Carbon Dynamics in Peatland Forests «Ditch or no ditch?»

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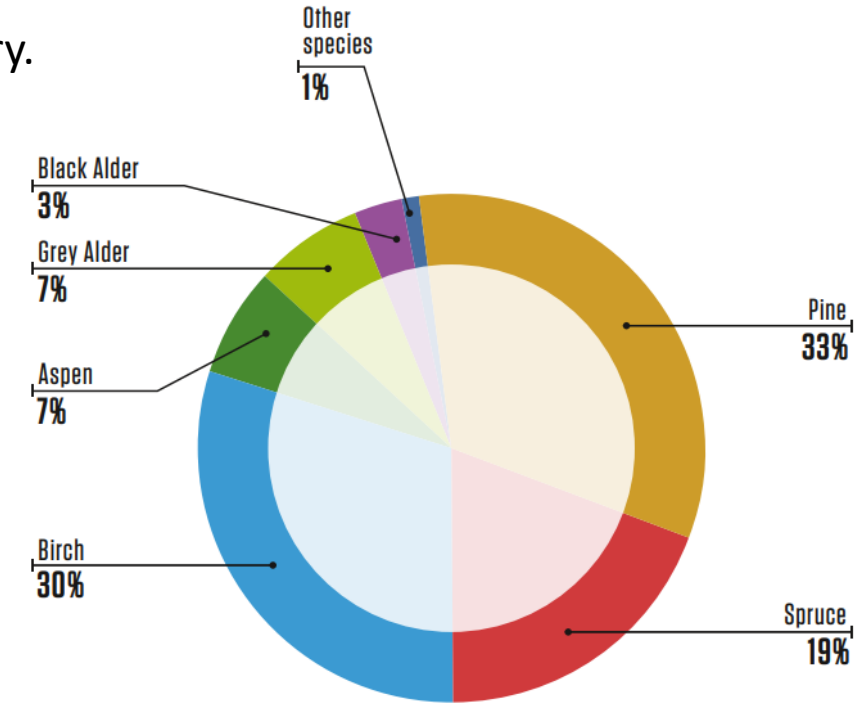
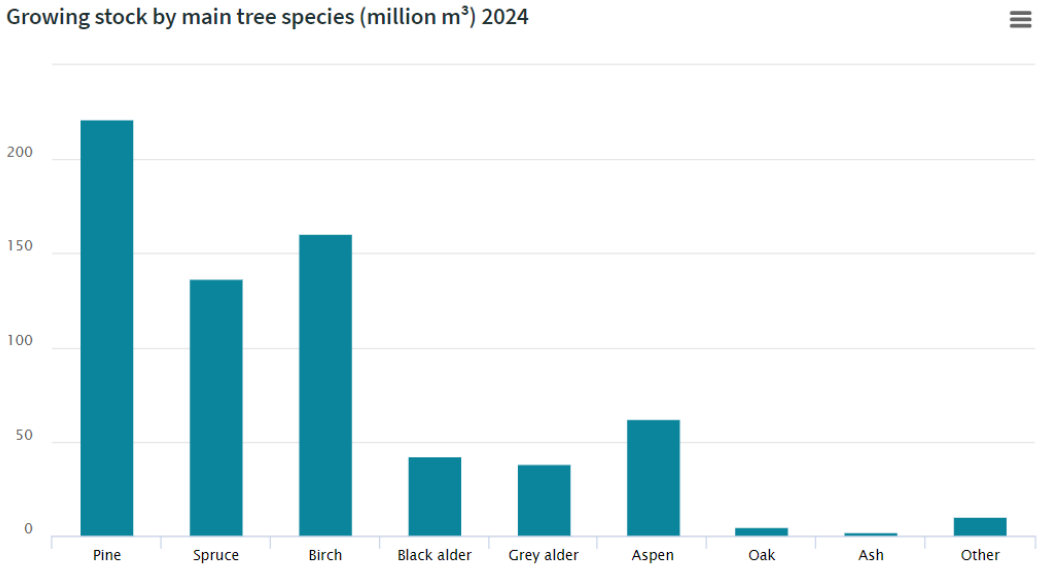
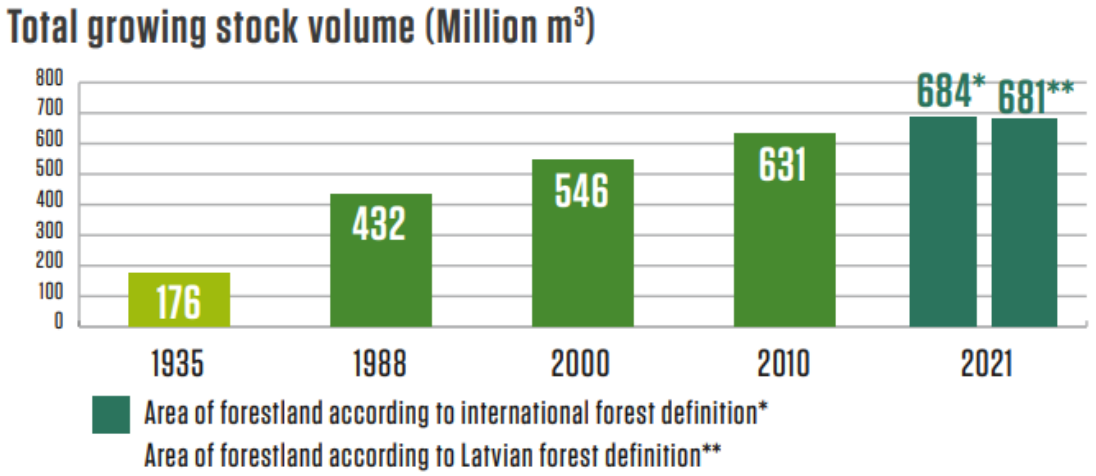
Agenda

- Foresty in Latvia.
- Peatlands and Peatland forestry.
- Drainage disruption – what we know so far.

