Abandoned extracted peatlands – brownfields in nature

Their negatiive effect on environment and need for restoration

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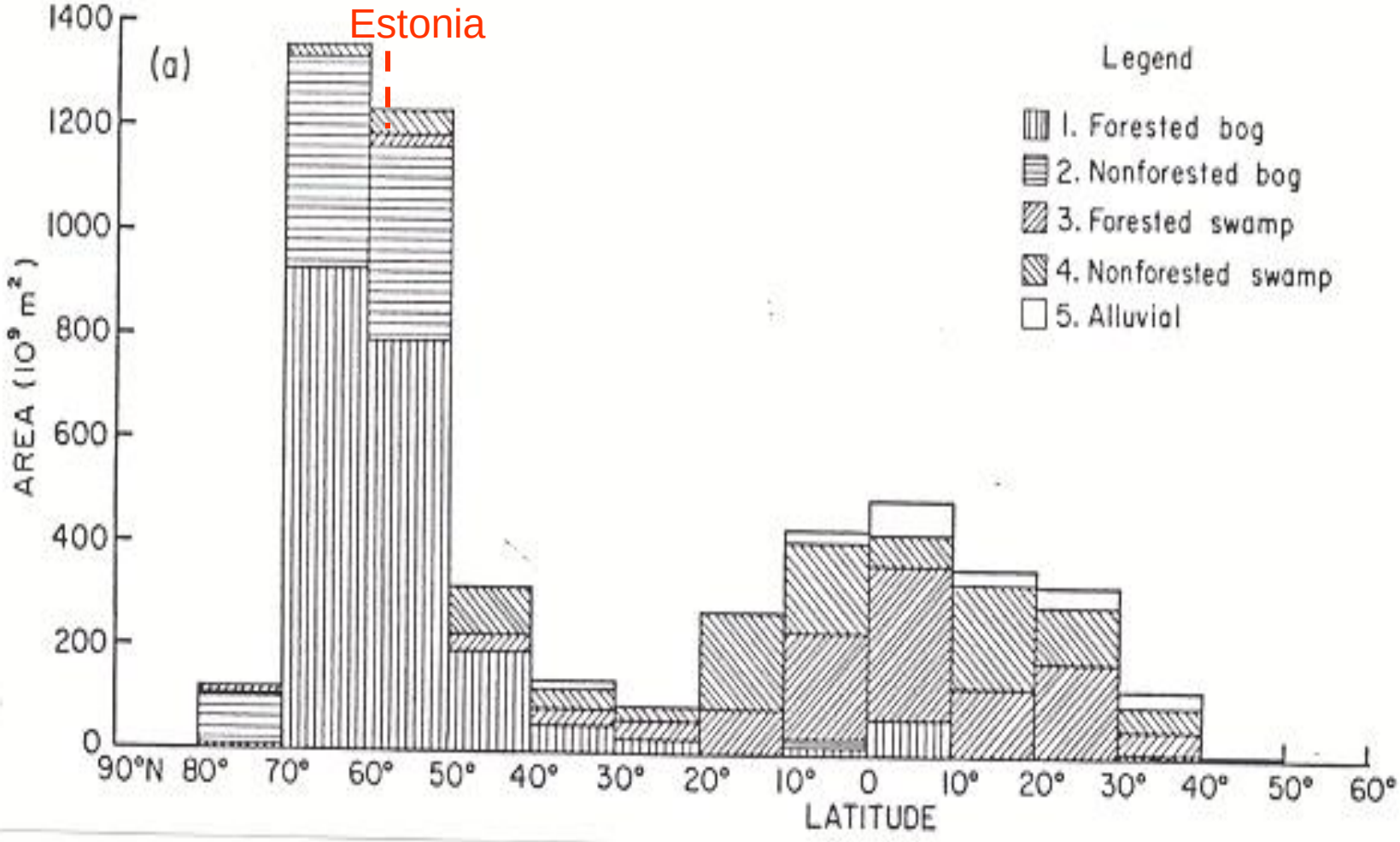
ESTONIA is situated in Northern-Europe. It is bordered from the North by the Gulf of Finland and Finland, from the East by the Lake Peipsi and Russia, from the South by Latvia and from the West cross the Baltic sea with Sweden.
Poulation *ca* 1,3 milj.
Capital Tallinn.

