Wood-ash application on cutaway peatland accelerates vegetation succession and increases plant biomass accumulation

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Peatland mining areas in Latvia

Afforestation

Agriculture

Biomass production

Cranberries

Abandonment - Natural succession without rewetting

Restoration of mire ecosystem

Waterbodies and recreation

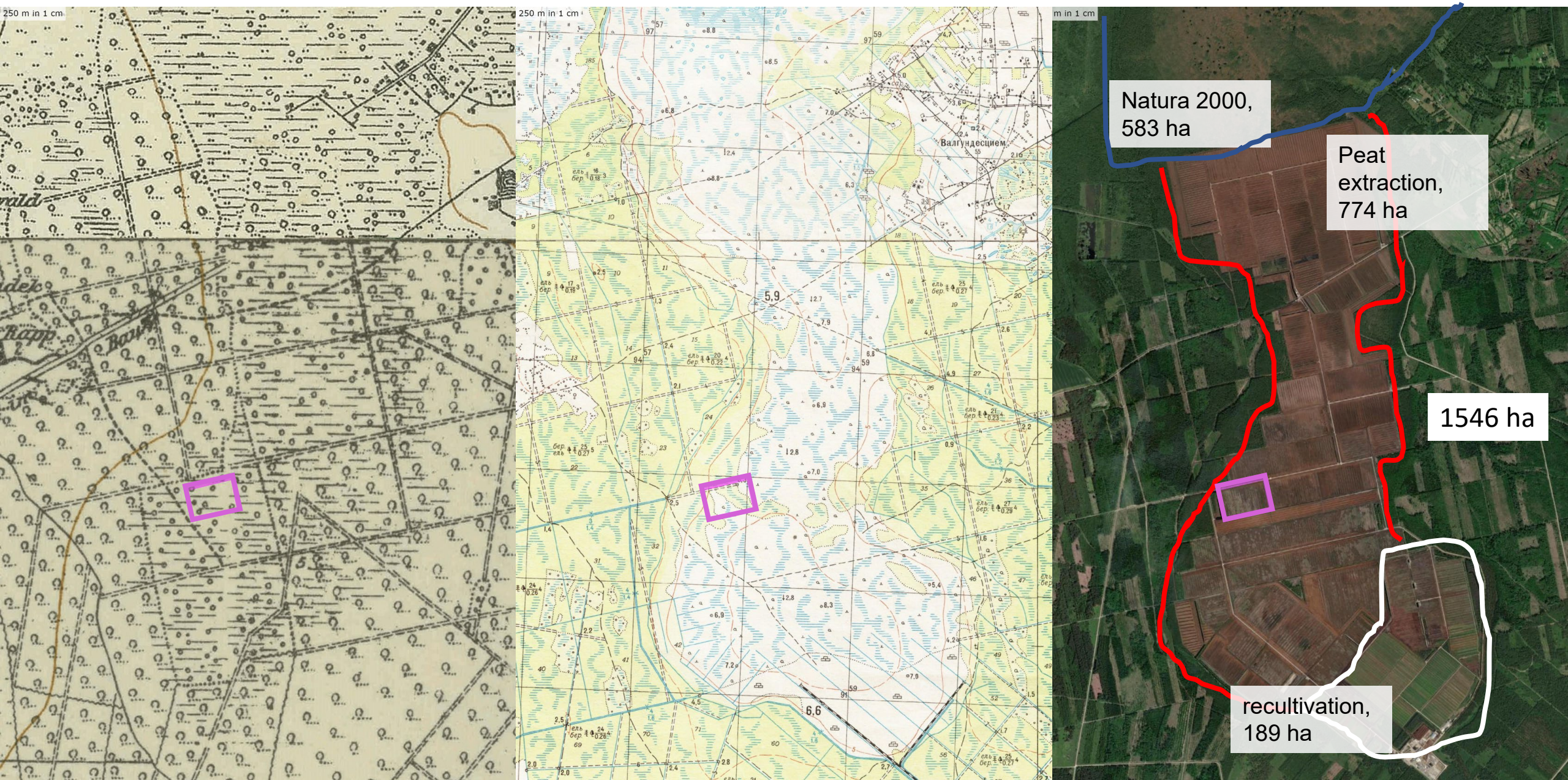
When to choose afforestation?

