NO 6 | OKT 2022

Spruce logging residue potentials in the Finnish side of Botnia-Atlantica Region

Logging residues are used as a feedstock for bioenergy, but besides the energy use, interest to utilize that raw material for production of valuable chemical compounds has increased. In this project we have calculated updated information about the potential amounts and spatial distribution of spruce needles and branches. Based on the updated resource information, we also calculated preliminary estimates about the resources of chemical compounds in logging residues in the Finnish side of Botnia-Atlantica region. This region includes South Ostrobothnia, Ostrobothnia and Central Ostrobothnia.

FINNISH FOREST RESOURCES SYSTEM

In Finland the information about nationwide forest resources is produced through the National Forest Inventory (NFI) that is developed and run by Natural Resources Institute Finland (LUKE). NFI calculations are made to large areas, e.g. to regions or to national level. The Multi-Source National Forest Inventory method (MS-NFI) is developed to get results also to smaller areas. This method utilizes NFI sample plot data, remote sensing data and other existing geographical data sources (Mäkisara et al. 2016).

Whereas the NFI and the MS-NFI produce information about the existing forest resources, the MELA forest planning and analysis system provides estimates about the future outcomes and development of forests. MELA system can be used to calculate different wood production scenarios and consider their effects over the planning period on forest growth, development of the growing stock and different kind of harvest removals from the forest (Hirvelä et al. 2017).

AIM

The aim of this study is to calculate updated information about the logging residue potentials in the Finnish side of Botnia-Atlantica region. Specially, besides the use of new updated datasets in calculations, the results should be more accurate and commensurable with the Swedish data when it comes to the spatial resolution of the results. To accomplish this, we need to improve the method we have developed in the previous Botnia-Atlantica project, BioHub, to get the results to more accurate grid size. Furthermore, we also aimed to provide estimates about the amounts and spatial distribution of the most important groups of valuable compounds.

MATERIAL

MELA report generator is used to calculate estimates about spruce needle and branch biomass in region level (Mela tulospalvelu 2021). The realized cutting removals logging schedule is applied in calculations. MS-NFI data provides areal covering data sets in 16 meters grid size for over 40 different themes. Themes describe different biomass assortments and also include information about growing stock and site properties.

In this study themes volume of different tree species, biomass of living and dead branches and needles, site class, mean diameter, site type, age, main class, basal area, mean height are utilized. Also, some open GIS dataset from Finnish Environment institute (SYKE) and National land survey of Finland (NLS) are used in study. That material includes mainly different kind of nature conservation areas and administrative boundaries. Case study area in Finland covers three regions (South Ostrobotnia, Ostrobotnia and Central Ostrobotnia) and 40 municipalities.

Spatial distribution is the arrangement of individual entities across the area and is used here to describe the location of logging residue resources.

METHODS

The method used in this work combines the results calculated in MELA system with the forest resource information of the MS-NFI data. It gives predictions of the outcomes and spatial distributions of different biomass assortments in future according to certain logging schedule.

In this study we are interested in spruce needles and branches and the results about those biomass assortments are calculated to 1 km grid size. The basic principle in this method is calculate raw material potential index which describes how the region-specific amounts of raw material should be divided to one kilometer grid cells. Calculation method is programmed to geographical information system and analysis and calculations are implemented in GIS.

Table 1. Amount of spruce in logging residues by municipality, dry tons / year.

Municipality	Branches, tons/year	Needles, tons/year	Total, tons/year
Kurikka	5349	2965	8314
Närpiö	5268	2935	8203
Mustasaari	3435	1942	5377
Kokkola	3316	1922	5238
Seinäjoki	3194	1761	4955
Kristiinankaupunki	3080	1694	4775
Ähtäri	2777	1516	4292
Kauhajoki	2441	1343	3784
Teuva	2376	1309	3685
Ilmajoki	2258	1231	3489
Isojoki	2174	1182	3356
Vöyri	2122	1228	3350
Kruunupyy	2026	1177	3203
Pedersören kunta	1995	1177	3171
Laihia	1973	1122	3095
Maalahti	1898	1089	2987
Alavus	1824	1017	2841
Uusikaarlepyy	1743	982	2725
Alajärvi	1714	966	2680
Kauhava	1546	907	2452
Lapua	1418	805	2223
Kuortane	1085	604	1689
Toholampi	1056	595	1651
Vaasa	1004	568	1572
Evijärvi	1001	562	1562
Soini	971	542	1513
Lappajärvi	940	536	1475
Isokyrö	878	492	1370
Veteli	830	487	1317
Korsnäs	799	458	1257
Perho	786	442	1228
Karijoki	747	406	1153
Lestijärvi	739	416	1155
Vimpeli	665	377	1041
Kaustinen	561	328	889
Kannus	493	284	777
Luoto	446	243	689
Halsua	286	161	447
Pietarsaari	164	93	257
Kaskinen	36	19	55
Total	**67411**	**37884**	**105295**

POTENTIAL AMOUNTS AND SPATIAL DISTRIBUTION OF SPRUCE LOGGING RESIDUES

Results of our study include the potential outcomes of spruce needles and branches from final fellings. Results are calculated both to the municipalities and to 1 km grid. Both in raster and region-specific results different kind of areas which are not usable for wood production (e.g. conservation areas) are not included in the calculations. Biomass estimates in the case of municipalities are described in units of dry weight (tons) per year. Highest potential resources of logging residues in municipalities are over 8000 tons / year when the lowest amounts are only couple of hundred tons per year (Table 1). The municipalities with highest potential are Kurikka and Närpiö. The total amounts of spruce logging residues in the Finnish side of BA-area were 105 000 dry tons per year where about 67 000 were branches and 38 000 needles.

