvartals to leskhoz centers, where the lower landing is, is assumed to be an average 35 km (figure 3) and with the cost of 57 rubles/m^3, one can acquire a total of approximately 12 mill m^3 in the seven leskhozes mentioned (figure 4), excluding the stumpage as mentioned in the methods.

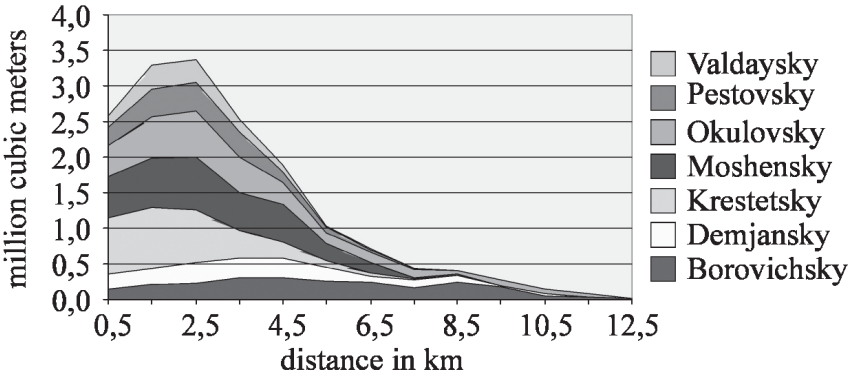


Figure 2. Coniferous volume (mill. M3) by distance from the kvartal to the road

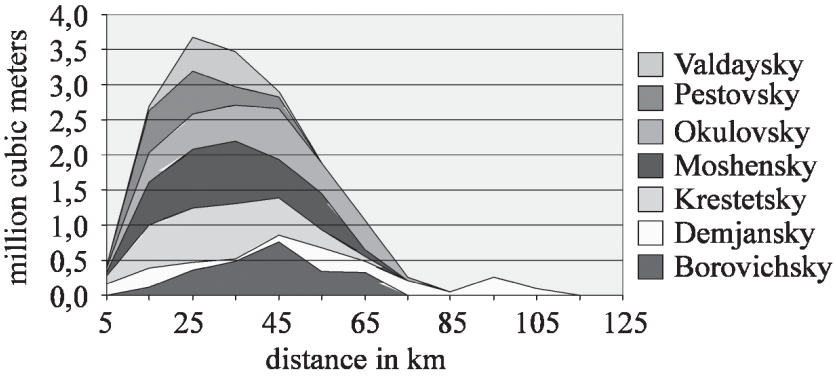


Figure 3. Coniferous volume by distance to lower landing

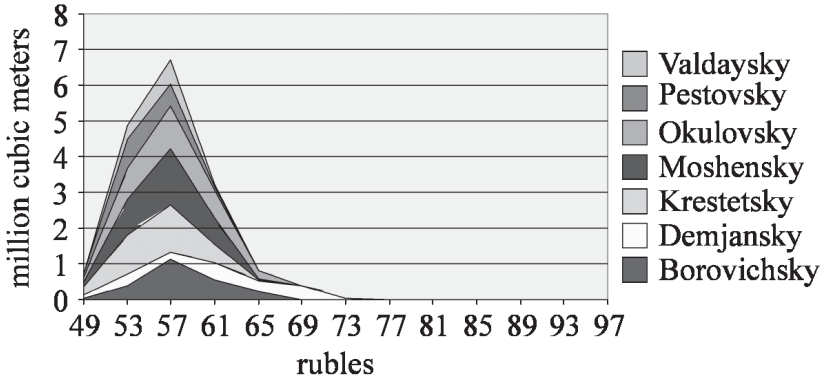
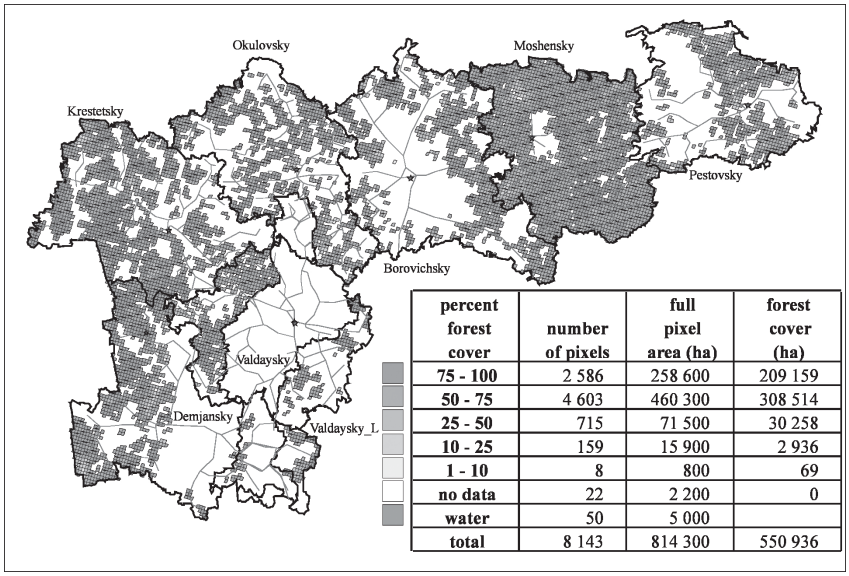


