Case studies of afforestation of organic soils in Latvia - costs, benefits & climate change mitigation

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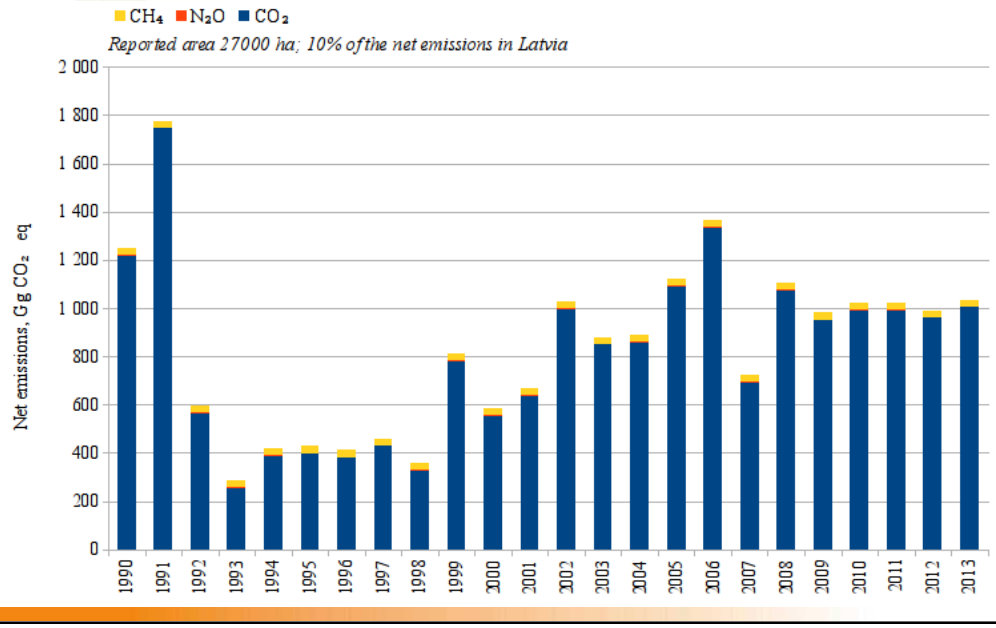
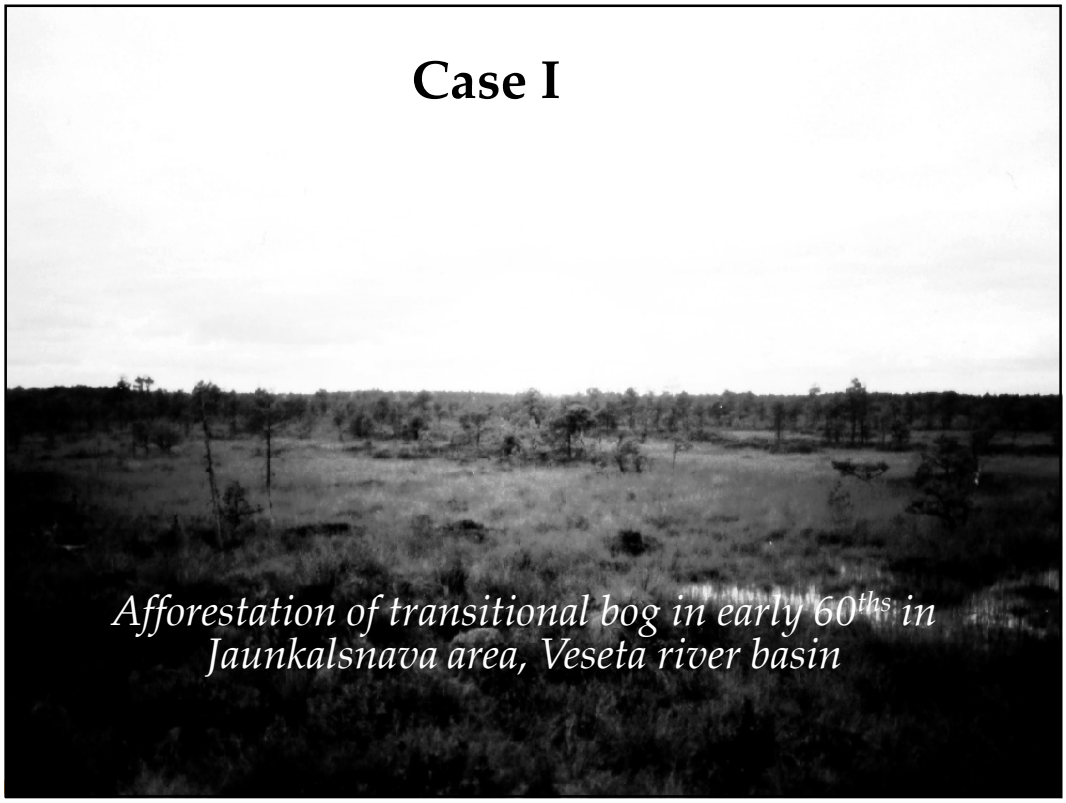
Greenhouse gas (GHG) emissions due to peat extraction in Latvia