- Peat layer depth?
- Peat chemical structure
- Ongoing peat extraction in nearby territories
- Historical peatland type
- Economical value

1914

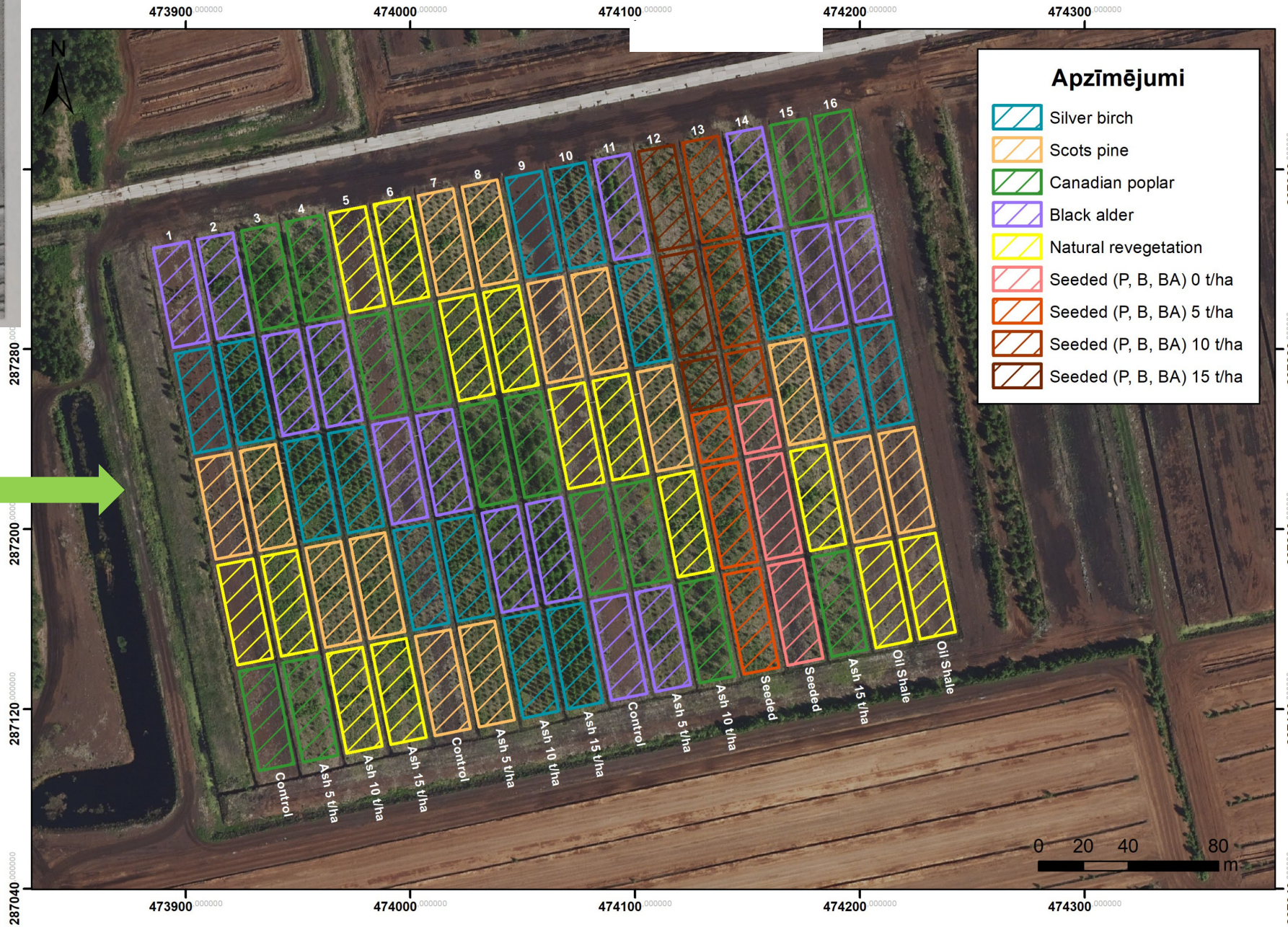
1963

2022



Cleaning of ditches and sparse vegetation removal

Dispersion of wood-ash
Control, 5,10 and 15 t ha^{-1}

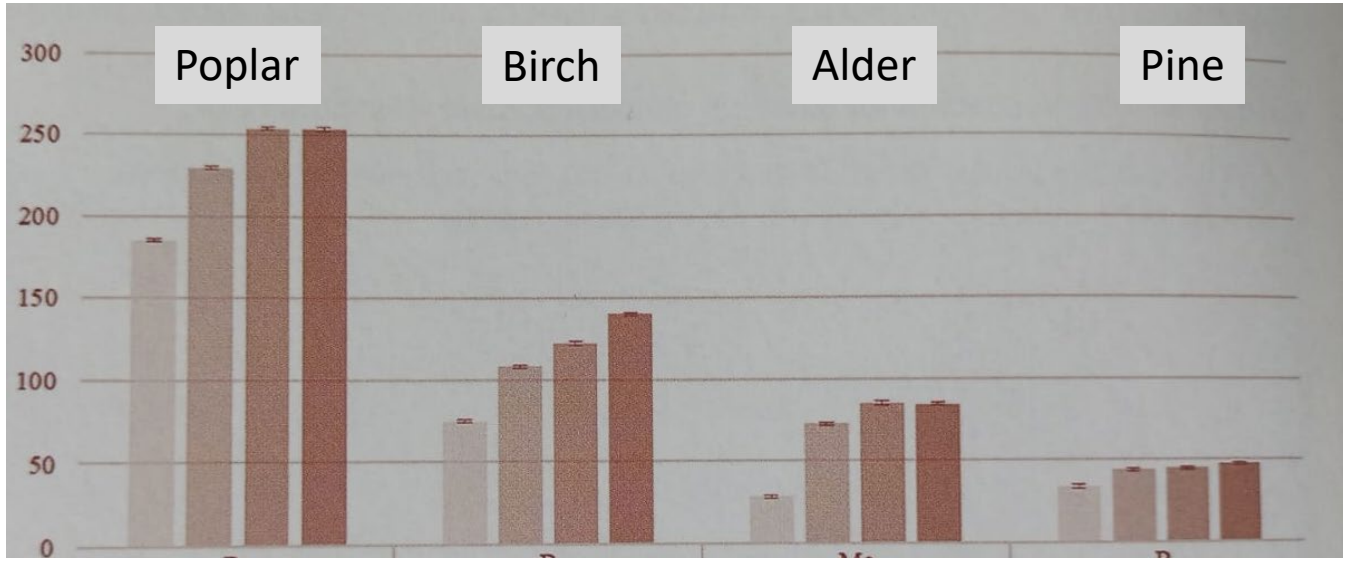


Soil chemical structure:

pH, P, K, Mg, Ca

Treatment (Mg ha^{-1})	0		5		10		15	
Distance from drainage ditch	2 m	9 m	2 m	9 m	2 m	9 m	2 m	9 m
2nd season: pH_{CaCl2}	3.5 ±0.01		4.2 ±0.03		4.8 ±0.04		5.9 ±0.04	
2nd season: P, mg kg^{-1}	237.0 ±8.1		258.5 ±7.6		452.7 ±58.0		791.9 ±40.0	
2nd season: K, mg kg^{-1}	72.0 ±5.8		331.8 ±6.2		694.7 ±74.4		1703.0 ±115.7	