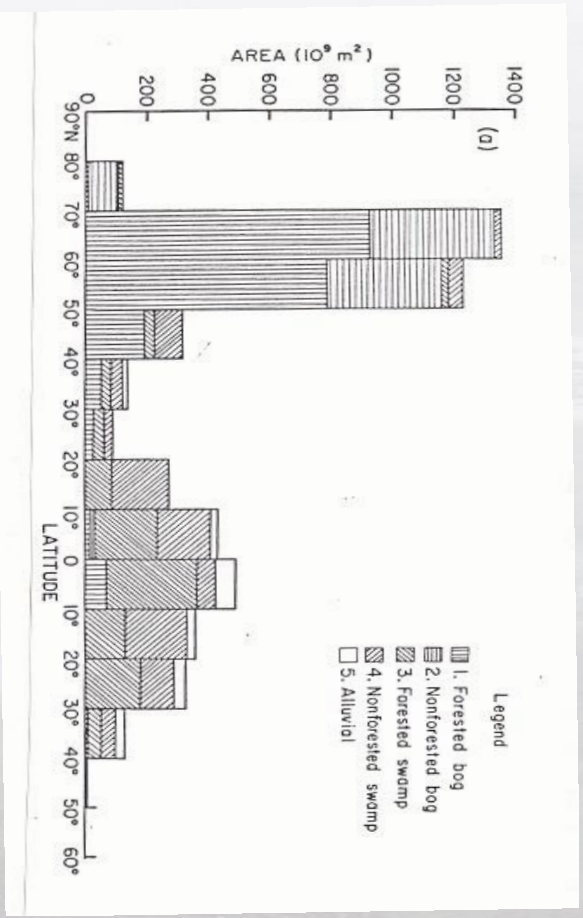
Estonian center geographical coordinates: N 58º41'42", E 25º25'59"

Total territory 45,23 km^2.
Humid continental climate. The annual mean precipitation 600 to 700 mm yr^{-1}. Mean air temperature 17 °C in July to -6 °C in February

Global distribution of peatlands on latitudinal gradient



Global distribution of peatlands on latitudinal gradient



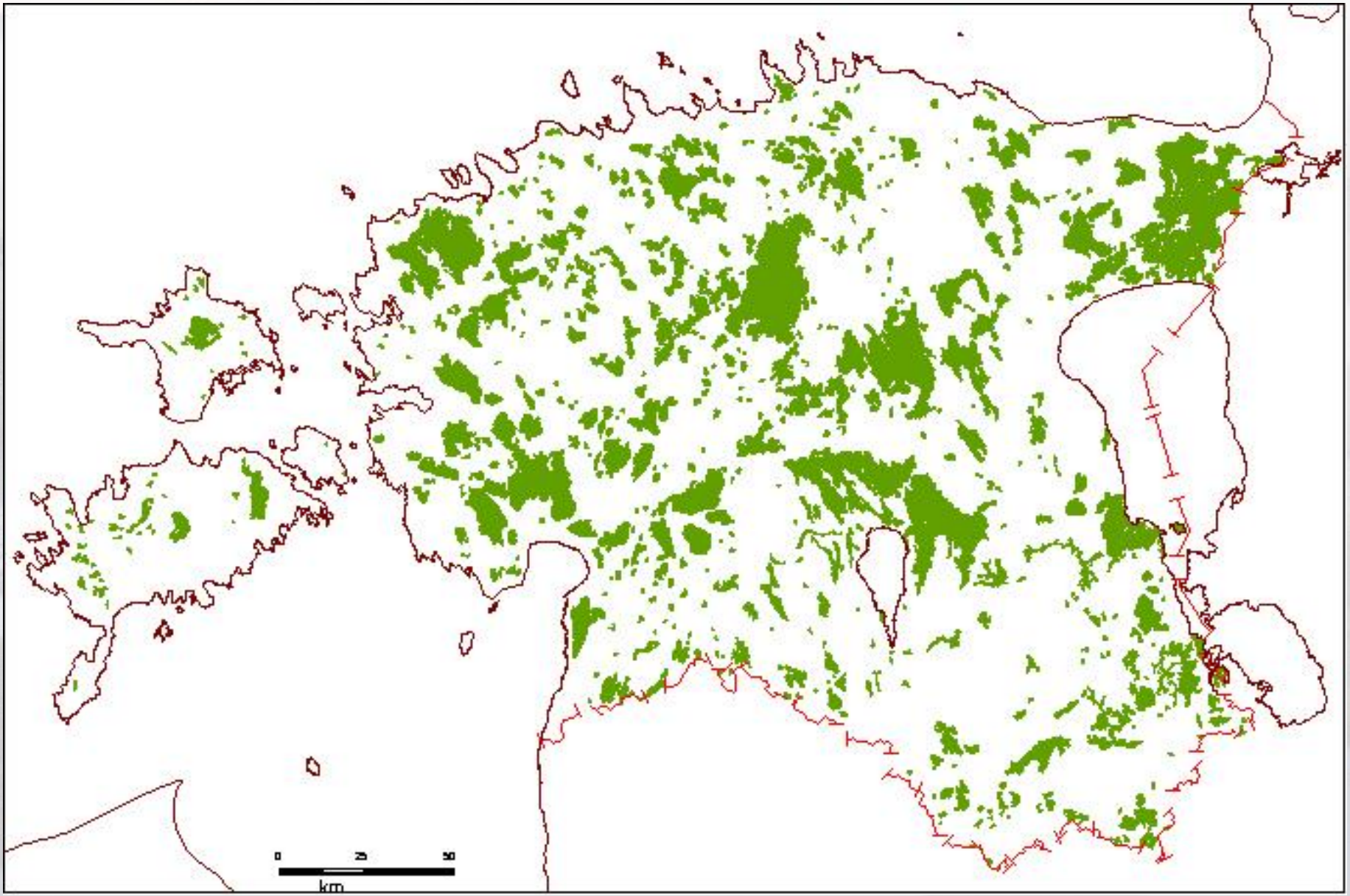
From Estonian territory:

- *ca* 50 % is covered by forest (pine, spruce, birch)
- 22 % peatlands in various state
- 4,8 % lakes

Different type of peatlands cover *ca* 1 milj ha or *ca* 22 % of Estonian territory. This would make Estonia second peatland rich country in the world after Finland with *ca* 30 %. But ...

