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Geographical Distribution and Potentials of Needles in the Finnish Side of Botnia-Atlantica Region

In this project we have developed a method by which it is possible to calculate estimates of outcomes for different biomass assortments in the Botnia-Atlantica region. In Finland we used MS-NFI data and data from MELA calculations to find out the most potential areas for needle outcomes of different tree species. Results showed that there are differences in different areas when it comes to the potential needle outcome levels. Also the proportions of needle outcomes between regeneration fellings and thinnings can vary a lot in different areas.

INTRODUCTION

Data from the National Forest Inventory (NFI)

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). The aim of the NFI at the moment is to produce information about forest resources, land use and ownership structure, logging possibilities, forest health, silvicultural status and indicators of biodiversity (Korhonen et al. 2013).

This information is based on extensive field measurements and statistical and computational methods. In the latest forest inventory in Finland (NFI10) field measurements have been done from nearly 68 000 sample plots. Development and changes in forest resources are considered by comparing the current status of forest resources to the results of earlier inventories.

In the NFI the calculations and statistics are made to large areas, e.g. to forest centers or to national level. To get results also to smaller geographical areas a method which utilizes sample plot data, remote sensing data and other data sources is developed (Mäkisara et al. 2016).

This multi-source National Forest Inventory method (MS-NFI) produces areal covering data sets in 16 meters x 16 meters spatial resolution (cell size) for over 40 different themes. Themes describe different biomass assortments e.g. stem and bark, branches, roots, stumps, needles and leaves separated from pine, spruce, birch and other broadleaved and also include information about growing stock and site properties.

Calculating future development of the forests

Whereas the NFI and the MS-NFI produces information about the existing forest resources, the MELA forest management planning system is used to produce information also about the future development of forests. With the MELA system it is possible e.g. 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) (Figures 1 and 2).

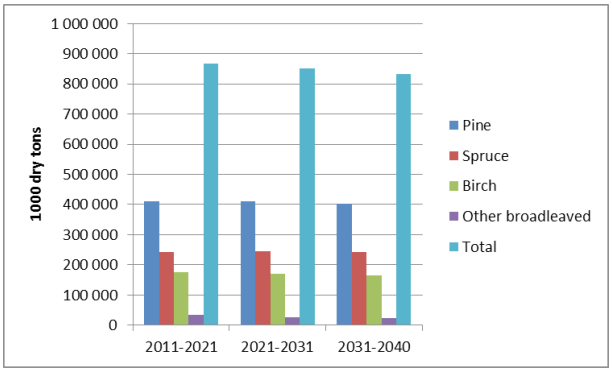

Figure 1. Biomass of living stemwood (1000 dry tons) in Finland and the development according the maximum sustainable harvesting level.

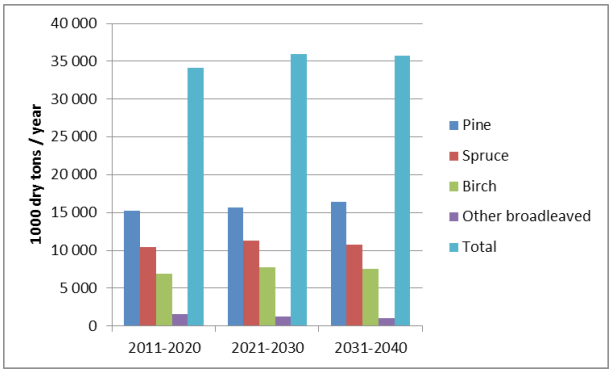

Figure 2. Stemwood removals (1000 dry tons / year) in Finland and the development according the maximum sustainable harvesting level.

The method described in this work combines the results calculated with the aid of the MELA system with the forest resource information of the MS-NFI. It gives predictions of the amounts of different biomass assortments according to certain logging schedule. Results about biomass assortments are calculated to 8 km x 8 km grid.

NEW METHOD FOR UPDATING THE BIOMASS ASSORTMENT DATA

In this study a new method is developed for updating the biomass assortment data. The method is programmed to ArcGis geographical information system. The basic idea behind the method is to use the MELA calculations to make a forest management schedule to the Finnish side of Botnia-Atlantica area and to use The Multi-source National Forest Inventory Raster Maps of 2015 (©Natural Resources Institute Finland, 2017) to distribute and refine those results to a grid of a certain cell size.