2nd season: Mg, mg kg^{-1}	1037.2 ±10.6		1450.5 ±2.1		2068.6 ±10.6		2807.8 ±7.5	
2nd season: Ca, mg kg^{-1}	1111.9 ±14.8		1346.1 ±26.0		1867.8 ±113.7		2493.1 ±69.8	
3rd season: pH_{KCl}	3.6 ±0.1	3.3 ±0.1	3.8 ±0.1	3.9 ±0.2	4.5 ±0.5	4.0 ±0.2	4.7 ±0.5	4.1 ±0.2
3rd season: P, mg kg^{-1}	288.1 ±50.0	247.1 ±28.2	444.5 ±44.7	440.9 ±84.0	588.8 ±220.0	306.1 ±60.3	550.4 ±160.4	430.7 ±34.1
3rd season: K, mg kg^{-1}	133.7 ±17.0	123.2 ±24.9	253.9 ±52.9	321.5 ±66.0	986.6 ±266.8	477.8 ±69.1	624.4 ±164.8	462.3 ±88.8
3rd season: Bulk density	172.4 ±9.6	170.8 ±24.7	216.8 ±15.3	225.4 ±17.9	213.1 ±9.8	228.3 ±15.9	281.8 ±35.6	221.0 ±14.6

Planted tree growth rate:



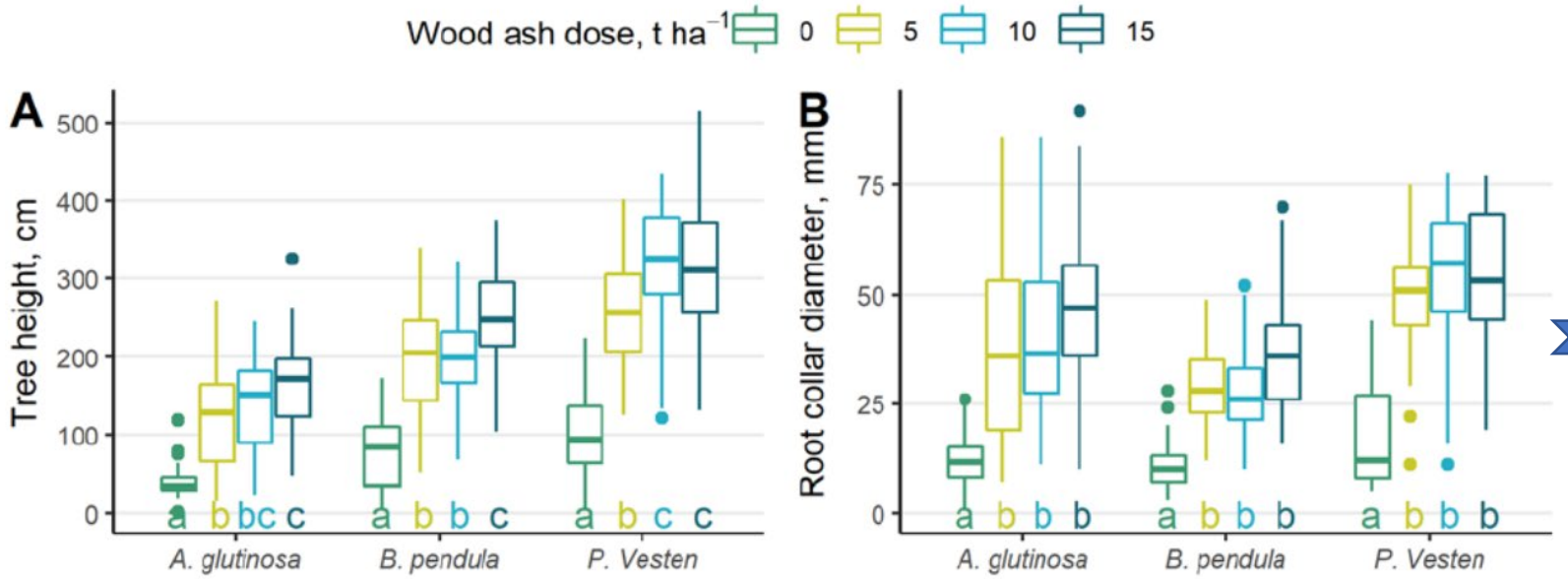
Planted tree survivance:

Deciduous tree survivance after 2nd growing season

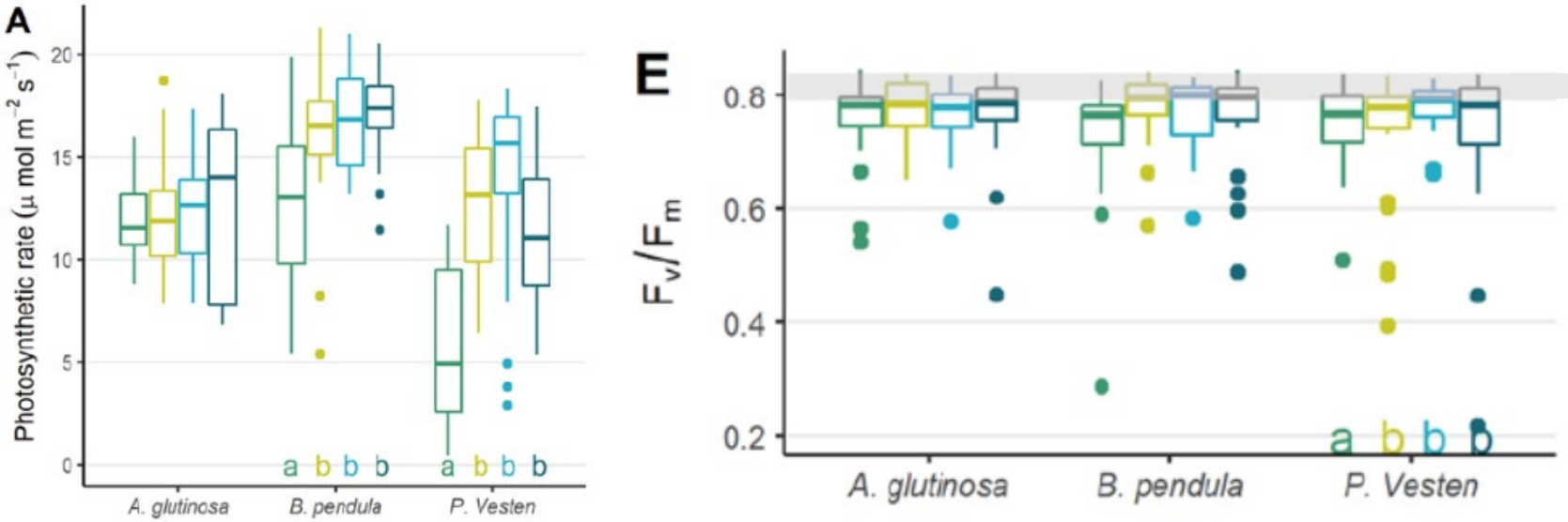
Wood ash dose, t ha^{-1}	Survival (%)		
	A. glutinosa	B. pendula	P. v. Vesten
0	90.1	84.0 b	93.8
5	82.7	97.5 a	98.8
10	77.8	95.1 ab	98.8
15	86.4	96.3 ab	100.0