... recent inventory compleated in 2011. a reveals that **mires in near natural state cover only 238,6 thousand ha or 5,2-5,5 %.**

Distribution of bigger mires in Estonia



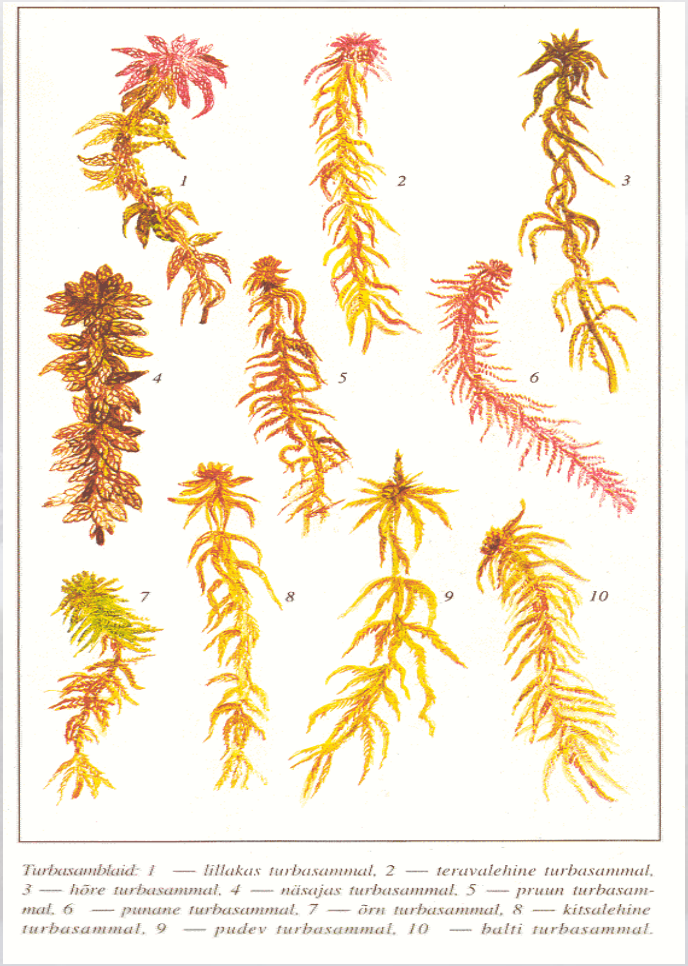
Beginning of mire reasearch in Estonia:

Johannes Christop Klinge (1851-1902) started in Tartu University in 1879. special lecture cource dedicated to mires which he named „***telmatology***“.

Klinge was first who:

- showed the effect of litoral type on lake overgrowing and infilling (Klinge's rule),
- described solification of peat massifs, and
- was likely first who described ombrotrophy of bogs, fed solely by precipitations and are relatively independent from the ground water.

Bryologist **Edmund A. Russow** (1841-1897) was prof. of botany in University of Tartu and became famous for his studies on *Sphagnum* mosses anatomy and systematics.



Turbasamblaid: 1 — lillakas turbasammal, 2 — teravalehine turbasammal, 3 — hõre turbasammal, 4 — näsajas turbasammal, 5 — pruun turbasammal, 6 — punane turbasammal, 7 — õrn turbasammal, 8 — kitsalehine turbasammal, 9 — pudev turbasammal, 10 — halti turbasammal.

Together with his colleague **G. K. Girgenson** they described 8 new *Sphagnum* species.