Forests in Latvia cover 3.4 million hectares - 53% of the country's territory.







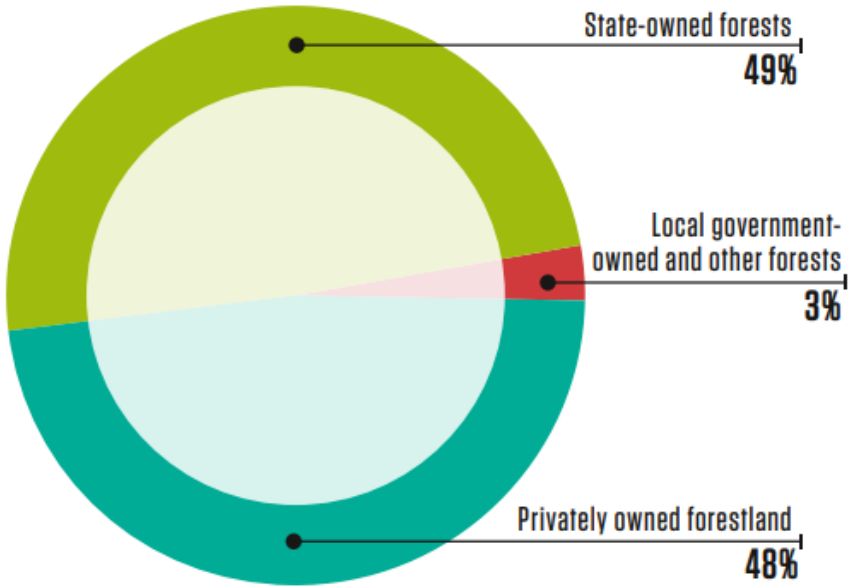
An average of approximately 11 million m³ of timber have been harvested each year in Latvia's forests during the past decade.

The state owns about half of the total forest territory managed by JSC «Latvian State Forests".

The remaining forest area belongs to approximately 135,000 different forest owners, mostly private individuals.

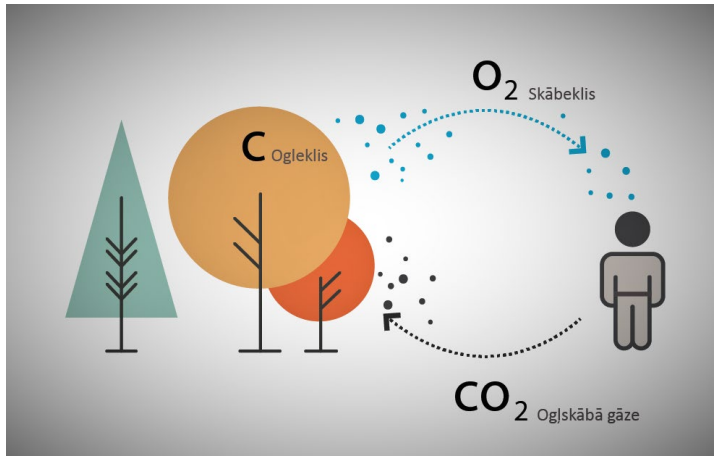
The TOP 20 largest forest owners together own more than 300 thousand forests. ha area.

Limitations on economic activity apply to 28.2% of Latvia’s forests at this time, and most of this territory is owned by the state



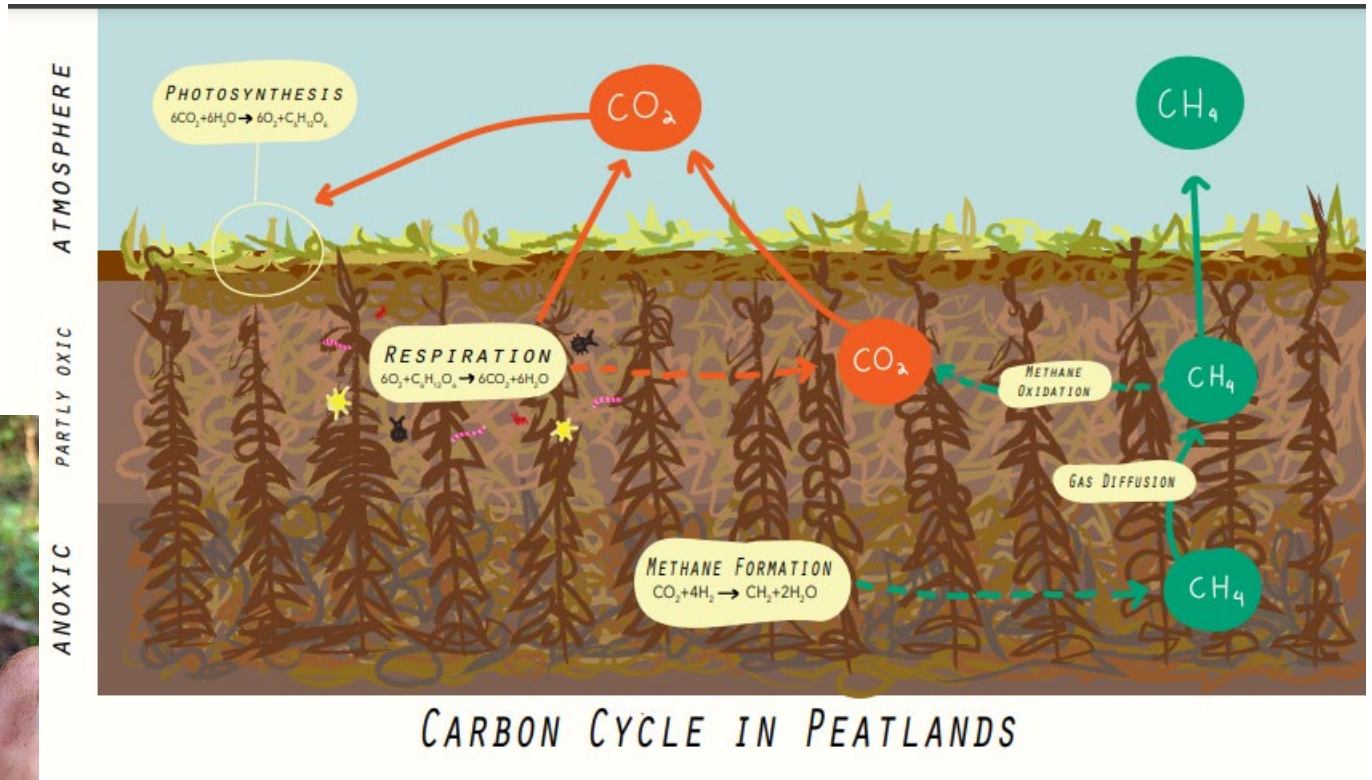
The forest sector is one of the cornerstones of the national economy

