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Potential and distribution of branches in the Finnish side of Botnia-Atlantica

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

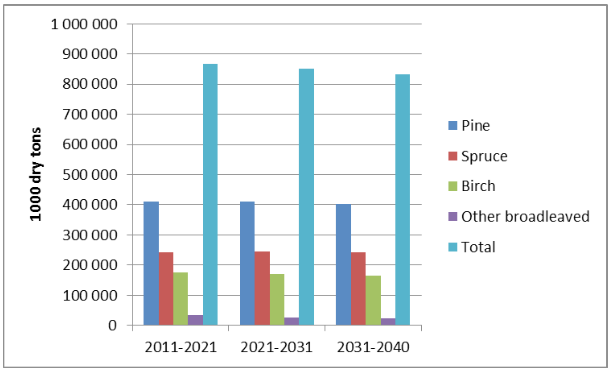

Figure 1. Biomass of living stemwood (1000 dry tons) in Finland and the development according the maximum sustainable harvesting level.

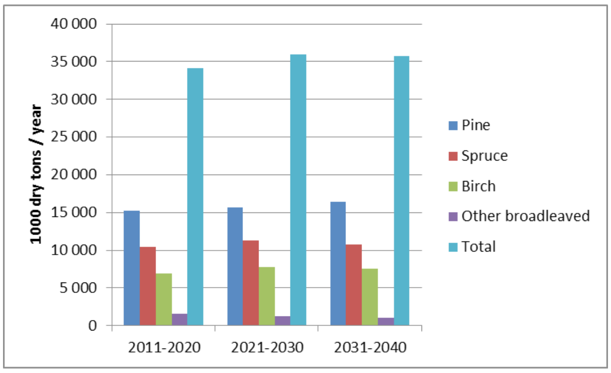

Figure 2. Stemwood removals (1000 dry tons / year) in Finland and the development according the maximum sustainable harvesting level.

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 ASSORTMANT 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 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

Results show that the highest harvestable potential of branches of Norway spruce is located in the southeast part of the study area (Figure 4 and 7). Keski-Suomi (K-S) and Pirkanmaa (Pir) forest centers have the biggest potentials of the total biomass of spruce branches (Table 1). Pir has also the highest hectare wise average potential whereas Pohjois-Pohjanmaa (P-P) has the lowest. Inside the Botnia-Atlantica region, areas near to the coast have bigger potential of spruce branches than inland areas (Figure 4 and 7).

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

Inside the forest centers there are not very big differences between regeneration fellings and thinnings, when it comes to the geographical distribution of spruce branches potentials. However, P-P forest center makes an exception in that. In this area the location of spruce branch biomass potentials from regeneration fellings and thinnings differ from each other. Also an interesting branches potential concentration from thinnings can be seen in the south part of P-P forest center (Figure 4).

Pine

According to our results, pine branches potential is rather equally distributed among forest centers, though biggest potentials can be found from the middle and the

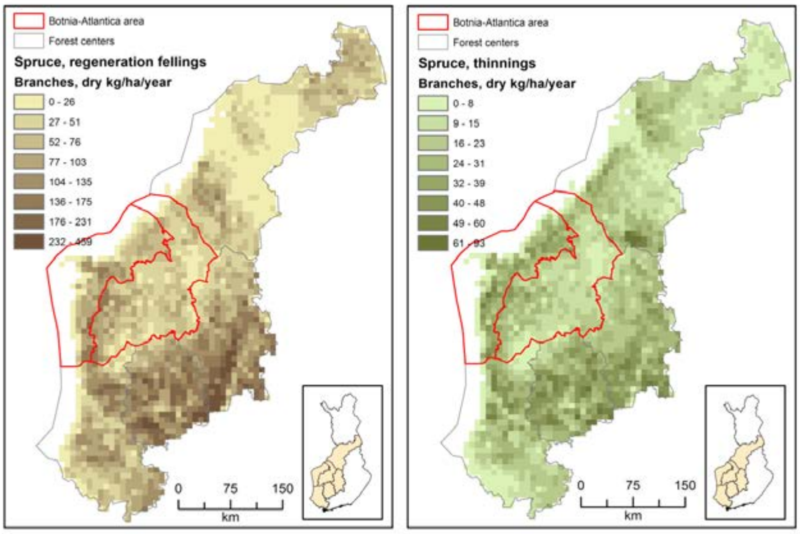

Figure 4. Potential outcome of spruce branches biomass from loggings and its geographical distribution, dry mass kg/ha/year.