As a first step, we made forest management programmes for our study area which consists of the two forest centers located in the BA-region (E-P, RaP) and of the four surrounding forest centers (P-P, K-S, Pir, L-S) (Figure 3). Forest management programmes are made by MelaTupa –web application (http://mela2.metla.fi/mela/tupa/index.php). In the logging schedules made by MelaTupa the objective was to maximize sustainable roundwood and energy wood yield.

Figure 3. Botnia-Atlantica area in Finland and the surrounding forest centers (P-P = Pohjois-Pohjanmaa, RaP = Rannikko Pohjanmaa, E-P = Etelä-Pohjanmaa, K-S = Keski-Suomi, Pir = Pirkanmaa, L-S = Länsi-Suomi).

As a second step we used the information about the outcomes of different biomass assortment from each forest center, as an input data in our calculation method. In the calculation phase, we distributed the biomass assortment information to 8 km x 8 km gridcells by aid of the MS-NFI data and rules for regeneration fellings and forest thinnings. As a result, we got the updated forest biomass data as areal covering rasters – five forest biomass assortments for each of the three tree species.

Our calculation method is programmed as scripts by Python language which enables easy repetition of the calculations when needed and also helps the documentation of calculation details and used parameters.

RESULTS

Results during the period 2011-2010 are calculated both to the forest centers (in tables) and to 8 km x 8 km raster surfaces (in figures). At the forest center level dry biomass estimates are produced for the whole area of each forest center and also as an average per hectare and per year outcome of wood production forest land. In the raster surface format dry biomass estimates are calculated to the area of every grid cell and presented in figures as an average dry biomass amount per hectare and per year. Both in raster and forest center results different kind of areas which are not usable for wood production (e.g. conservation areas) are not included in the calculations.

Spruce needles

According to our results the most potential areas for gathering Norway spruce needles is located in the southeast part of the study area (Figure 4 and 7). Keski-Suomi (K-S) and Pirkanmaa (Pir) and Pohjois-Pohjanmaa (P-P) forest centers have the biggest harvestable potential of the total biomass of spruce needles (Table 1). The highest hectare wise average potential can be found at the Pir forest center and lowest at the P-P forest center. Inside the Botnia-Atlantica region, areas near to the coast have bigger potential of spruce needles than inland areas (Figure 4 and 7).

In Pir, Länsi-Suomi (L-S) and K-S forest centers, relatively big amount of needles biomass comes from regeneration fellings, whereas in Rannikko Pohjanmaa (RaP) and P-P the difference in proportions between thinnings and regeneration fellings are smaller (Table 1).

The relation of needle potentials between regeneration fellings and thinnings is very similar among forest centers (Figure 4). However, P-P forest center makes an exception in that. In this area the location of spruce needles biomass potentials from regeneration fellings and thinnings differ from each other. Also an interesting needle concentration from thinnings can be seen in the south part of P-P forest center.

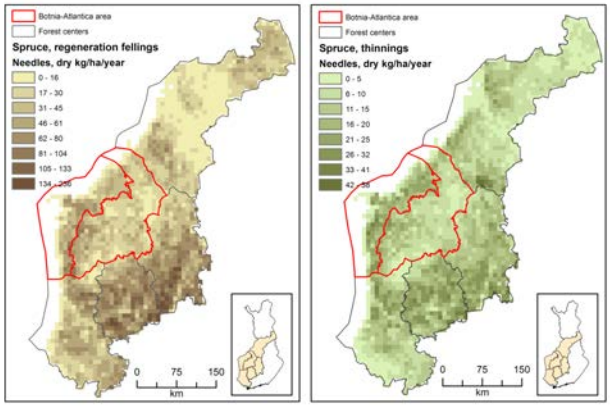

Figure 4. Potential outcome of spruce needles biomass from loggings and its geographical distribution, dry mass kg/ha/year.