Forestry, wood processing and furniture manufacturing represented 6.5% of GDP in 2021, while exports amounted to EUR 3.6 billion – 22% of all exports.



By increasing the use of wood, the amount of greenhouse gas emission is reduced, accumulating carbon dioxide and thus reducing the negative effects of climate change.

Peatlands are lands with a naturally accumulated peat layer at their surface



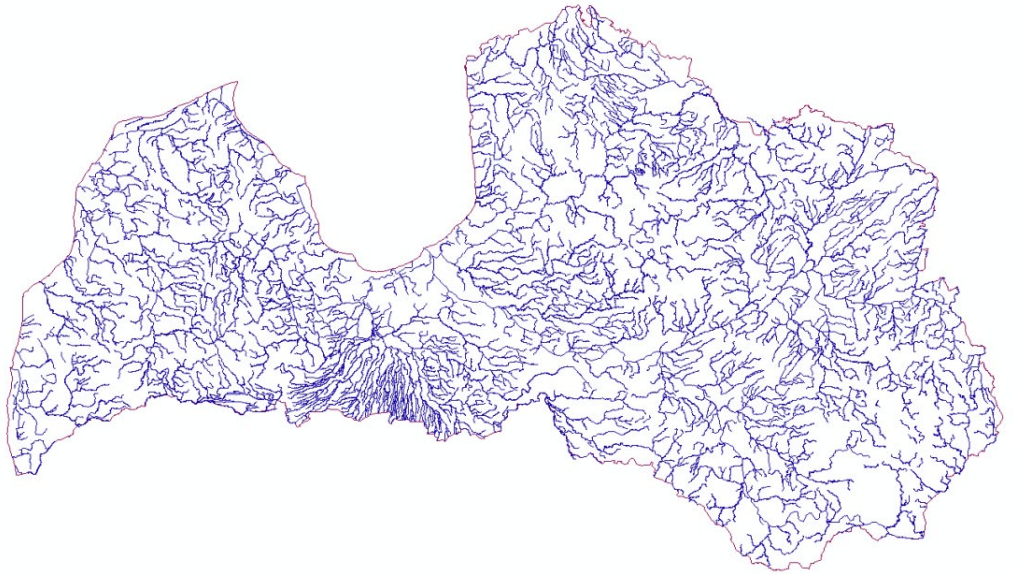
CARBON CYCLE IN PEATLANDS

For the purpose of assessing emissions, Intergovernmental Panel of Climate Change (IPCC) guidelines included the concept of peatland in the 'land with organic soil' category and identify organic soils as histosols.

Because of drainage, organic soils are currently the third-largest emitter of GHGs in the Agriculture, Forestry and Land Use (AFOLU) sector; they emit almost one gigatonne of CO2 equivalent (CO2 -eq).

Land drainege – land improvement that reduces adverse effects of climatic conditions and ensures sustainable use of natural.

Drainage system – specialized structures and devices set for the regulation of the ground water regime.