After 4th season, no survivance in the control group for poplar

B. pendula and *P. Vesten* tree species growing conditions in cutaway peatland can be improved by incorporating wood ash into the soil



Higher growth parameters after fertilisation, but not influenced by ash amount



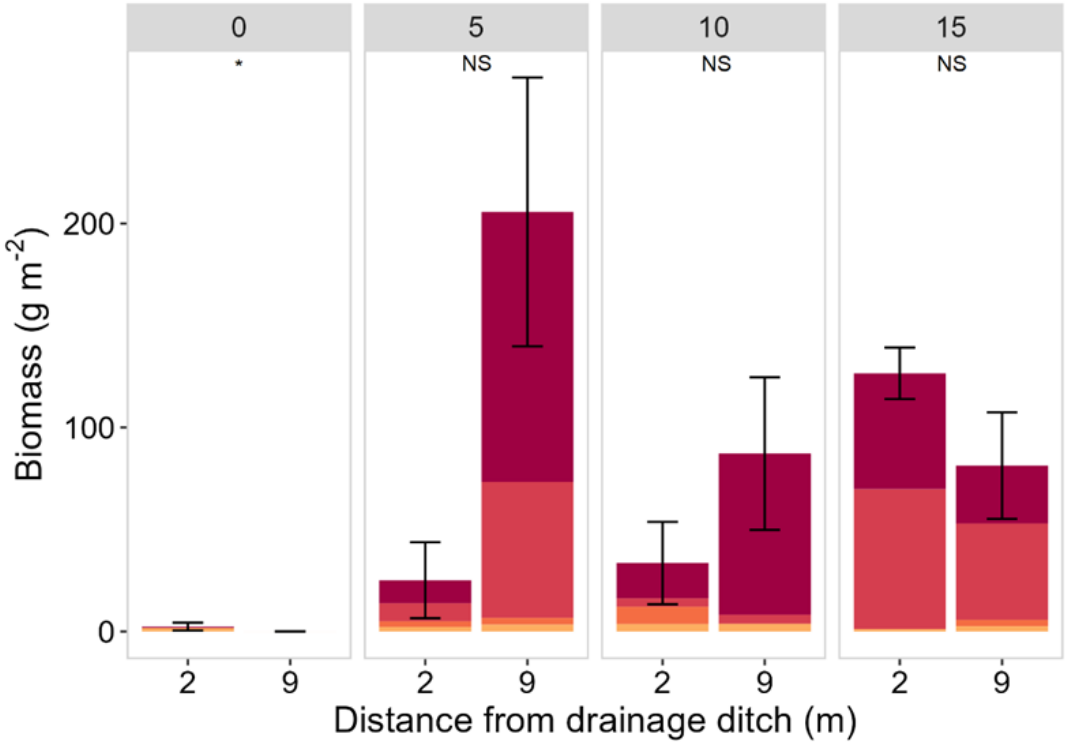
Optimal level, plant stress indicator

Although still not optimal, better performance