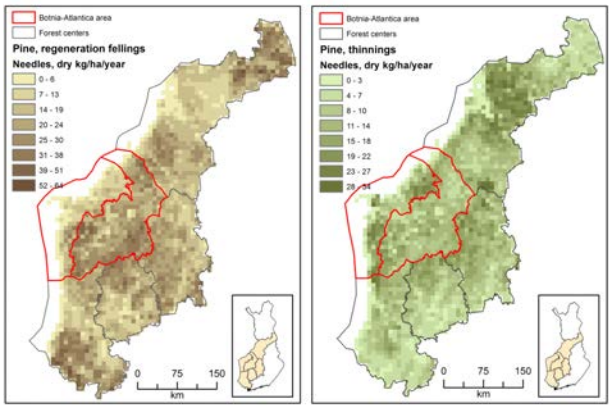

Figure 5. Potential outcome of pine needles biomass from loggings and its geographical distribution, dry mass kg/ha/year.

Pine needles

Our results show that the biggest potentials of pine needles can be found at the middle part of the study area (Figure 5 and 7). However, the potential in the case of pine needles is rather equally distributed among forest centers. When it comes to the total potential of pine needles, P-P forest center has clearly the biggest potential whereas RaP and Pir have the lowest ones (Table 1). When it comes to the average hectare wise biomass potentials, L-S and Etelä-Pohjanmaa (E-P) forest centers have the highest amounts and in this case Pir has the lowest amount.

When considering the Botnia-Atlantica area, E-P forest center has clearly more potential for the total amount of pine needles than RaP forest center. In hectare wise results that difference is smaller (Table 1).

There are notable differences in the location of pine needles potentials between regeneration fellings and thinnings. In the area of RaP forest center, the relation of outcomes between thinnings and regeneration fellings is weighted toward thinnings and also in P-P and K-S forest centers there is relatively more outcome from thinnings than in the other forest centers (Table 1).

There are also differences inside the forest centers when it comes to the relative of outcomes from thinnings and regeneration fellings. In P-P forest center, the north and most south part of the area has a remarkable potential for pine needles from regeneration fellings, but in the middle areas of that forest center, the potential is small. When considering thinnings the situation is rather the opposite. (Figure 5).

Broadleaved trees' needles

In In broadleaves category the most important tree species is birch. The amounts and utilization of other broadleaved tree species are much smaller. Highest potentials of broadleave leaves can be found near the coastline and from the southeast parts of the study area (Figure 6 and 7).

The most potential areas for broadleaves leaves are P-P and K-S forest centers (Table 1). When considering hectare wise average amounts of leave biomass, the RaP forest center has high potential, especially from thinnings. Inside the Botnia-Atlantica area, areas near the coastline and Keski-Pohjanmaa district have higher potential for broadleaves leaves than other areas (Figure 7).

When considering the differences in potential outcomes of broadleaves leaves between regeneration fellings and thinnings we can notice that the outcomes at the forest center level mainly vary in a very similar way in both treatment options (Figure 6). However, also differences exist. Especially in P-P and L-S the most potential outcome areas for broadleave leaves can be found from different locations in different treatments.

Outcomes from thinnings in the Botnia-Atlantica area are concentrated to the coast. As an exception to other tree species, in the broadleaves category, the biggest absolute potentials of leaves come from thinnings (Table 1). In other forest centres but RaP, there are not notable differences in the total biomass potentials of leaves between regeneration fellings and thinnings. In RaP forest center, the total biomass potential of broadleaves leaves is clearly bigger in thinnings than in regeneration fellings (Table 1).

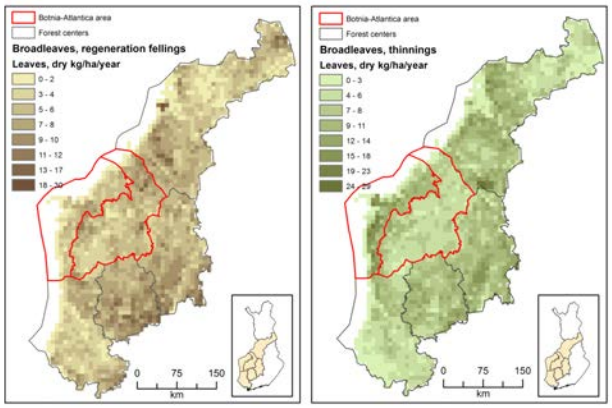

Figure 6. Potential outcome of broadleaved trees needles biomass from loggings and its geographical distribution, dry mass kg/ha/year.