Case I

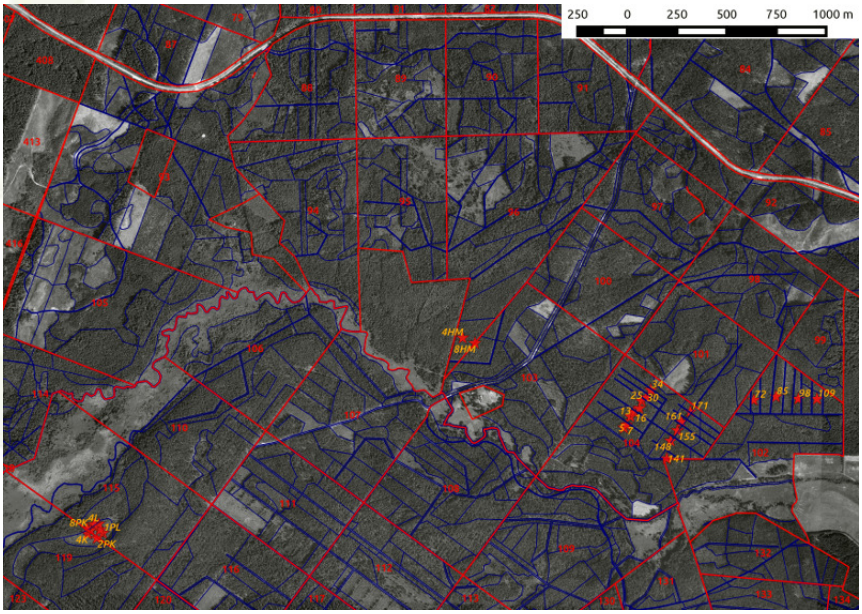


Afforestation of transitional bog in early 60^{ths} in Jaunkalsnava area, Veseta river basin

Target of the study

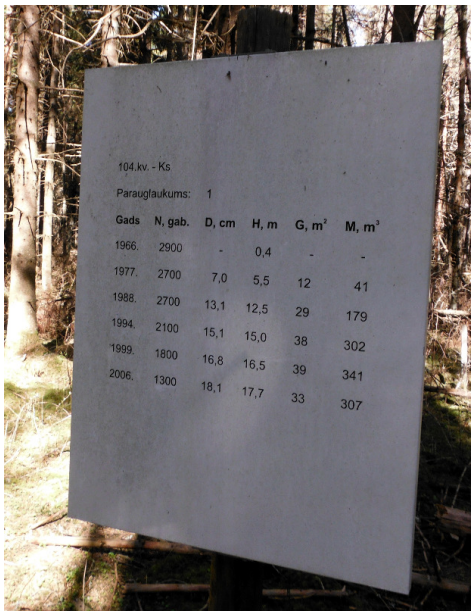
- To estimate **carbon stock** in soil and other carbon pools **5 decades after drainage** and afforestation of transitional bog.
- To **compare the carbon stocks** in drained and afforested part of the bog and untouched, protected area.
- To contribute to elaboration of the **country specific factors of carbon stock changes** in drained organic soil.

Study area in Vesetnieki



The study area with & without drainage

Stand development in drained area

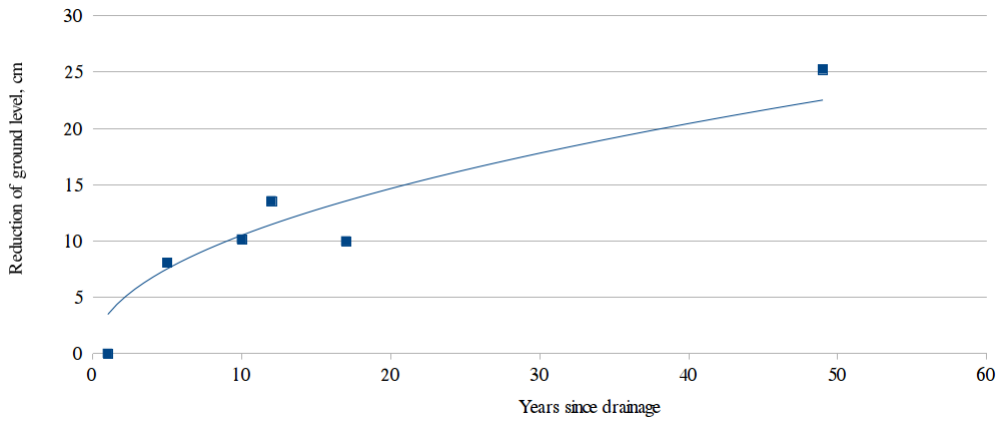


Measurements

- **Stand** characteristics.
- **Surface** levelling data.
- Bulk **density** of soil and litter layer down to 80 cm depth.
- **Biomass** of fine debris.
- **Carbon** content in soil, litter and fine woody debris.
- **Groundwater** level during sampling.
- Soil **penetration** resistance.