The raster approach gives a view about the spatial distribution of spruce logging residue potential (Figure 1). The biomass estimates are calculated as dry tons per year per hectare. Most potential sites are located at the southwest part of the area. However, there also exists some smaller separate areas with high potential, for example the coast of Central Ostrobothnia. The spatial distribution of branches and needles are similar.

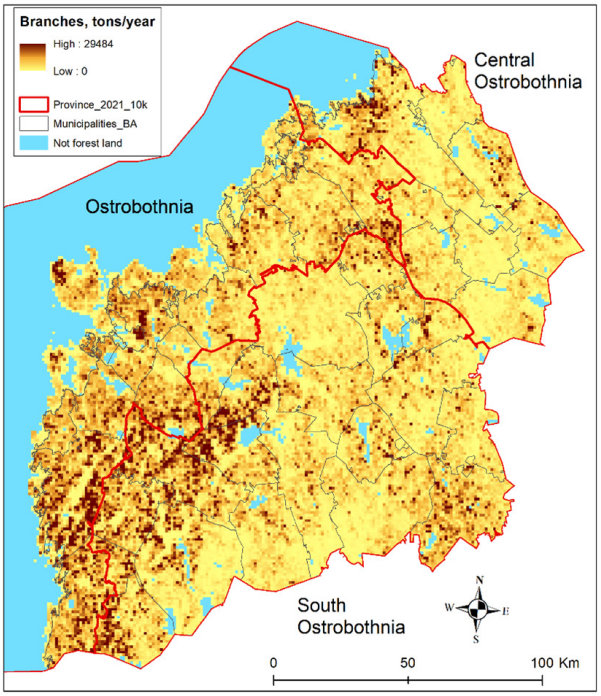

Figure 1. Spatial distribution of spruce logging residue potentials.

The total annual potential of branches and needles are 67 000 dry tons and 38 000 dry tons. This gives a potential of 12 500 tons of total extractives per year in this region.

Table 2. Valuable compounds in logging residues in the Finnish side of BA-area.

Needles	Concen-tration,%	South Ostrobothnia	Ostrobothnia	Central Ostrobothnia	Total_BA, tons / year
Dry biomass, Tons/year		18 521	14 726	4 637	37 884
Fatty acids	3,22	596	474	149	1 220
Rosin acids	0,11	20	16	5	42
Lignans	0,46	85	68	21	174
Sterols	0,40	74	59	19	152
Steryl esters	0,09	17	13	4	34
Triglycerides	0,14	26	21	6	53
Total phenolics	5,80	1 074	854	269	2 197
Total extractives	***28,30***	***5 242***	***4 167***	***1 312***	***10 721***

Branches	Concen-tration, %	South Ostrobothnia	Ostrobothnia	Central Ostrobothnia	Total_BA, tons / year
Dry biomass, Tons/year		33 355	25 990	8 066	67 411
Fatty acids	0,04	13	10	3	27
Rosin acids	0,03	10	8	2	20
Lignans	0,13	43	34	10	88
Sterols	0,61	203	159	49	411
Steryl esters	0,02	7	5	2	13
Triglycerides	-	-	-	-	-
Total phenolics	0,75	250	195	60	506
Total extractives	***2,77***	***924***	***720***	***223***	***1 867***

VALUABLE COMPOUNDS IN SPRUCE LOGGING RESIDUES

Preliminary results about the concentrations of different groups of valuable chemical compounds were calculated in this project. We utilize those concentrations to calculate region specific estimates about the amounts and spatial distribution of valuable compounds in spruce needles and branches. According to the preliminary concentrations the amount of total phenolics was 2 700 tons per year and total extractives 12 500 tons per year altogether in branches and needles. Also, the amounts of fatty acids, rosin acids, lignans, sterols, steryl esters and triglycerides were calculated based on the concentrations and estimated amounts of spruce logging residues (Table 2). However, because of the preliminary status of the concentrations, the calculated estimates about the amounts of valuable compounds, should be taken more as indicators about the right levels than an exactly amounts.

AUTHOR

Ron Store

Natural Resources Institute Finland (LUKE)

ron.store@luke.fi

REFERENCES

Hirvelä, H., Härkönen, K., Lempinen, R. and Salminen, O. 2017. MELA2016 Reference Manual. Natural Resources and Bioeconomy studies 7/2017. Natural Resources Institute Finland, Helsinki. 547 p.

Mäkisara, K., Katila, M., Peräsaari, J. and Tomppo, E. 2016. The Multi-source National Forest Inventory of Finland – methods and results 2013. Natural resources and bioeconomy studies 10/2016, Natural Resources Institute Finland, Helsinki. 215 p. Available at: http://urn.fi/URN:ISBN:978-952-326-186-0. [Cited 3 May 2018].

MELA Tulospalvelu 2021. VMI12. Web based application. Available at: http://mela2.metla.fi/mela/tupa/tupaindex.htm. [Retrieved August 2021].