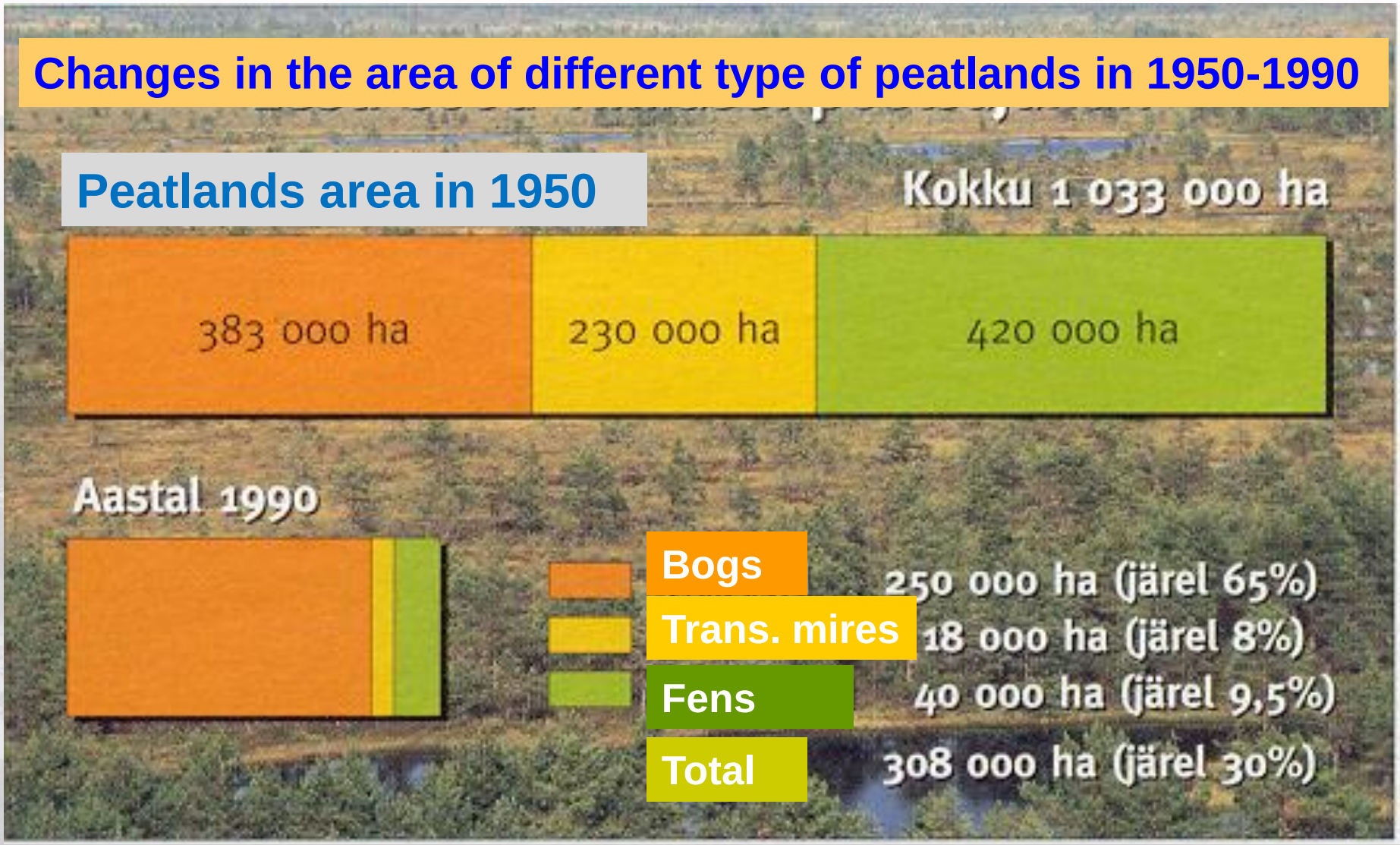
For their honour there are species named after them: *Sphagnum girgensohnii* and *Sphagnum russowii*.

- **Exploitable peat resources in Estonia are estimated to be 775 milj. t.**

- **Peat is extracted mostly by milling and vacuum mining method in *ca* 80 peatlands on over 100 peat fields with total territory 18-19 thousand ha.**

- **Biggest peat extraction – *ca* 2,9 milj. t yr^{-1} – was in 1986, currently 0,8-1,2 milj t yr^{-1}. Estonia is Word 3.-4. biggest peat exporter.**

Changes in the area of different type of peatlands in 1950-1990



Mires, especially fens and transitional mires were drained especially in 1950.-1970.s mostly for agriculture (grasslands, pastures *etc*) and forestry and only in lesser extent for peat extraction.

Up to 1940-s peat was mostly dug manually from trences on bog margin without drainage and these areas revegetated spontaneously (A).

A

Situation changed drastically since 1950.s with peat milling on large areas with deep drainage (B)

B

Almost plantless abandoned extracted peatland in Viru bog, Lahemaa NP.

Spontaneous re-vegetation of extracted peatlands is very slow process because of:

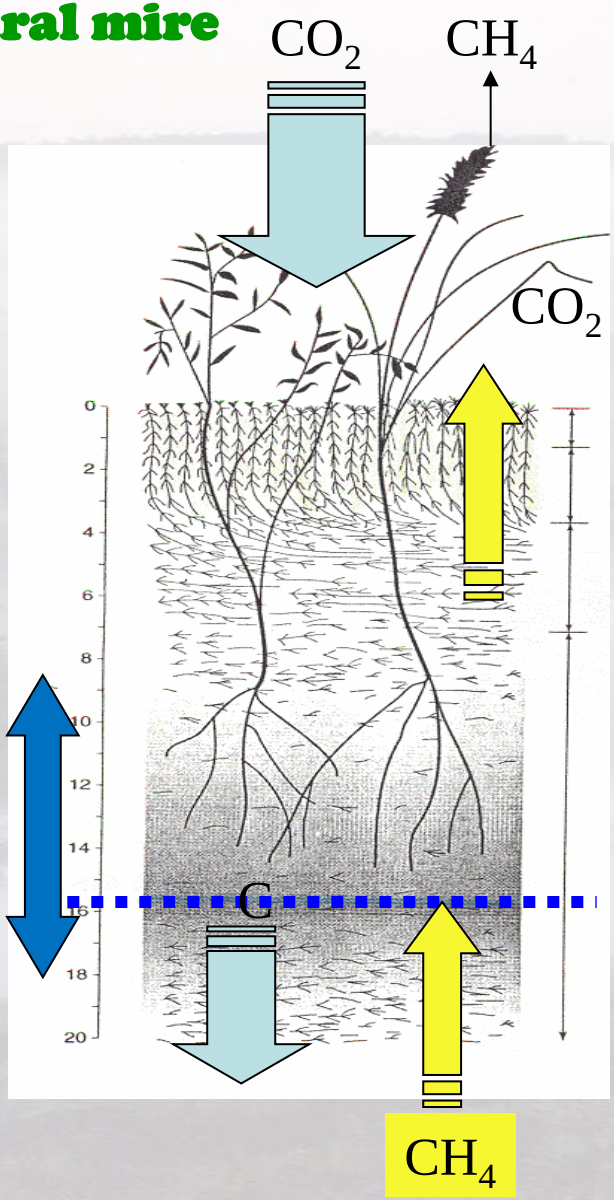
- Deep ongoing drainage
- Removal of all viabale seeds and diaspores with extraction of surficial peat layers
- Harsh environment on peat surface for germination: frost heaving, wind erosion, temporal floods, dryness in summer with surface temperature up to 50^{o} C.

Natural mire / Extracted peatland

- Valuable ecosystem with ecological services
- Clean water reservoir, stabilisation of Regional hydrological regime
- High diversity of habitats and species
- CO_2 fixation on photosynthesis, carbon accumulation as peat, release of free oxygen.

- Natural ecosystem is destroyed, splitting natural areas
- Natural water regime is destroyed, big water table fluctuation, outflow of peat dust etc.
- Essentially decreased biodiversity
- No photosynthesis and carbon accumulation, peat mineralisation and emission of greenhouse gases

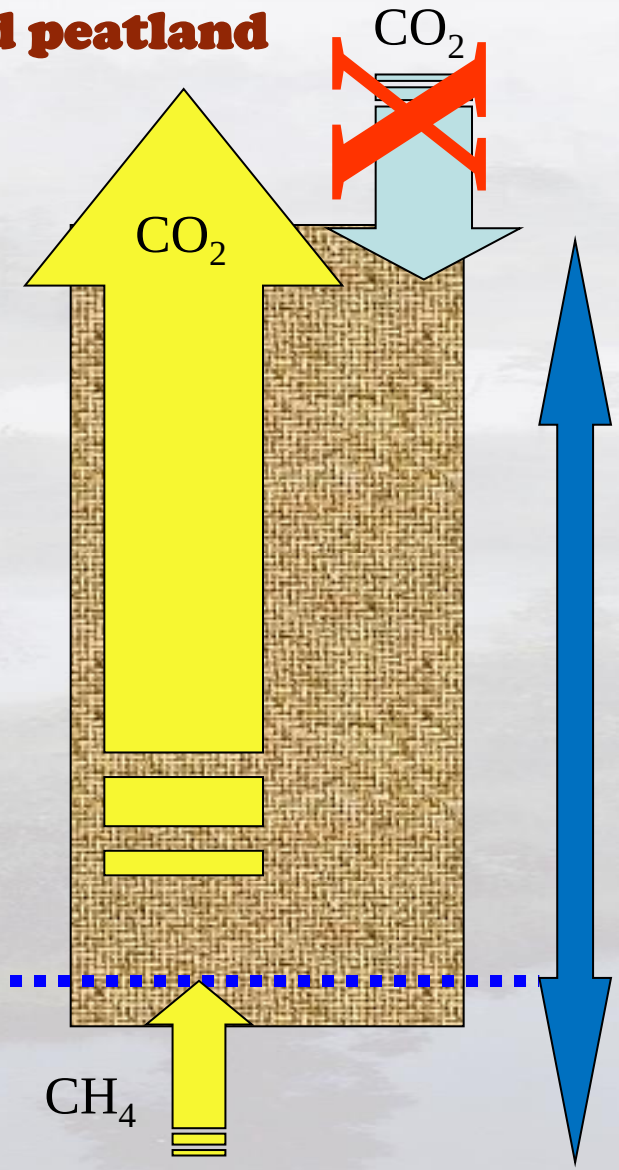
Natural mire



CO_2 fixation in photosynthesis, peat accumulation 1,1-1,8 t or *ca* 700 kg C ha^{-2} a^{-1}

Mineralisation of 5-10 t dry peat and emission of 3-5 t C (12-20 t CO_2) ha^{-2} yr^{-1}.