Reduction of ground level

Dominant species / years	7	12	14	19	51
Norway spruce	11.8	11.5	15.9	13.9	28.6
Scots pine	-	13.7	15.6	6.8	21.4
Average	**11.8**	**12.0**	**15.8**	**11.8**	**25.7**

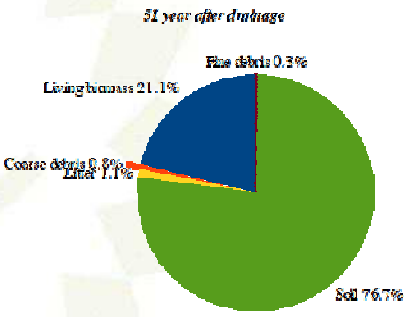


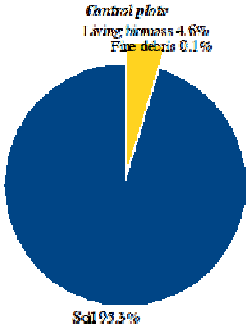
Carbon stock changes in soil

Growth conditions	Dominant species	0-10 cm	10-20 cm	20-40 cm	40-80 cm	Total
Drained forest	Norway spruce	80.4	70.4	133.0	248.9	**537.0**
	Scots pine	65.5	63.1	116.9	226.0	**477.5**
	Average	**74.4**	**67.5**	**126.6**	**239.7**	**513.2**
Transitional bog	Norway spruce	35.3	31.7	61.0	174.6	**302.6**
	Scots pine	39.3	38.3	83.5	196.6	**357.6**
	Average	**38.0**	**36.1**	**76.0**	**189.3**	**339.3**

- **Carbon stock in soil increased** significantly after drainage, even if the upper 25.7 cm layer is considered to have zero carbon.
- The increase of carbon stock in all pools is **106 tons ha^{-1}** *(corresponding to removals of **7.6 tons CO_2 ha^{-1} annually**).*

Structure of carbon stock and location of sequestrated carbon





Carbon pool	Living biomass	Fine debris	Litter	Soil	Total
Norway spruce	84.9	6.0	4.5	15.6	**110.9**
Scots pine	75.4	2.8	6.1	11.5	**95.7**
Average	**81.1**	**4.7**	**5.1**	**15.0**	**105.8**

Conclusions

- The study demonstrates considerable overestimation of CO_2 emissions due to drainage of organic forest soil in Latvia *(0.97 tons C ha^{-1} or 1 524 Gg CO_2 annually, if obtained results are applied to all drained organic soils)*.
- Monetary value of the overestimation of the emissions can reach **15.4 mill. EUR annually**.
- The study highlights **need to obtain more data** representing different stand types and growth conditions.
- The study demonstrates, that use of **short term flux** measurements might lead to **overestimation** of the GHG emissions.