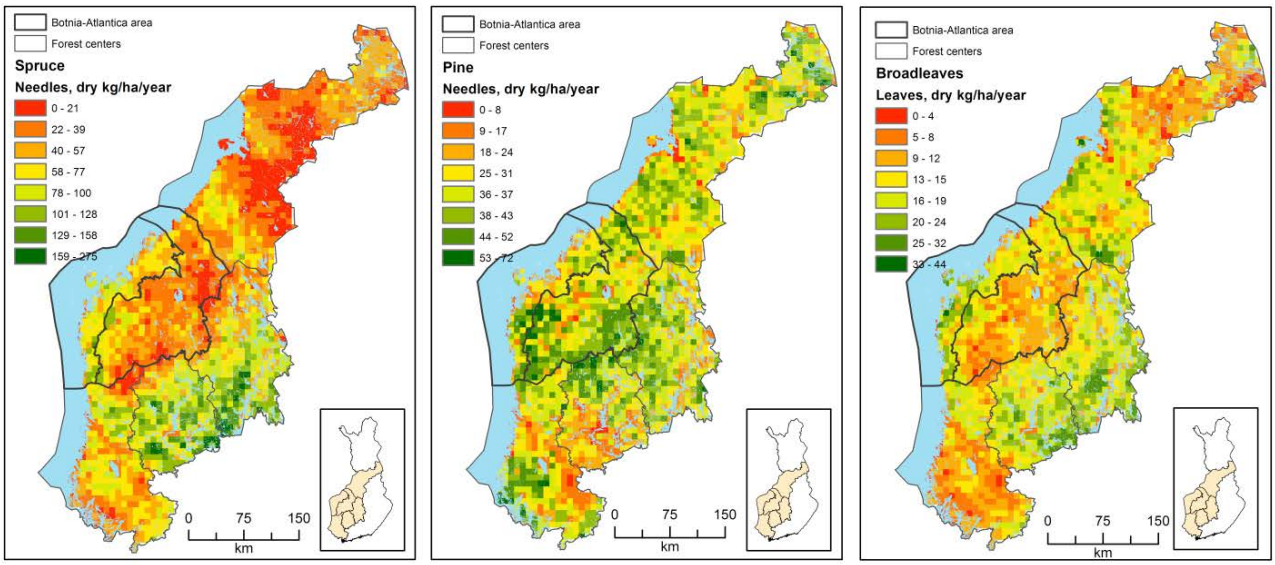

Figure 7. Potential needle biomass outcome of different tree species from loggings and its geographical distribution, dry mass kg/ha/year.

Table 1. Amount of harvestable biomass form needles in regeneration fellings and thinnings within the Finnish Botnia-Atlantica area and the neighboring forest centers. RaP = Rannikko Pohjanmaa, L-S = Länsi-Suomi, Pir = Pirkanmaa, E-P = Etelä-Pohjanmaa, K-S = Keski-Suomi, P-P = Pohjois-Pohjanmaa.

	Regeneration fellings						Thinnings					
Needles	**RaP**	**L-S**	**Pir**	**E-P**	**K-S**	**P-P**	**RaP**	**L-S**	**Pir**	**E-P**	**K-S**	**P-P**
pine												
1000 t/year	12	42	28	51	41	73	13	17	13	23	25	48
kg/ha/year	24	39	30	38	29	27	26	16	14	17	18	18
spruce												
1000 t/year	39	84	107	64	123	94	16	23	29	21	34	38
kg/ha/year	78	79	116	47	88	35	32	22	31	15	24	14
broadleaves												
1000 t/year	4	10	12	12	14	21	10	11	13	12	19	30
kg/ha/year	8	9	13	9	10	8	20	10	14	9	14	11
total												
1000 t/year	55	136	147	127	178	188	39	51	55	56	78	116
kg/ha/year	110	127	159	94	127	70	78	48	59	41	56	43

AUTHORS
Ron Store
Natural Resources Institute Finland (LUKE)
ron.store@luke.fi
Dimitris Athanassiadis
Swedish University of Agricultural Sciences (SLU)
dimitris.athanassiadis@slu.se
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