Forest typology in Latvia

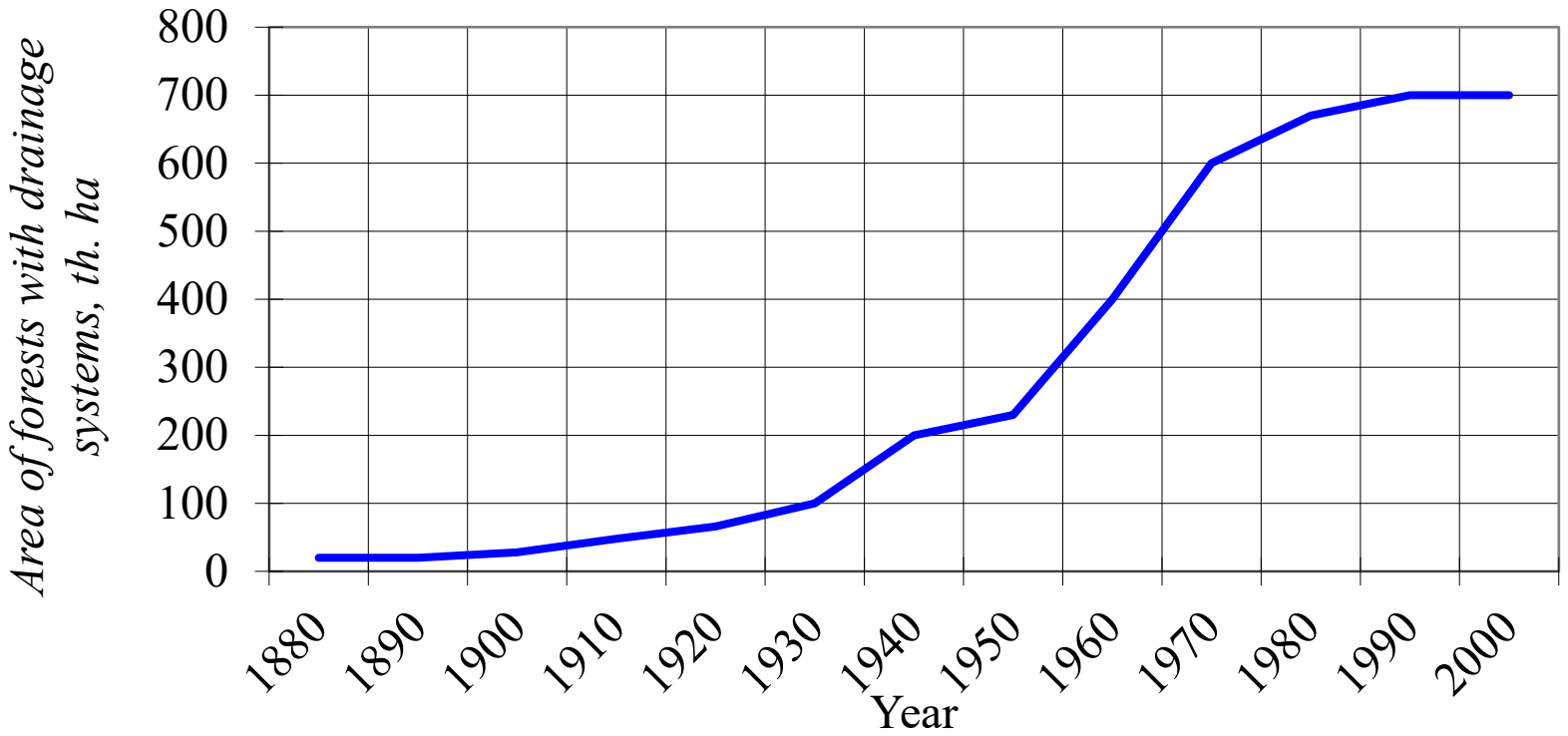
Mineral soil			*Peat soil*	
☼ *Normal moisture regime – dry all year round*	≈ *Wet, periodically waterlogged* <30cm	Y *Drained wet mineral soils* <20cm	≈ *Wet, periodically waterlogged* >30cm	Y *Drained wet peat soils* >20cm
(*Cladinoso-callunosa*)	(*Callunoso-sphagnosa*)	(*Cladinosa mel.*)	(*Sphagnosa*)	(*Cladinosa turf. mel.*)
(*Vacciniosa*)	(*Vaccinioso-sphagnosa*)	(*Vacciniosa mel.*)	(*Caricoso-phragmitosa*)	(*Vacciniosa turf. mel.*)
(*Myrtillosa*)	-	-		
(*Hylocomiosa*)	Dms (*Myrtilloso-sphagnosa*)	(*Myrtillosa mel.*)	(*Dryopterioso-caricosa*)	(*Myrtillosa turf. mel.*)
(*Oxalidosa*)	(*Myrtilloso-polytrichosa*)			
(*Aegopodiosa*)	(*Dryopteriosa*)	(*Mercurialiosa mel.*)	(*Filipendulosa*)	(*Oxalidosa turf. mel.*)

Most of drainage was established during 1960 - 1990

Post 1990 – mainly renovation.

About 26% of the wet forests have been drained.

7.9% of bogs have been drained for forestry.



Peatland forestry is common in the boreal zone, but also occurs across the temperate climate zone.

Globally, approximately 12 million hectares (Mha) of peatlands have been drained for forestry (Minkkinen et al. 2023).

This represents approximately 3% of the global peatland area (ca. 440 Mha, Yu et al. 2010).

Most of the area under peatland forest is situated in Fennoscandia and Russia, where over 10 Mha of peatlands have been drained for forestry.