Case II

Afforestation of abandoned peat extraction site near Riga in 2005

Target of the study

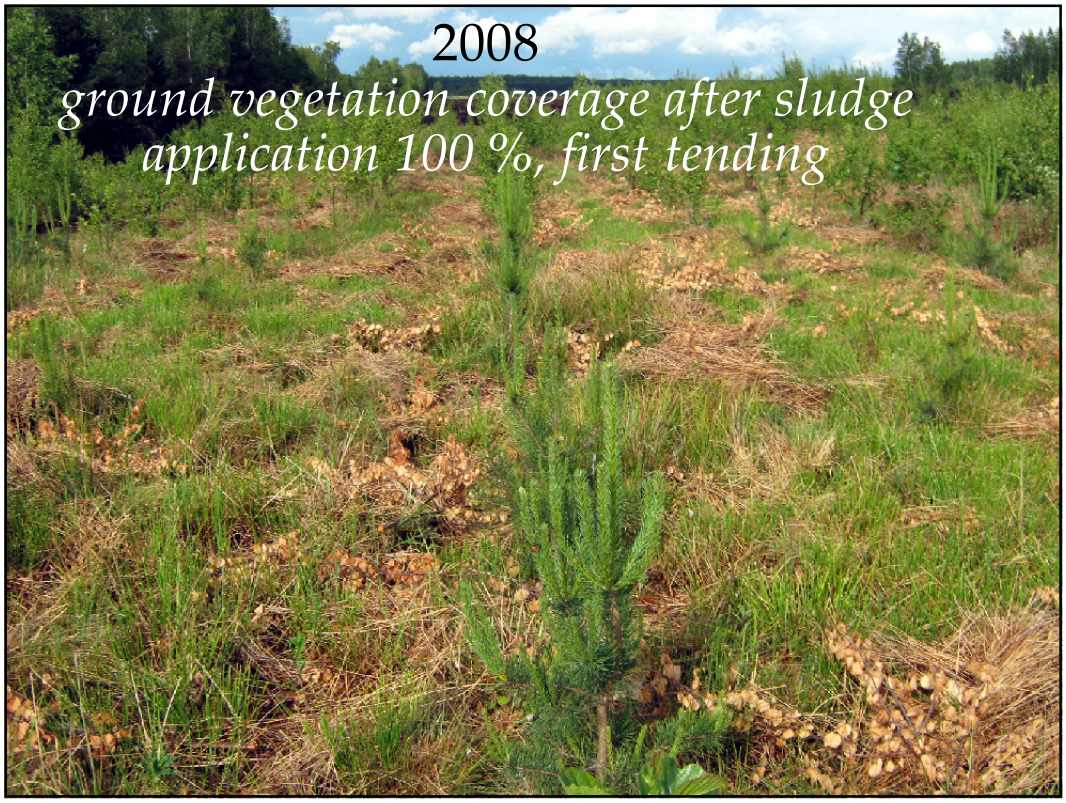
- To evaluate possibilities to **utilize wastewater sludge** in restoration of abandoned peat extraction sites.
- To compare **effect of mineral fertilizers and wastewater sludge** on growth of pine, birch, spruce, black alder and *Salix sp*. (willow and poplar).
- To estimate possibilities to grow **reed canary grass** on abandoned peatlands using organic fertilizers.
- To compare **natural regeneration of birch with planting** of birch.
- To elaborate **recommendations for restoration** of extracted peatlands using mineral and organic fertilizers and liming material.

Spreading of sludge and mineral fertilizers in 2005

The first autumn after establishment

Establishment of liming trials in 2006

Conclusion of 2007
mineral fertilizers are the best


2008
ground vegetation coverage after sludge application 100 %, first tending


2009
now we like more wastewater sludge and natural regeneration of birch

2011
control, sludge mineral fertilizers

2015
birch, pine and black alder grows excellent

Current status and costs of establishment

Variant	Height, m	Diameter, cm	Number of trees per ha	Average tree, m^3	Stock, m^3 ha^{-1}
Sludge, birch planted	6,44	5,4	2225	0,008	18,68
Sludge, birch natural	5,78	3,9	4825	0,004	20,04
Sludge, pine	4,05	5,8	3633	0,008	28,97
NPK, birch planted	4,01	4,3	2633	0,004	9,73
NPK, birch natural	4,21	2,9	4633	0,002	8,56
NPK, pine	2,96	2,9	3133	0,002	5,97

Position	Units	Number of units	Cost of unit	Total cost
Spreading of sludge	ha	1	€ 350,00	€ 350,00
Seedlings	number	2000	€ 0,09	€ 170,00
Planting	ha	1	€ 260,00	€ 260,00
Tending (twice)	ha	1	€ 260,00	€ 260,00
Total establishment cost				€ 1 040,00

Monetary and climatic benefits using wastewater sludge

Variant	Rotation duration	Growing stock, m^3	Cost	Income	Harvest cost	Net income	Net income per year
Birch planted	40	200	€ 1 040	€ 6 205	€ 2 800	€ 2 365	€ 59
Birch natural	40	200	€ 610	€ 6 205	€ 2 800	€ 2 795	€ 70
Pine planted	40	182	€ 1 040	€ 5 372	€ 2 548	€ 1 784	€ 45

- Other benefits:
  - utilization of sludge – no benefits at that time, should be **1844 EUR ha^{-1}**;
- Climatic benefits:
  - **reduction of losses of soil carbon stock** – visually identifiable *(mainly due to reduction of erosion and accumulation of litter)*, but no measurements were funded;
  - **CO_2 removals in living biomass** – 160-400 EUR ha^{-1};
  - **other GHG emissions** – ???

Things to do

- Elaboration of country specific **emission factors** combining flux measurement data (N_2O and CH_4) and long term land use management trials.
- **Classification of "natural" peatlands** according their "vitality" and real values of non-accounted GHG emissions.
- Elaboration of realistic **projection tools** for evaluation of different peatland management scenarios.
- **Implementation of climate change mitigation** targeted measures in peatlands on the base of scientifically approved information.
- *Remembering that more than 90 % of organic soils in EU are located in Baltic and Nordic countries and nobody else really understand this issue and will not provide solution.*