Extracted peatland



In Estonia **drained and extracted peatlands are second biggest CO_2 emitters** after oil-shale industry and exceeding pollution from traffic several times.

ca 100 abandoned extracted peatlands, in total ~ 9900 ha

ca 800 th vehicles

By restoring abandoned extracted peatlands we can reduce CO_2 emission exceeding the amount emitted by 60-100 thousand cars driwing 15 000 km.

In natural mires plant remains will stay partly undecomposed for thousands of years because of anaerobic and acidic conditions.
We have learned from it long time ago to conserve our food.

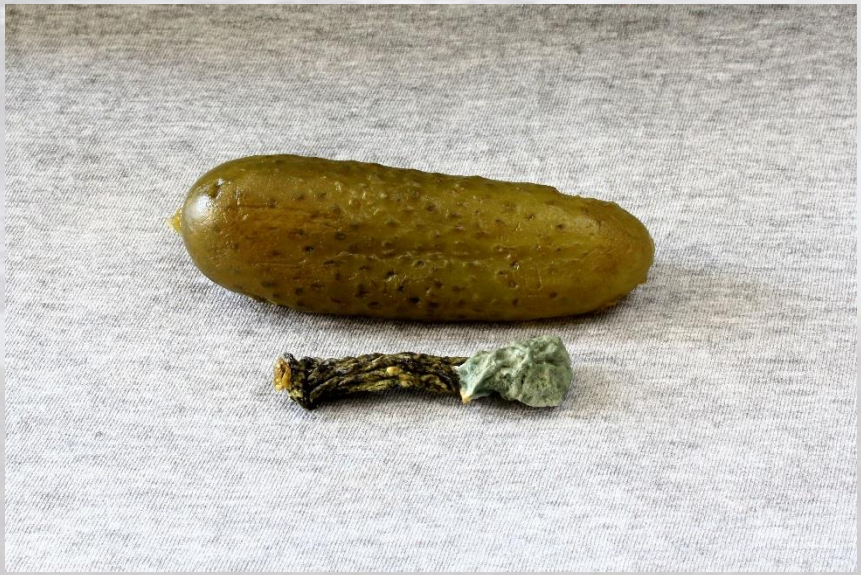
Pickled gherkin

When aerated, conserved food will go bad fast.

We know it, but why we can not learn from it and expand this knowledge to nature?

We can see negative changes in conserved food and do not accept it.

But why we do not see negative changes on much bigger scale which affect all of us?



How big is the negative effect of drained peatlands?

In Germany agricultural lands on drained peatlands emit over two times more CO_2 than the most polluting coal burning power plant.

In 2015 drained peatlands fires in Indonesia emitted *ca* 16 milj. t of CO_2 per day.
This is almost equal with entire industry of United States in the same time.

Drained peatlands cover ~ 0,3 % of Earth land surface but they emit ~ 5,6 % from all man-made CO_2 emissions.

We have to restore our drained and extracted peatlands

Berry plantation in Sapi-Lulli extracted peatland.

Afforestation of extacted peatlands.

Restoration of extracted peatland should start from the aim and direction of the restoration.

Different restoration aims have different effect on the reducing of extracted peatlands negatiive effect.

Restoration aim	Habitats fragmentation	Biodiversity	Hydrology	C budget	Fire risk
Afforestation	+	+			
Agriculture	–	–	–		
Berry plantat.	+	+			
Waterbody			+		+
Mire initiation	+	+	+	+	+

Ecosystems value

Ecosystem services are the many and varied benefits that humans freely gain from the natural environment and from properly-functioning ecosystems.

Ecosystem services are grouped into four broad categories:

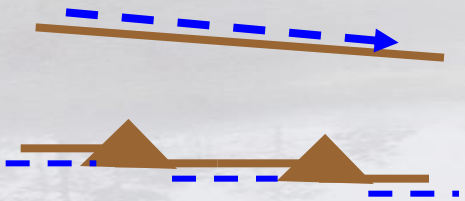
- ***provisioning*** – such as the production of food and water;
- ***regulating*** – the control of climate and disease;
- ***supporting*** – nutrient cycling and oxygen production; and
- ***cultural*** – spiritual and recreational benefits.

Based on the estimated cost of 17 ecological services (gas, water and climate regulation, water and food supply, erosioon control, nutrients cycling, biodiversity etc.) ecosystems are ranked:

- **River estuaries 22 832 $ ha a^{-1}**
- **Peatlands 19 580 $ ha a^{-1}**
- Tropical forest 2007 $ ha^{-2} yr^{-1}
- Boreal forest 302 $ ha^{-2} yr^{-1}
- Agricultural land 92 $ ha^{-2} yr^{-1})

Main stages of extracted peatland restoration toward mire initiation (following the Moss Layer Transfer Teqhnique)

1. **Surface preparation, peeling surficial oxidized peat layer, surface flattening**



2. Collecting plant fragments from dronor site

3. Spreading plant fragments and their covering with straw mulch. Blocking drainage ditches.

4. Restored extracted peatland in Canada

Abandoned extracted Tässi peatland *ca* 25 years after abandoment before the restoration in April 2012.