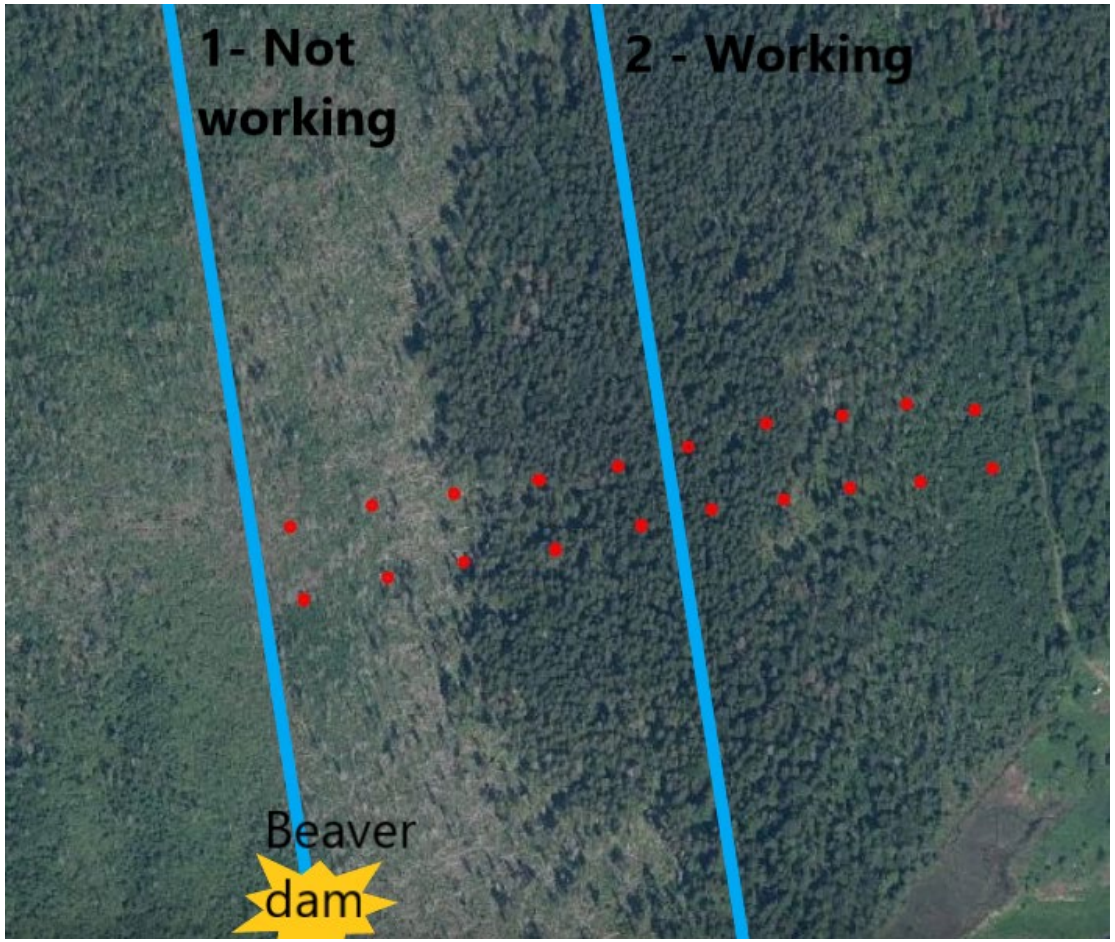
- ***Rewetting*** describes the deliberate action of raising the water table on drained soils to re-establish water-saturated conditions.
- ***Restoration*** refers to the full re-establishment of all ecosystem functions that cannot be done directly but only be aimed at facilitating measures, such as rewetting, removal of degraded topsoil, and re-introduction of mire-typical vegetation, etc.

What happens when drainage stops working?

Research object – Ķemeri National Park

- Beavers dams – cause of ditch blockage.
- No drainage maintenance -> return to pre-drained state.
- The aim of the study was to find out:

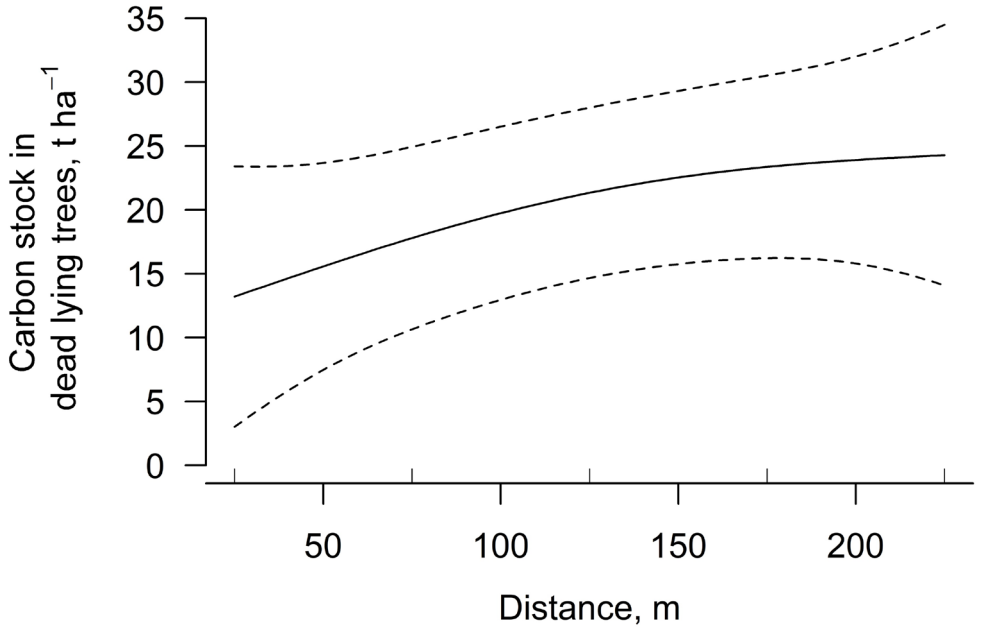
1. How disruption of drainage system affects the development of the forest stand.
2. Effect on carbon storage.

