Peatland Recultivation - a Case study of a Comercial Tree Plantation in a Former Peat Extraction Area

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Establishment of a tree plantation on a cutaway peatland in the central part of Latvia

Who

Dagnija Lazdina, Santa Neimane, Santa Celma, Vita Krēsliņa, Kārlis Dūmiņš, Toms Arturs Štāls, Modris Okmanis, Gints Spalva, Andis Lazdiņš, Kristaps Makovskis

dagnija.lazdina@silava.lv

Latvian State Forest Research Institute *Silava*

Why

The Aim and Scope

Testing of the tree cultivation as an after-use type for cutaway peatlands, and identification of the most effective, optimal dose of biological fertilizer – wood ash – for various tree species was the aim of designing this experimental site.

What is special about cutaway peatlands

Introduction

- In countries where peat extraction is of economic importance, planting or sowing of trees as an after-use of former extraction areas is considered an economically viable and environmentally friendly solution. It is more reasonable if the area was covered by forest before the peat bog formed since during extraction the layer containing ancient tree remains is reached.
- If the peat extraction is continued while the drainage system is operating, the mire cannot be restored because of the low water level (Woziwoda, Kopeć 2014). The peat layer remaining after the extraction is likely to have unbalanced nutrient element composition and wood ash can be used for soil improvement, liming and nutrient input (Mandre *et al*. 2010; Kikamägi *et al*. 2013; Ots *et al*. 2017).
- Vegetation development after the soil improvement is very important for nutrient circulation and carbon storage in extracted peatlands (Huotari *et al*. 2009, 2011). Scots pine (*Pinus sylvestris*), silver birch (*Betula pendula*) and black alder (*Alnus glutinosa*) are common on forest sites with organic soils with fluctuating water levels and such conditions are also characteristic for extracted peatlands (Hytönen, Saarsalmi 2009; González *et al*. 2013; Lazdina *et al*. 2017). Female poplar clone *Vesten* is a breed developed in Belgium in a search for fast growing trees suitable for afforestation of peaty substrates.

How

Methods

Recultivation of the cut-away peatland was performed in the spring of 2017 on a 9 hectare area (56°43'42.1"N, 23°34'33.3"E). Before the planting of the collection of trees the adjacent ditches were cleaned. After removal of the vegetation from the sides of the ditches, which mainly consisted of trees and reeds, wood ash was spread. For the liming and fertilization the chosen doses of wood ash were similar to the ones recommended in Finland and Sweden 5–10 t ha^{-1}, as well as 15 t ha^{-1} dose, which would allow the long-term observation of the correlation between the application of various soil improvement materials and the vegetation development as well as the tree growth. After the site preparation, the trees were planted in May 2017. The distance between the tree rows was 3.5 m, between the trees - 2.5 m; a 2.5 m wide strip was left along the ditches. Each variation was replicated three times. For planting of pines, birches and alders, container seedlings were used as they can be easily planted using both a shovel and a planting tube. Compared to other available types of planting material, container seedlings are less exposed to the risk of drying out because of their compact root system, which develops in enriched peat. The poplars were planted with 1.8 m long cuttings that were inserted into the soil at a depth of at least 50 cm (Zeps *et al*. 2011).

What we found out

Results

The area affected by peat extraction was afforested without interrupting the peat extraction in adjacent areas. By applying wood ash to the soil the agro-chemical properties in experimental extracted peatlands were improved. In the second year after fertilization the soil acidity was reduced from $pHCaCl_2$ 3.5 to 4.2 with 5 t ha^{-1} of wood ash, up to 4.8 with 10 t ha^{-1} and up to 5.9 when 15 t ha^{-1} was spread. Soil was enriched with calcium, magnesium, phosphorus and potassium (Table1).

Soil chemical properties

Table 1. Difference in soil acidity and P,K, Mg and Ca content in the soil two years after the fertilization with wood ash fertilization

Wood ash applied	$pHCaCl_2$	Total N, g kg^{-1}	P, g kg^{-1}	K, g kg^{-1}	Mg, g kg^{-1}	Ca, g kg^{-1}
Control	3,5	16,2	0,2	0,1	1	11,1
	+/- in % relative to control:					
5 t ha^{-1}	20	-17	50	200	50	22
10 t ha^{-1}	37	-15	150	600	110	68
15 t ha^{-1}	69	-25	300	1600	180	124

Trees in the fertilized parts of plantation were more vital than in control plots. At the end of the second growing season they had grown significantly higher than in the unfertilized control plots (Figure 1). Example with *P. sylvestris* can be seen in Figure 2.

Vegetation development after spreading of wood ash in the topsoil changed rapidly - ground vegetation was formed – herbaceous plants took root. A total of 33 – 39 taxons depending on the dose of fertilizer were recognized and counted. In addition to herbaceous plants, a natural afforestation process began. Naturally occuring trees - *Betula pubescens*, *B. pendula*, *Populus tremula*, various *Salix spp*. including *S. caprea.* In areas where no additional nutrients with wood ash were applied, the vegetation was solitary or in groups, fewer species were counted.