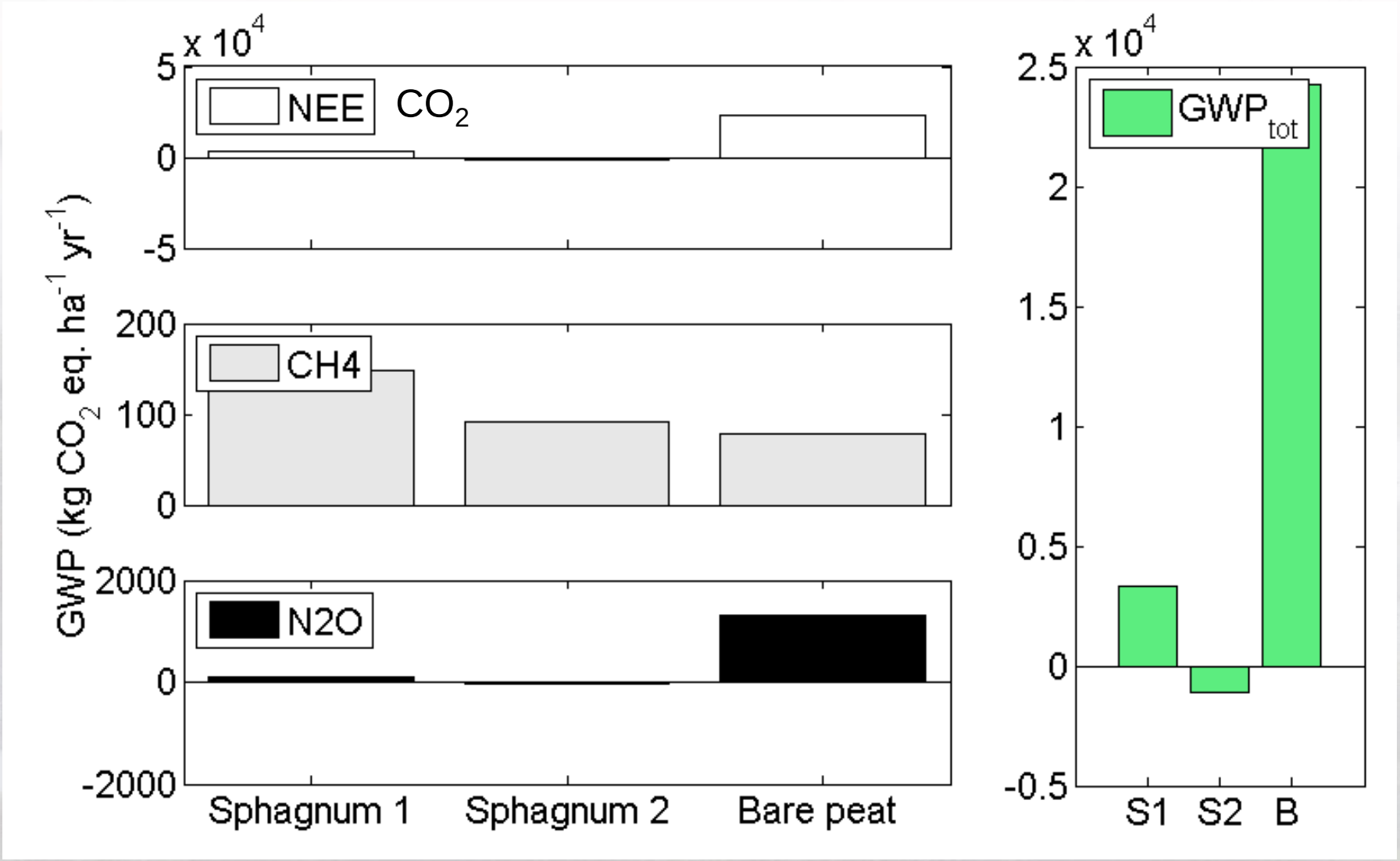
Cutting and collecting of *Sphagnum* fragments from the donor site

Spreading *Sphagnum* fragments and covering with straw mulch on restoration site

After the end of active restoration works in the beginning of May 2012

Before in April 2012.

... and on 4th summer after the restoration.



From the restored area flux of N_2O (298 x CO_2) is decreased by 1-2 orders of magnitude and CO_2 flux by the half as compared to not restored area (bare peat). Wetter restored area S 2 acts already as carbon sink, in GWP restoration effect is very big.