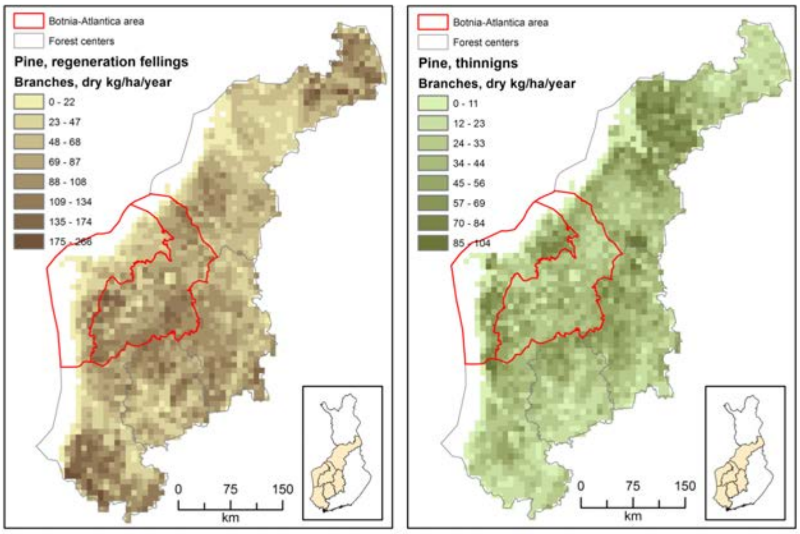

Figure 5. Potential outcome of pine branches biomass from loggings and its geographical distribution, dry mass kg/ha/year.

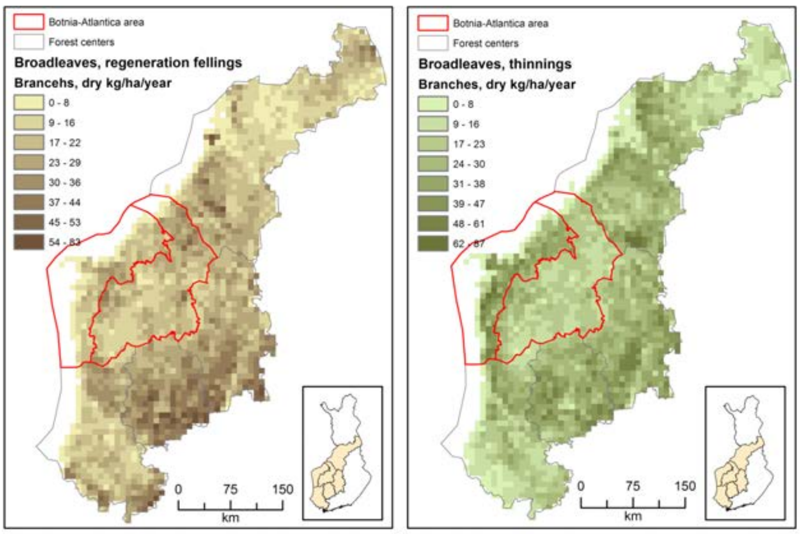

Figure 6. Potential outcome of broadleaved trees branch biomass from loggings for and its geographical distribution, dry mass kg/ha/year.

most southern part of the study area (Figure 5 and 7). When it comes to the total potential of pine branches, P-P forest center has clearly the biggest potential whereas RaP and Pir have the lowest ones (Table 1). In the case of hectare wise average pine branch biomass potentials, L-S and Etelä-Pohjanmaa (E-P) have the highest amounts and in this case P-P has the lowest amount (Table 1).

In Botnia-Atlantica area E-P forest center has much more potential than RaP when it comes to the total potentials of pine branches. There are no big differences between these two forest centers with regards to hectare wise results.

Differences between the outcomes of pine branches from regeneration fellings and thinnings are notable. In the area of RaP forest center, the relation of outcomes between thinnings and regeneration fellings is clearly weighted toward thinnings and also in P-P forest center there is relatively more outcomes 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. For example, In P-P forest center the north and most southern part of the area has a remarkable potential for pine branches from regeneration fellings, but in the middle areas of the forest center, the potential is small. When considering thinnings the situation is rather the opposite. (Figure 5).

Broadleaved trees

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 broadleaves branches can be found from the southeast parts of the study area and near the coast line (Figure 6 and 7).