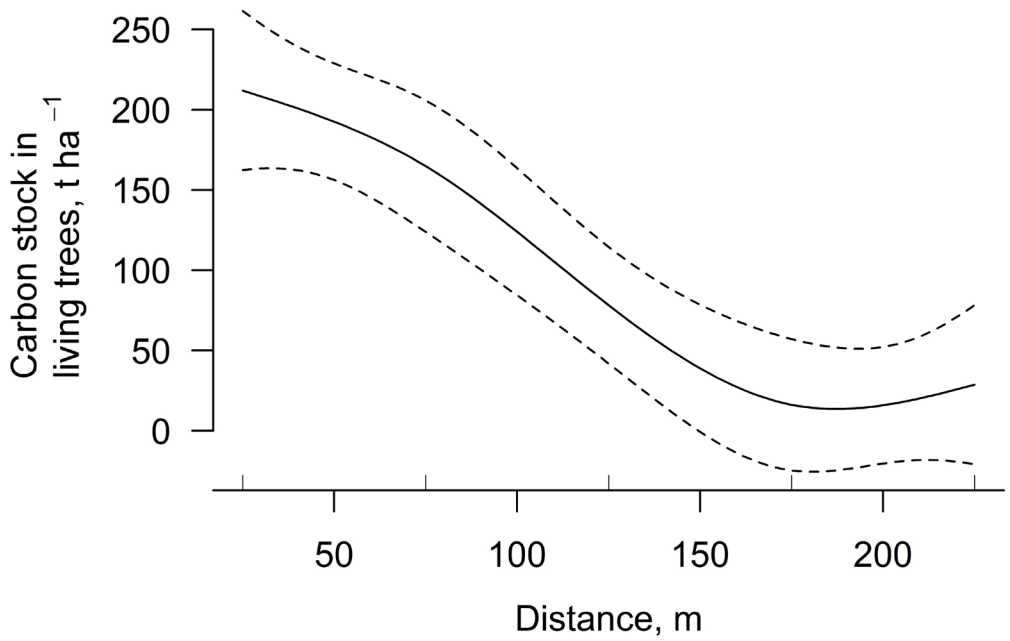


Effect on trees

As the distance from the working ditch increases, carbon accumulation in living trees decreases.

The working distance of the ditches is about 160 meters, which corresponds to the designed layout.