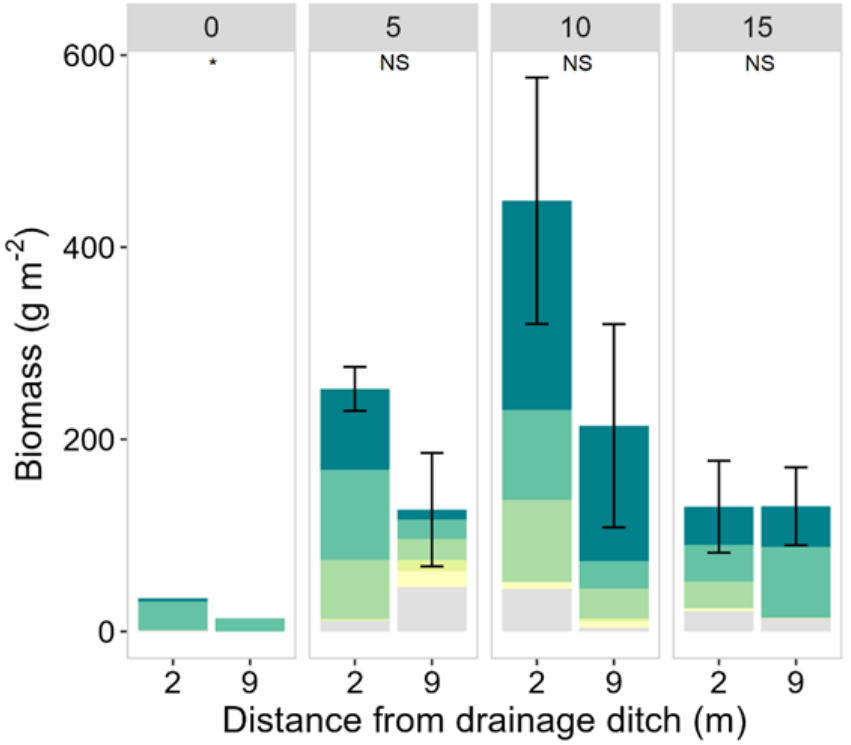
Spontaneous revegetation of a peatland

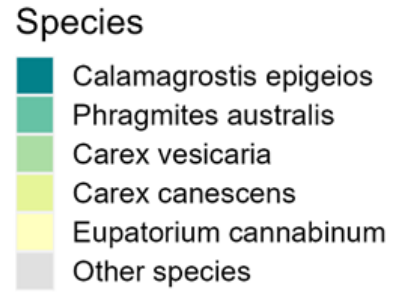
Biomass accumulation

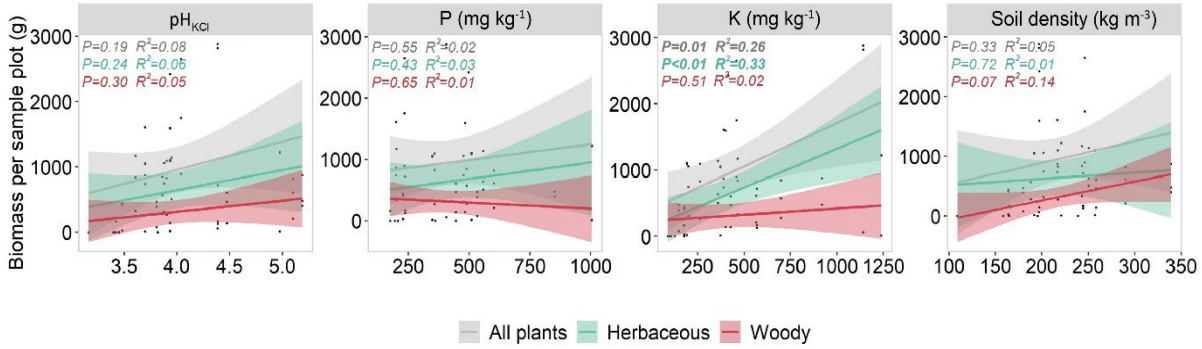
Tree species



Herbaceous species





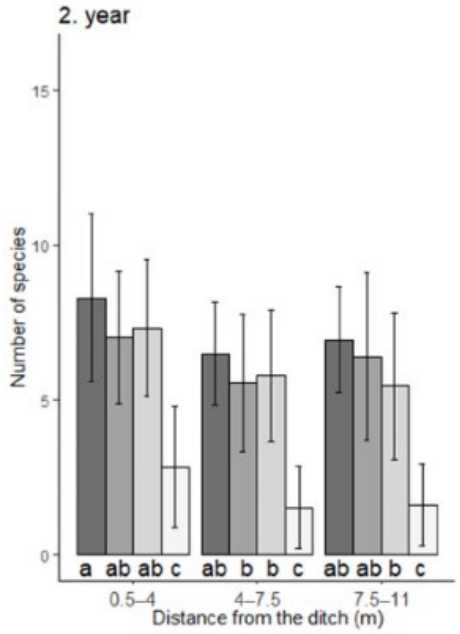


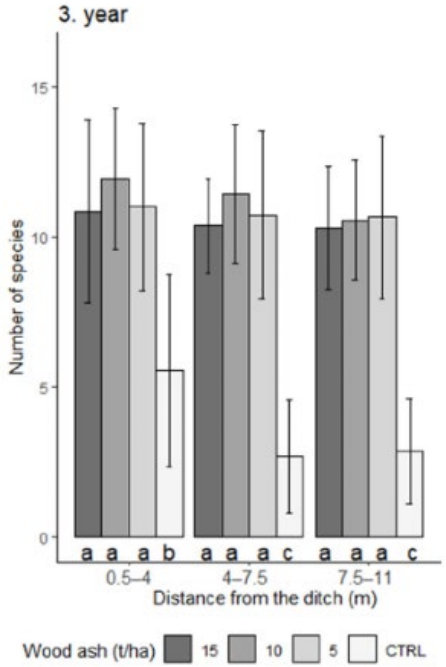
Fertilization leads to more than a **tenfold increase** in natural biomass accumulation