Figure 4. Coniferous volume by cost/m^3

The map combined from the forest inventory data (figure 1) was compared with a map combined from the satellite based information (figure 5). The forest resource satellite map has $1km^2$ * $1km^2$ pixels which can be put on top of the map data and can then be compared with the available forest inventory data.

The results show a slight differentiation in terms of area (figures 6 and 7). The total area is slightly higher in the forest inventory based calculations (area of management units) (figure 6) than in the satellite based calculations (area of pixels) as pixels falling only partly on top of management units have not been included. The merchantable forest area within management units is only a quarter of the amount of the forest cover area. This can easily be explained by the fact that the inventory data consists of areas designated for forest use and of merchantable areas only. Therefore there are no agricultural lands included in it, neither pre-merchantable areas. The satellite based information has no possibility of defining whether the area is controlled by the agricultural administration or if it is pre-merchantable forest area.



percent forest cover	number of pixels	full pixel area (ha)	forest cover (ha)
75 - 100	2 586	258 600	209 159
50 - 75	4 603	460 300	308 514
25 - 50	715	71 500	30 258
10 - 25	159	15 900	2 936
1 - 10	8	800	69
no data	22	2 200	0
water	50	5 000	
total	8 143	814 300	550 936

Figure 5. Forest coverage by percent

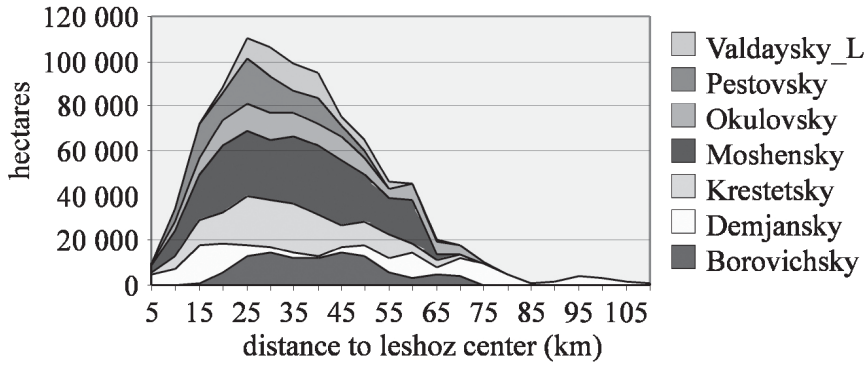


Figure 6. Total area of kvartals (ha) by distance to leshoz center, from the inventory data

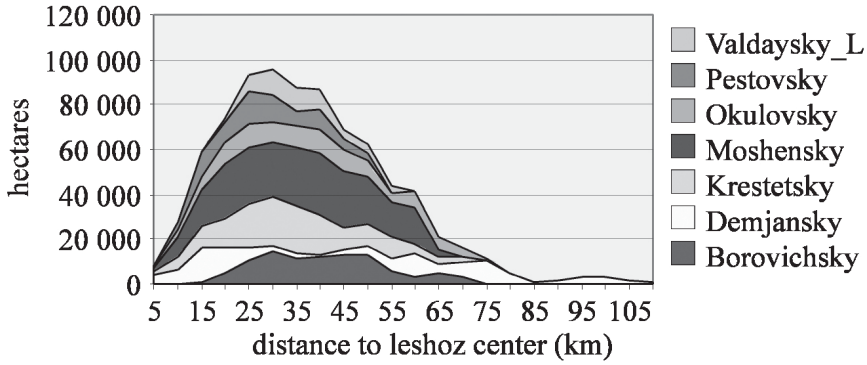


Figure 7. Total area of pixels (ha) by distance to leshoz center, from the satellite image

The distance from management units to leskhoz centers by the merchantable area of management units (figure 8) does not vary from the distance from pixel centers to leskhoz centers by the total area of the pixels (figure 9) too much.