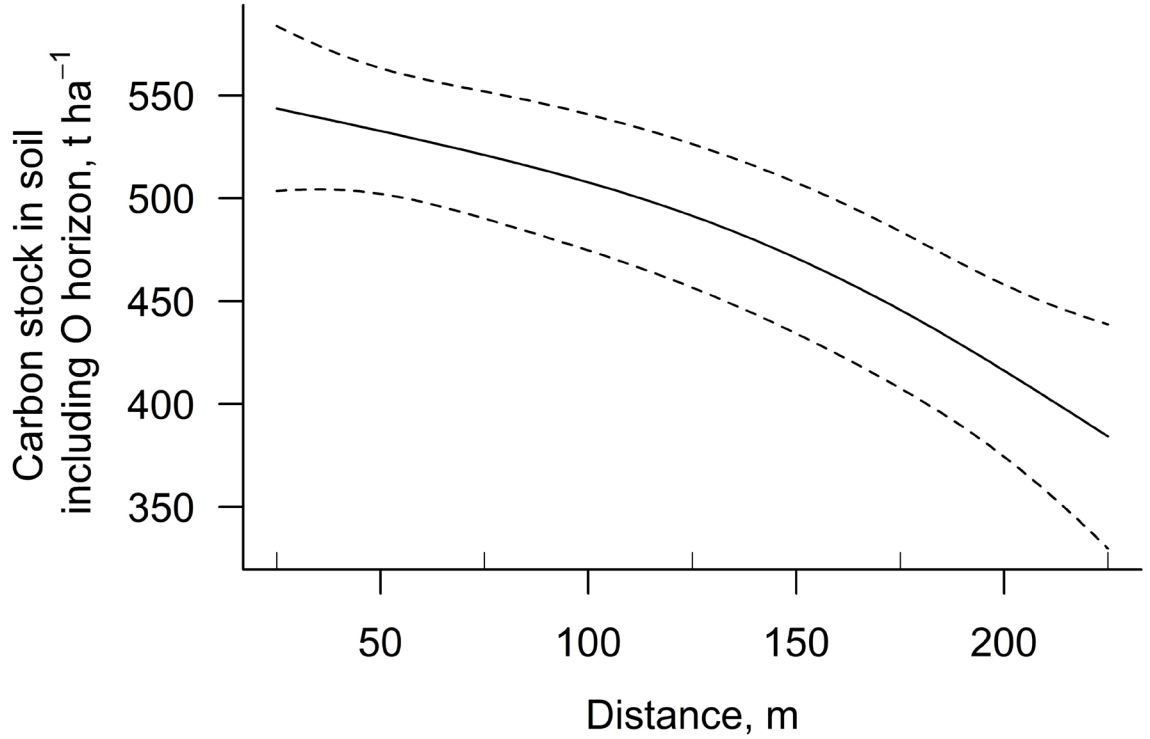




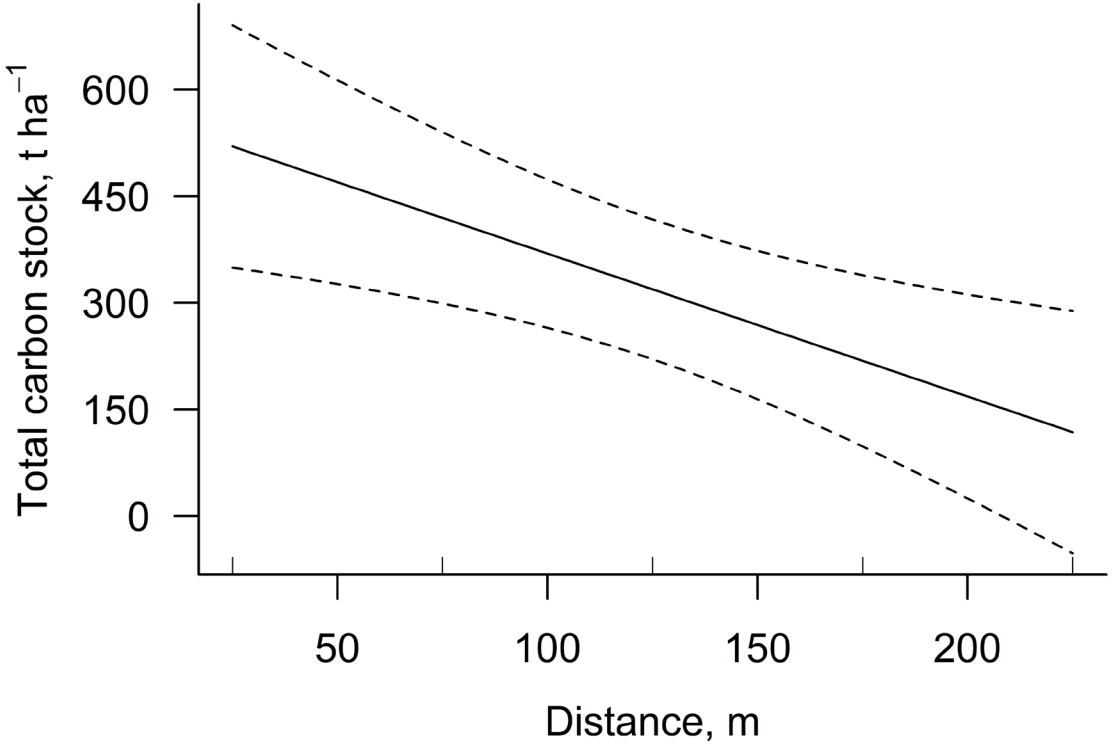
Carbon in soil.

The largest carbon accumulation is made up of organic soils (on average 480 t C ha^{-1} to a depth of 0.5 m).

The results show that soil carbon accumulation decreases with increasing distance from the working ditch.



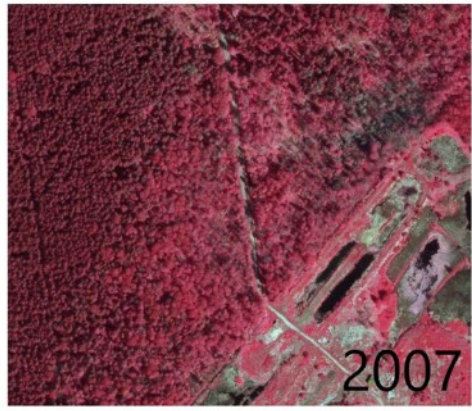
Total carbon stock

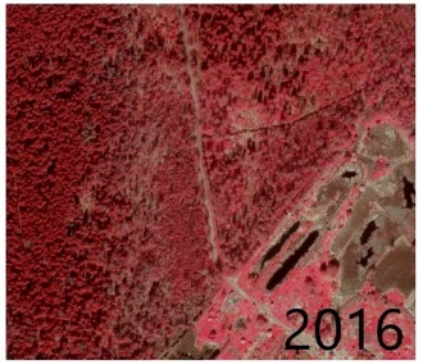


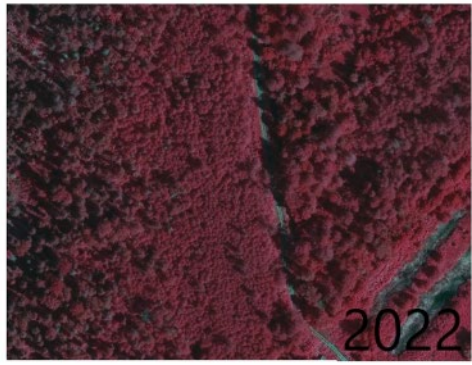
The total accumulated carbon in all pools decreases with increasing distance from the working ditch.

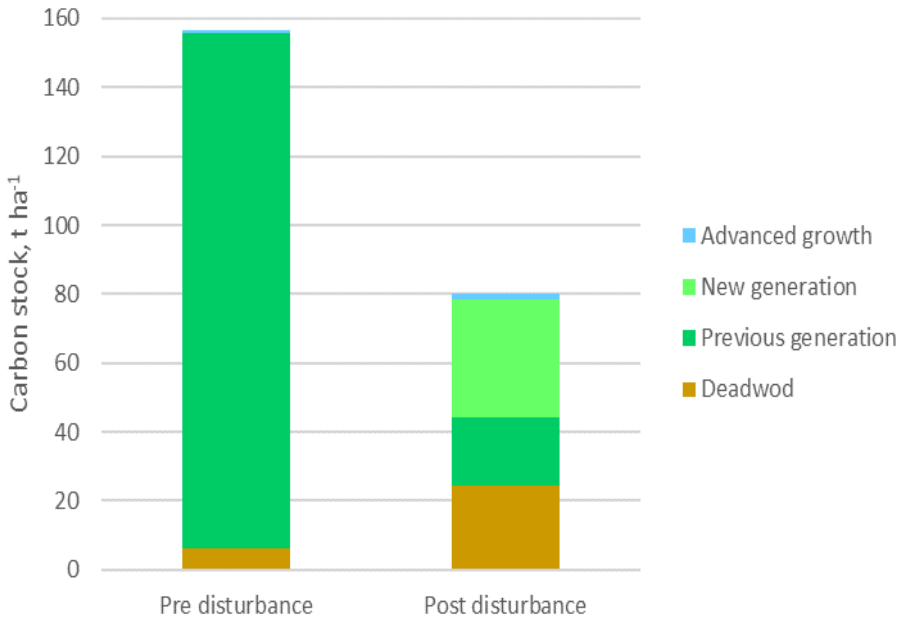
Carbon losses of 5.1 - 6.8 t C ha^{-1} $year^{-1}$