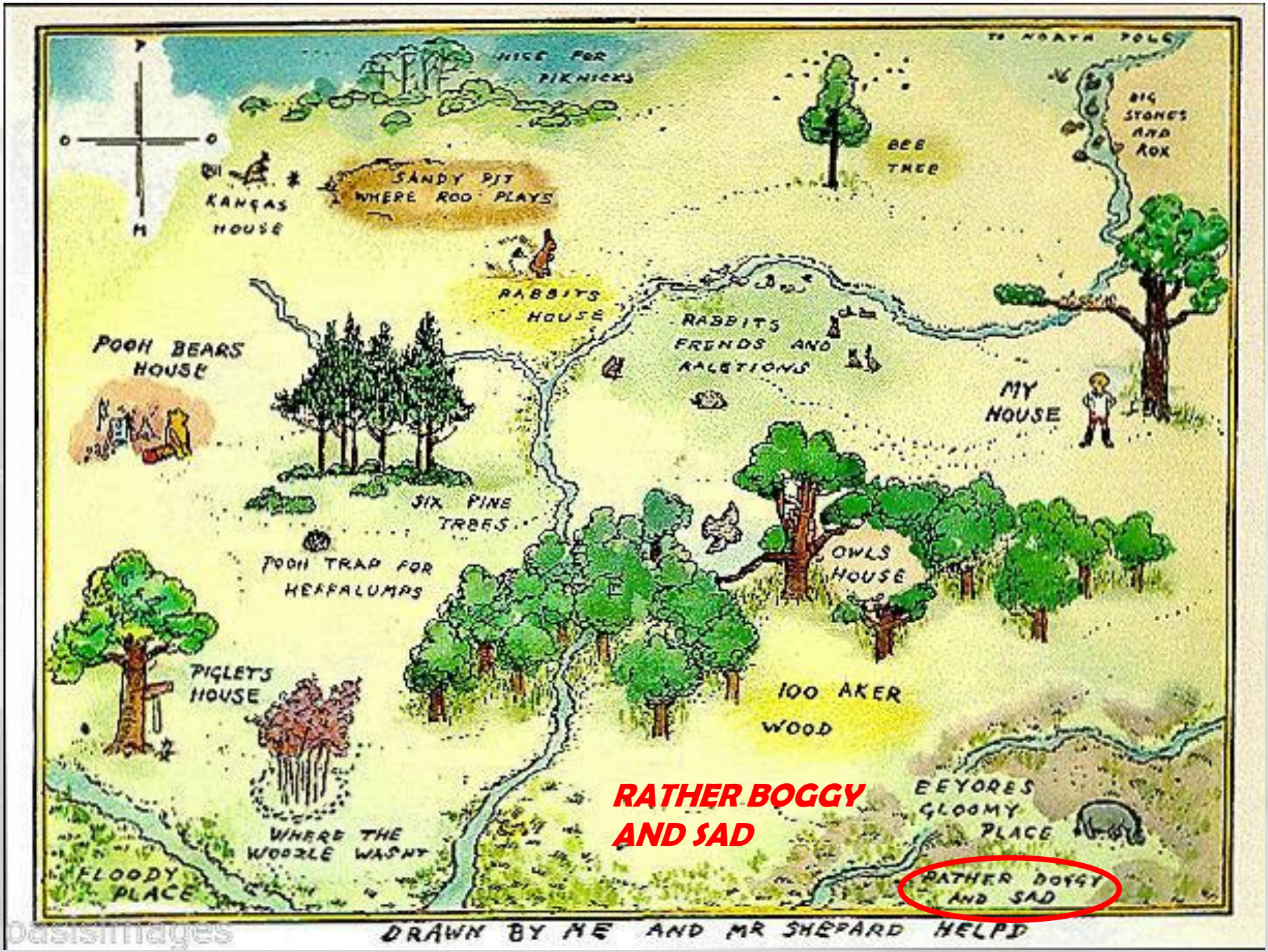
Restoration of extracted peatlands in Estonia will accelerate in 2014-2020, since EU have allocated support 10,9 milj EUR to reduce the mineralization of residual peat and to create near-natural self-regulating ecosystems **by restoring at least 2000 ha of extracted peatlands.**

The priority is given for extracted peatlands bordering with protected areas and where extraction of residual peat layer is not reasonable.

The recommendations for the restoration method depending from the current state of extracted peatlands and principles for monitoring have been worked out.

The preliminary selection of sites for restoration (~30) and detail plans for 5 sites are compleated and restoration will start in 2019.

We are going to see **Kallissaare** peat extraction area, ~ 80 ha


NICE FOR PIKNICKS
TO NORTH POLE
BIG STONES AND ROX
BEE TREE
SANDY PIT WHERE ROO PLAYS
KANGAS HOUSE
RABBITS HOUSE
RABBITS FRENDS AND RALETIONS
POOH BEARS HOUSE
MY HOUSE
SIX PINE TREES
POOH TRAP FOR HEFFALUMPS
OWLS HOUSE
PIGLETS HOUSE
100 AKER WOOD
RATHER BOGGY AND SAD
EEYORES GLOOMY PLACE
WHERE THE WOOZLE WASNT
FLOODY PLACE
RATHER BOGGY AND SAD
DRAWN BY ME AND MR SHEPARD HELPD

RATHER BOGGY AND COOL!

Thank you!