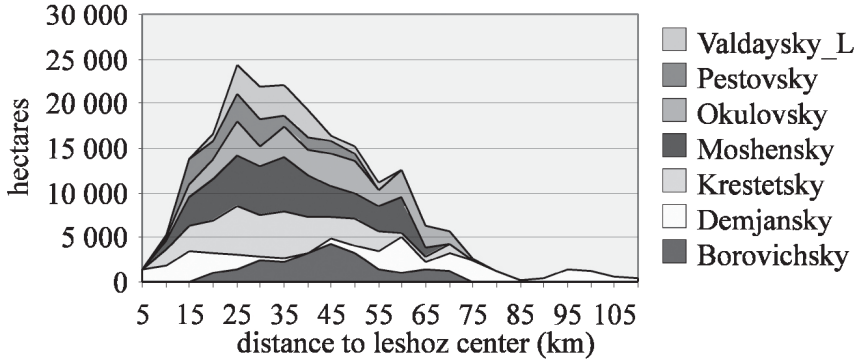


Figure 8. Merchantable forest area inside the kvartals (ha) by distance to leshoz center

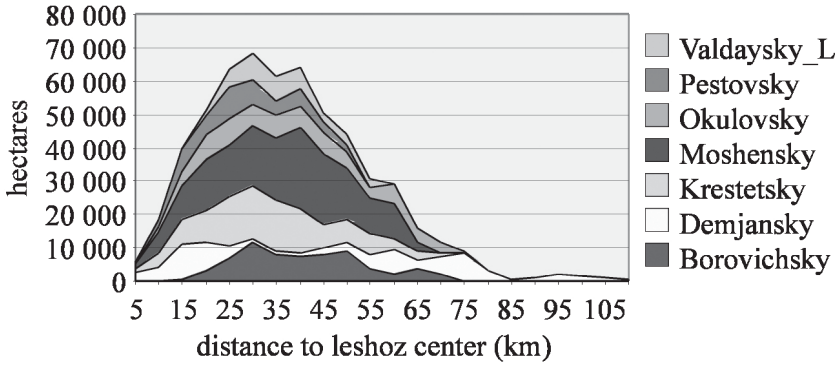


Figure 9. Forest cover area (ha) inside the pixels by distance to leshoz center

Discussion

Clearly, having full access to inventory data allows a more exact measure of the economic accessibility of merchantable timber. However, economic accessibility of forest land can be estimated from alternative sources of information such as satellite based information which are more broadly available. Figures 5-9 show that the results of this type of investigation are similar whether they are based on detailed management level information or on satellite based information.

Using the shortest distance from management units to roads may not be entirely realistic, given that marshes, rivers and lakes may block or restrict access along this shortest path. Methods that disallow paths that cross obstructions are less than satisfactory since they often result in inaccessibility to the management units. A system of penalties for crossing obstructions would allow feasible solutions, but then procedures for testing a large number of possible paths before optimizing the path would have to be developed. Adding existing forest roads to networks would be, perhaps, the best solution since each forest road can be used to access several management units. Temporary forest roads have been used for access, for example during winter time. These forest roads might also be considered for upgrading to permanent roads in the future.

The parameters used for cost calculations include some amounts of uncertainty. It is hard to obtain reliable cost estimates from Russia since there are no statistics available. Therefore the results on harvesting costs should be considered as guiding, not as definite costs occurring when harvesting. Generally the costs seem to be too low. It should also be noted that the costs used in these calculations are from one enterprise only and that the costs vary between logging companies, areas and different harvesting chains. Modern harvesting equipment would most certainly increase the cost of harvesting, but at the same time increase the productivity of work.

Conclusions

A careful consideration of the figures 2-4 lead to the conclusion that forests in the management units are managed and that no structural differences between very remote and more accessible forests is apparent in Novgorod region. These results clearly demonstrate that the leskhoz system as practiced in the Novgorod region of Russia has managed the forests rather equally regardless of the location. The methods described in this paper will allow the comparison of the economic accessibility of the existing forest resources in different parts of Russia.

Forest resources in Novgorod are cheap and economically accessible in western standards. Accessibility of these resources can be measured and minimum stumpage prices evaluated using the calculations described in this paper when full forest inventory information is available. Should inventory data be lacking then the accessibility of forest land can be estimated using satellite based information. New road locations can be evaluated using economic accessibility calculations. In more remote regions of North and North-West Russia long distance hauling costs should be included. Techniques described in this study will allow the design of future transport systems which will be more efficient than those currently in use. Nature conservation may increase in the future leading to a need to increase the effectiveness of forest management in the most accessible forests and leaving the more remote forests for nature conservation.

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