The best areas when it comes to the total biomass potential of broadleaves branches are P-P and K-S forest centers (Table 1). Pir forest center comes up when considering the hectare wise average amounts of broadleaves branch biomass. In the Botnia-Atlantica area, areas near the coastline and Keski-Pohjanmaa district have high potential for broadleaves branches (Figure 7).

There are also differences in geographical distributions in potential outcomes of broadleaves branches between regeneration fellings and thinnings (Figure 6). Outcomes from thinnings in Botnia-Atlantica area are concentrated to the coast. Exception to other tree species, in the broadleaves category, the biggest absolute potentials of branches comes from thinnings (Table 1). In other forest centres but RaP, there are not notable differences in the total biomass potentials of branches between regeneration fellings and thinnings. However, in RaP forest center the total biomass of branches is clearly bigger in thinnings than in regeneration fellings (Table 1).

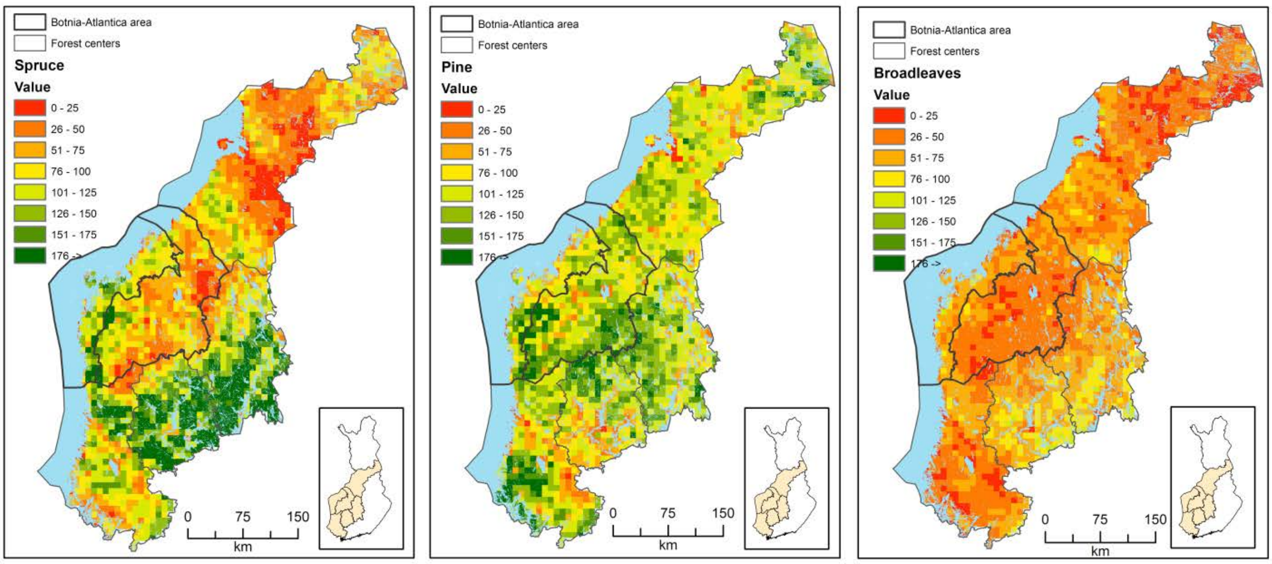

Figure 7. Potential branch biomass outcome of different tree species from loggings and its geographical distribution, dry mass kg/ha/year.

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

	Regeneration fellings						Thinnings					
Tree species	**RaP**	**L-S**	**Pir**	**E-P**	**K-S**	**P-P**	**RaP**	**L-S**	**Pir**	**E-P**	**K-S**	**P-P**
pine												
1000 t/year	46	171	110	190	158	250	40	58	45	74	80	151
kg/ha/year	92	160	119	140	113	94	80	54	49	55	57	57
spruce												
1000 t/year	68	152	196	113	230	159	27	39	49	34	55	60
kg/ha/year	136	143	213	83	164	60	54	37	53	25	39	22
broadleaves												
1000 t/year	16	43	49	41	55	68	30	39	47	39	62	89
kg/ha/year	32	40	53	30	39	25	60	37	51	29	44	33
total												
1000 t/year	130	366	355	344	443	477	97	136	141	147	197	300
kg/ha/year	260	343	385	254	316	179	194	128	153	108	141	112

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