Tree height and naturally occurring vegetation

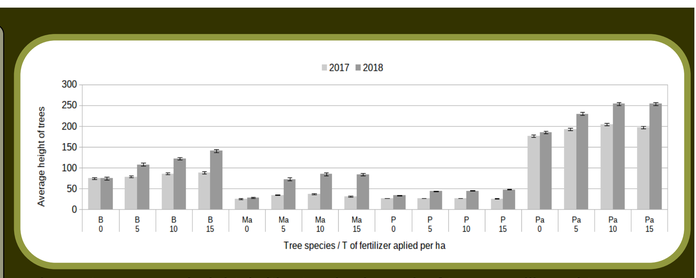

Figure 1. Average height (with standard error) of tree seedlings (Pa – poplar, B – silver birch, Ma – black alder, P – Scots pine) after the first and second growing season in fields with various doses of wood ash fertilization (0 t ha^{-1}, 5 t ha^{-1}, 10 t ha^{-1} and 15 t ha^{-1}).

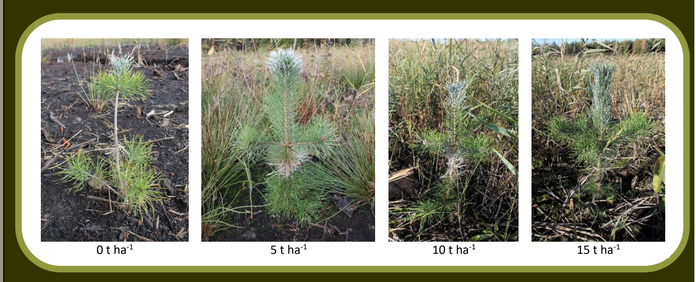

Figure 2. Scots pine tree seedlings in the study plots with various doses of wood ash fertilization (0 t ha^{-1}, 5 t ha^{-1}, 10 t ha^{-1} and 15 t ha^{-1}).

Since the cutaway peat layer in demo area is thicker than 30 cm and the water level is adjusted using ditches, according to the forest site type classification in Latvia such plantation corresponds to the type – forests on drained peat soils. Depending on the composition of planted and naturally occurring tree species, it is expected that in the future these woodlands will correspond to forest site types *Myrtillosa turf. mel.* or *Oxalidosa turf. mel.* with their characteristic vegetation (Zālītis, 2006).

In fields where the soil was not improved, the planted trees were less vigorous during the second vegetation season. Leaf and needle color indicated a lack of macronutrients, so that additional nutrient inputs – fertilization – is necessary there in order to keep the trees in the plantation.

If the field ditches and collection ditches in the plantation areas are not be maintained in the future, the development of conditions characteristic for forests on wet peaty soils, *Sphagnosa* or *Caricoso-phragmitosa* type peatlands are expected and the corresponding forest types will probably develop. Current soil density can be seen in Figure 3.

Soil density

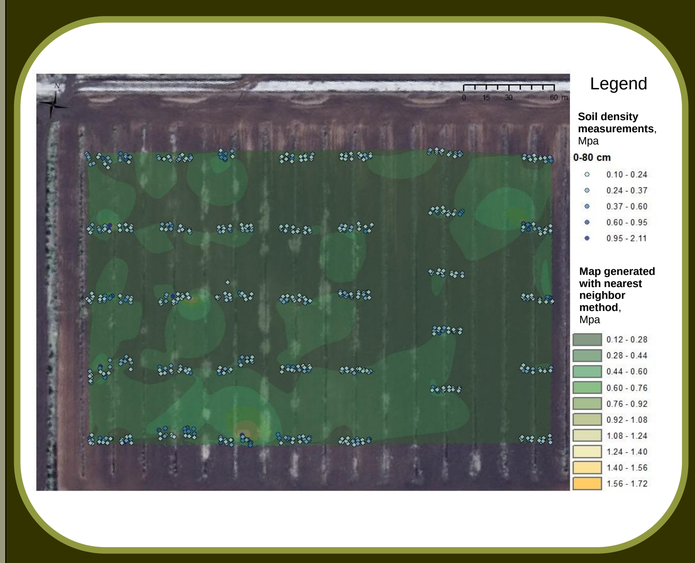

Figure 3. Soil density in the experimental trail. Measurements marked as blue dots and the overlay map made by using the nearest neighbor method.

Thus

Conclusions

- Significant differences in tree height and vitality were observed after the second growing season. To keep the unfertilized trees alive, fertilization is needed.
- After the use of wood ash the peat layer is enriched with P, K, Ca, Mg and pH levels increased depending on the wood ash dosage used.
- A variety of vegetation is recorded in the first and second year after wood ash is applied.
- The plantation will provide further economic benefits, promote soil shading and the following long-term carbon sequestration in tree biomass.

Keywords

Cutaway peatland, recultivation, natural vegetation, *Picea abies*, *Pinus sylvestris*, *Alnus glutinosa*, *Betula pendula*, *Populus* spp.

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