Reduction of 72% in the C stock of the previous generation of tree







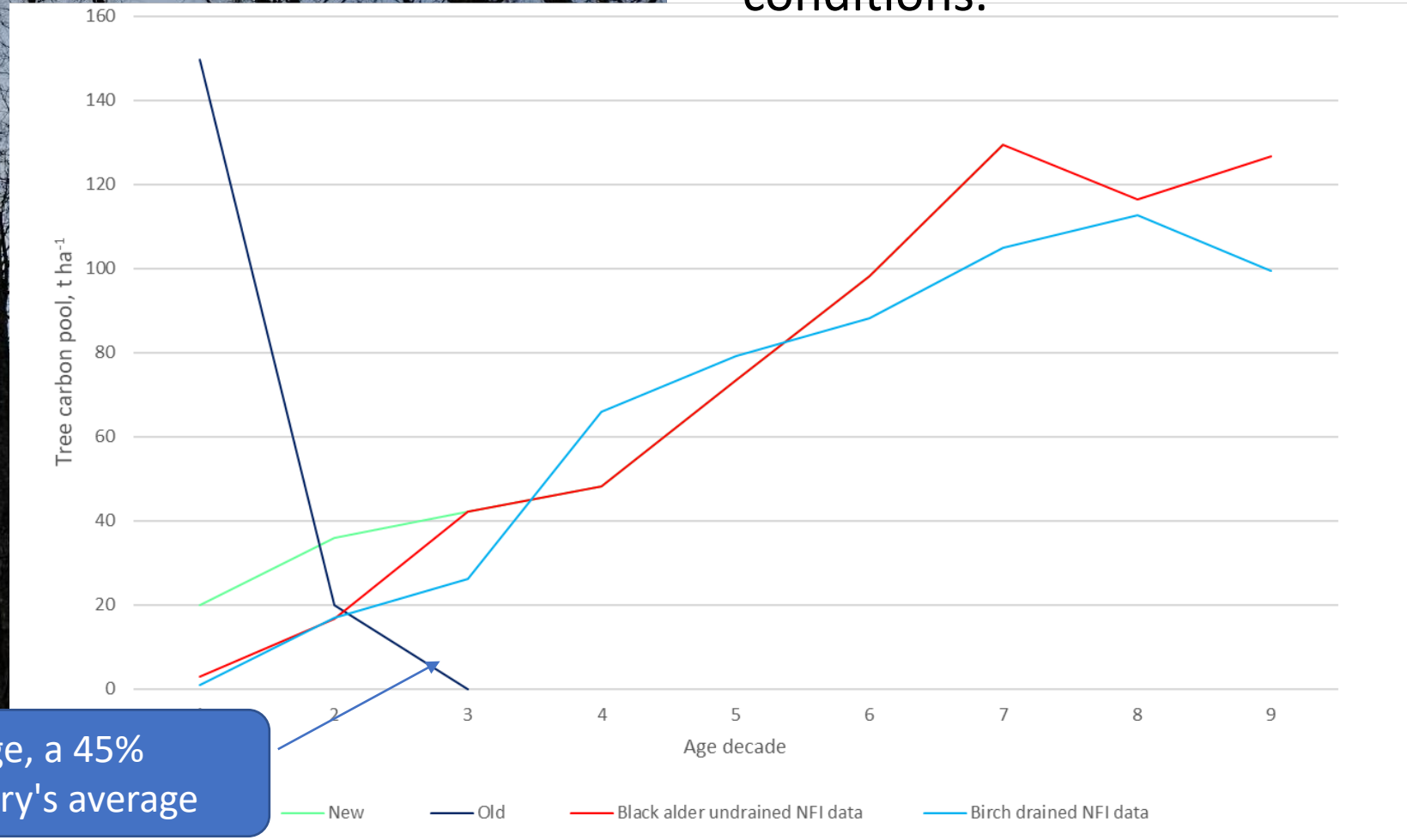


Stand component	Dominant Species	H, m	DBH, cm	Age	Standing volume, m^3 ha^{-1}	Stand density, trees ha^{-1}
Advanced growth	Black alder	5.7±0.2	3.02±0.2	8.6±0.7	3.6±1.8	1300±295
New trees	Black alder	12.4±0.1	11±0.2	12,7±0.7	53.8±26.9	1330±240
Old trees	Birch	17.1±1.7	23.7±2	84.2±6.8	44.9±19.6	75±37

Average decline of 52% in the total C stock of tree biomass in a forest stand 15 years after stand replacing disturbance.

The regenerated forest stand offsets carbon losses within the 2nd decade.

Black alder growing on wet organic soils generally exhibits higher achievable carbon stock than birch in drained conditions.



The regenerated tree cohort shows, on average, a 45% higher carbon stock at this age than the country's average

Discontinuation of the drainage system results in the collapse of the forest stand.

Stand-replacement disturbances significantly alter carbon dynamics in forest ecosystems.

Deciduous forests, reaching biological age, exhibit reduced resilience to stand replacement disturbances, leading to annual carbon losses up to 6.8 C t ha^{-1}.

Rapid regeneration transforms the stand into a carbon sink, accumulating 37.4 t C ha^{-1} after 15 years.

While rewetting drained areas may have benefits for certain ecosystem values, it introduces trade-offs that require careful consideration in management strategies.

Further research is crucial to investigate carbon dynamics after drainage disruption, considering:

- various tree species and site types
- management intensities

Thank you for attention!

Work carried out in Latvian State Forests project “Carbon cycle in forest ecosystem” (No 5-5.9.1_0081_101_21_87).

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