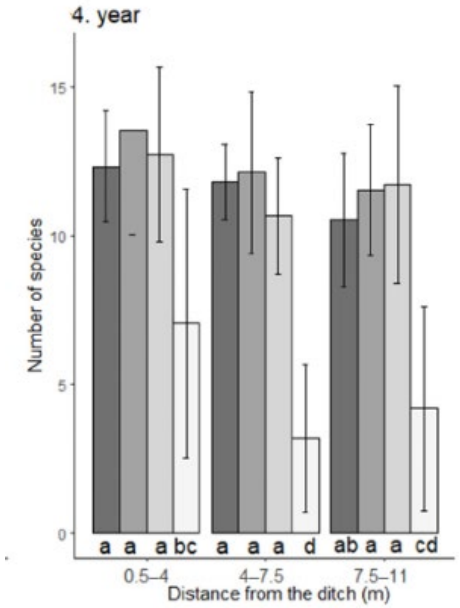
Highest correlation = soil P content

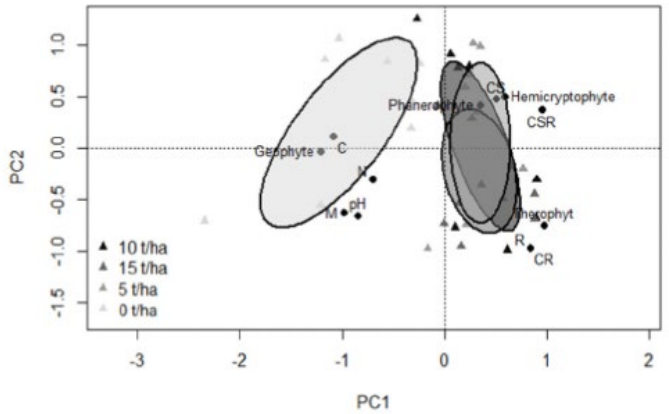
Vegetation composition

Species richness



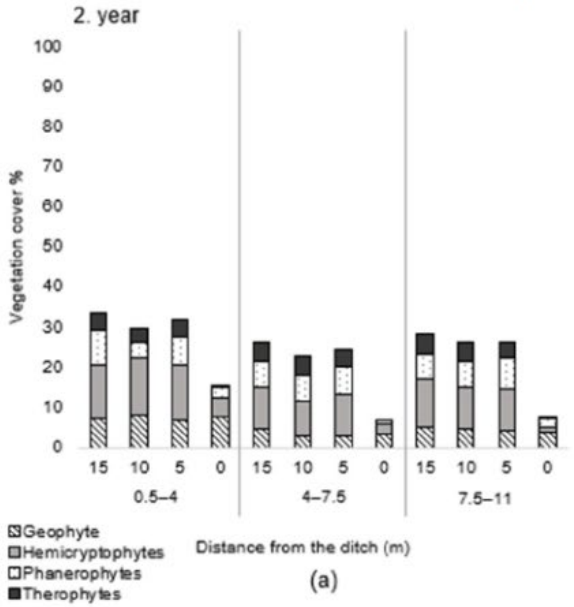


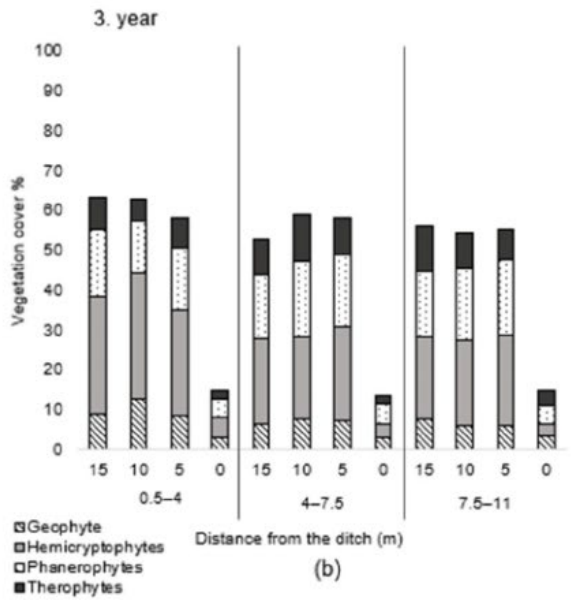


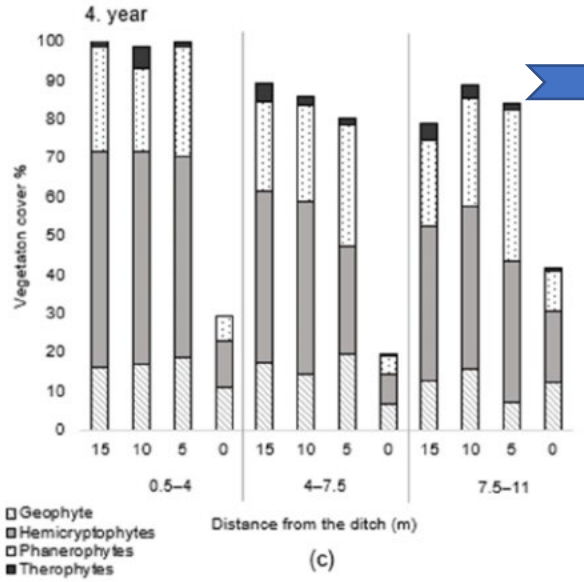


More rapid increase in fertilised groups

Vegetation compositon







Vegetation cover increases, but annual plant cover decreases


Anas platyrhynchos

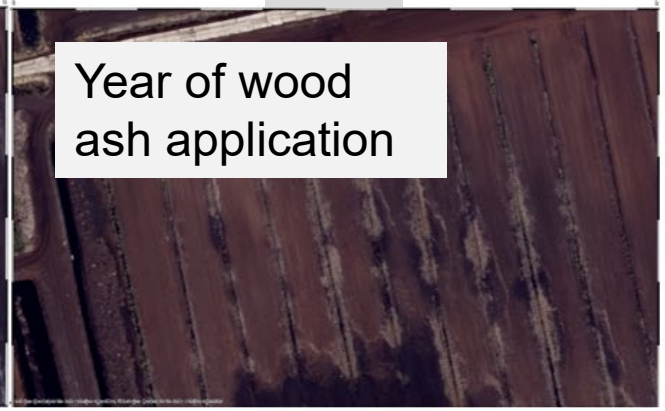

Suillus variegatus

2007

2010

2014

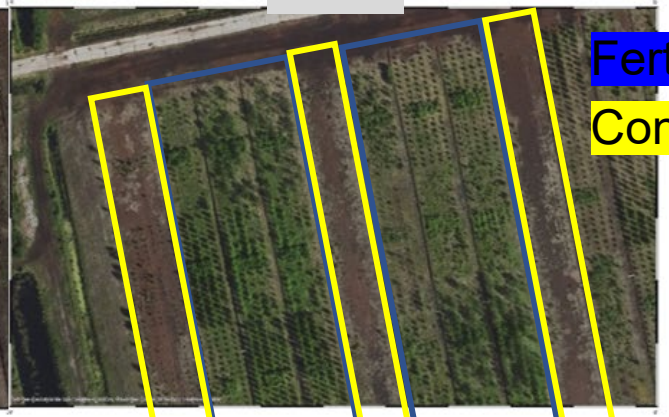
2017



Year of wood ash application

2019

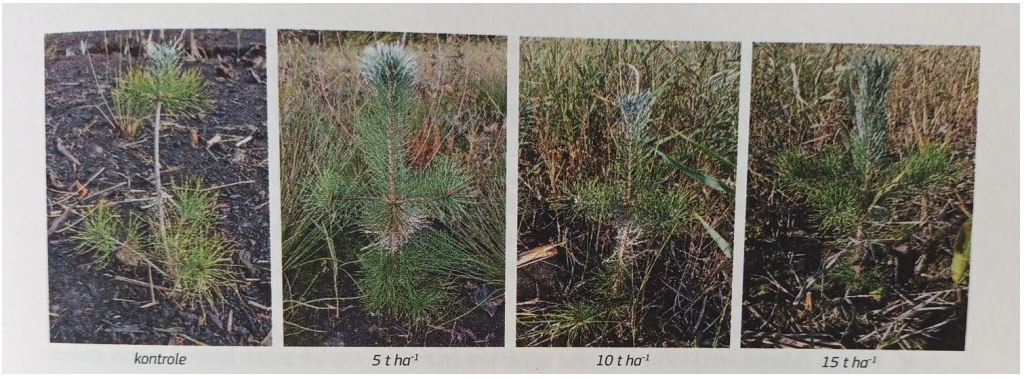
2022



Fertilised

Control

2018



2023

Conclusions

- Planted tree growth rate and growing conditions in cutaway peatland can be improved by incorporating wood ash into the soil, even in low doses

- Fertilisation did not alter survivance for species adapted to acidic soils (Pine), but dieback was observed for more sensitive species in the context of acidic soils (Poplar)

- Herbaceous vegetation plays an important role in early stage development of afforested cutaway peatland, by providing species and habitat diversity and higher biomass accumulation

- These results indicate that the best results from ecological, economic, and climate perspectives can be achieved with 10 Mg ha^{-1}; a higher dose application is not justified and should not be applied due to leaching possibilities.

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