

Forest and permanent excess of water – peatland forestry



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METLA

Ben Gurion's grave
Sdeh Boker, Negev



Patvinsuo, North Carelia



Too little or too much water – Management and culture



- Management realizes cultural values
- Management is a humanistic question
 - What is considered valuable?
 - What is considered undesirable?
 - Only after the values comes the techniques, ecology and economy
- Cultural meanings change slowly
 - History, need to understand the generations before

Peatlands: remote, marginal, inferior, wasteland

- Anomaly: neither land nor water
– meanings: unholy land...
- Turning peatland from wasteland to productive:
 - Suo, kuokka ja Jussi
- Attitude changes in time and distance from peatland
 - From work and utility towards aesthetics and nostalgia
 - Saving the world from climate change...



What is a peatland?

- Ground vegetation dominated by mire species
- Peat layer > 30 cm thick



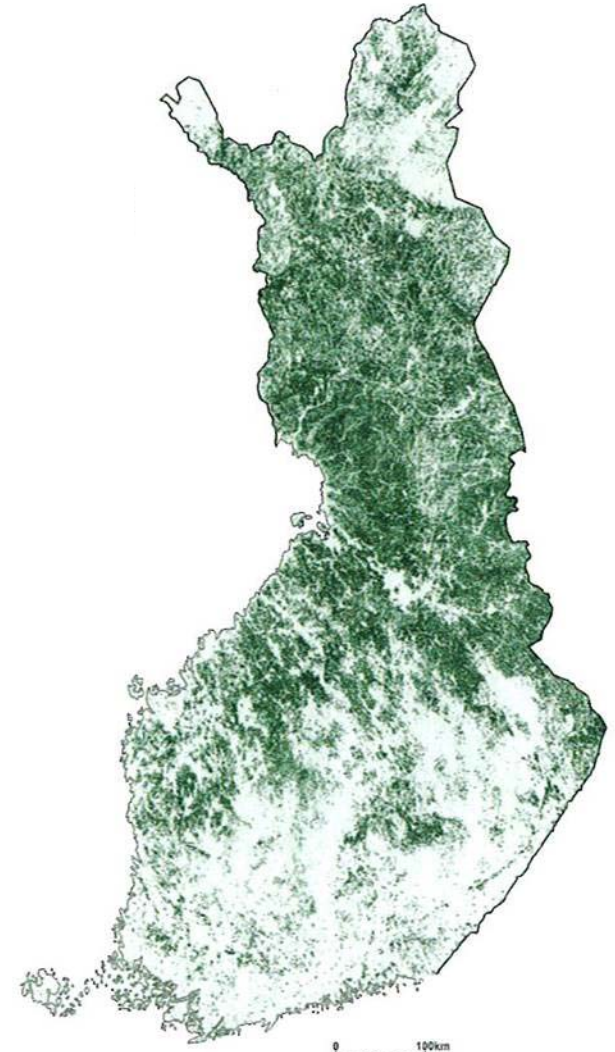
Forest and peatlands in Finland

Forest map



EFI

Peatland map

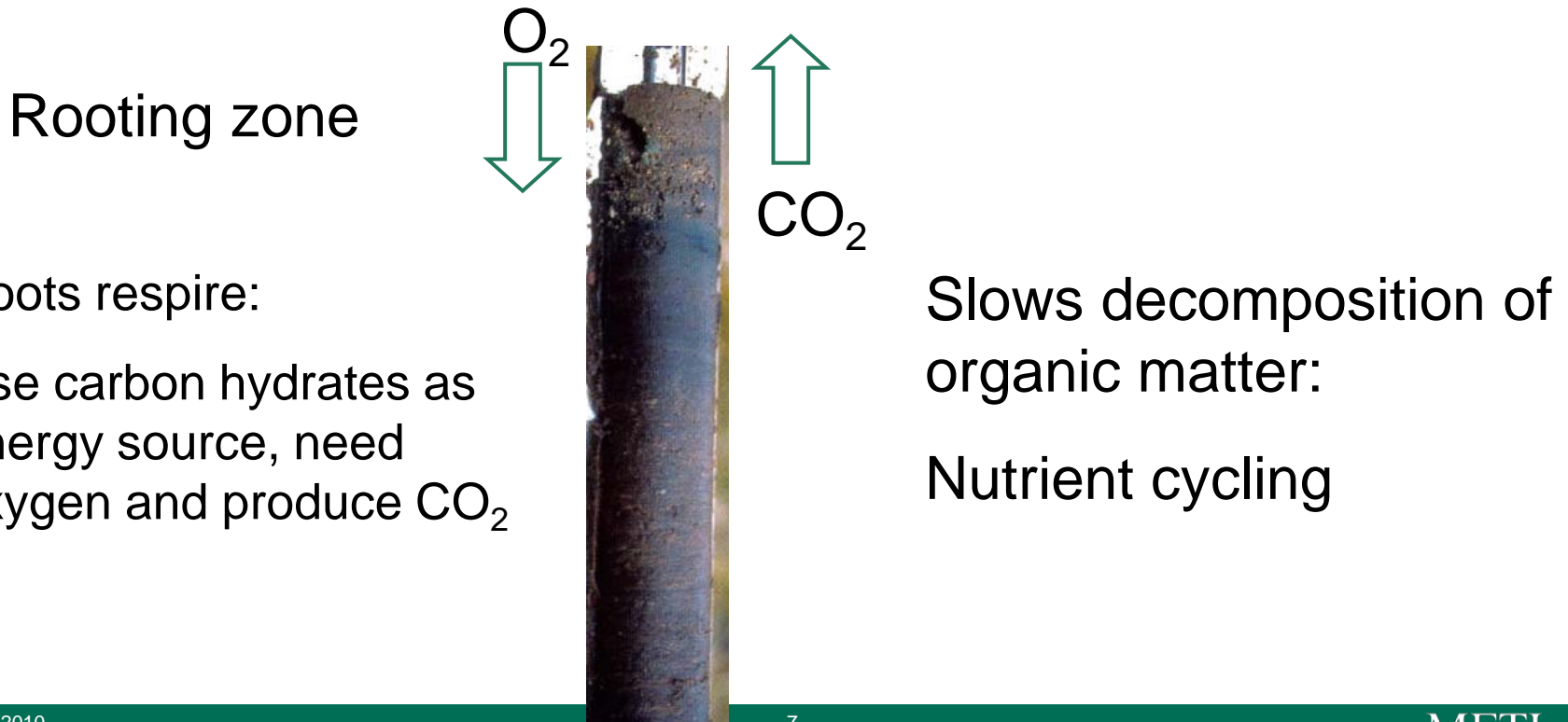


GSF

Distribution of mires in Finland.

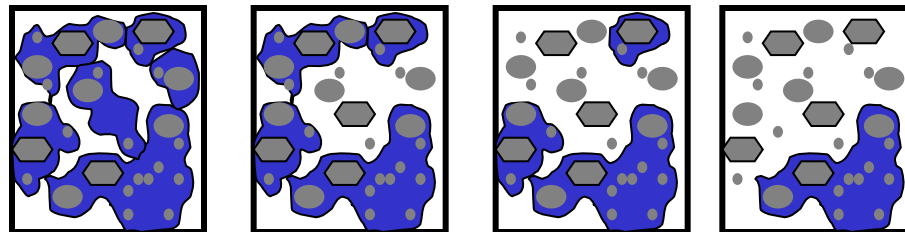
What makes peatlands inferior?

- Low productivity in agriculture and forestry
 - Peat chemical properties and excess water
 - Excess water restricts gas exchange



Gas exchange in soil

- Diffusion: concentration gradients
 - Diffusion is the most important mechanism
 - O₂ diffusion in air is 10 000 faster than in water
 - Connection of air-filled pores from root zone to the surface
 - Air filled porosity >10%
 - Water and air relations in soil: Water retention characteristics
- Mass flux: pressure gradients

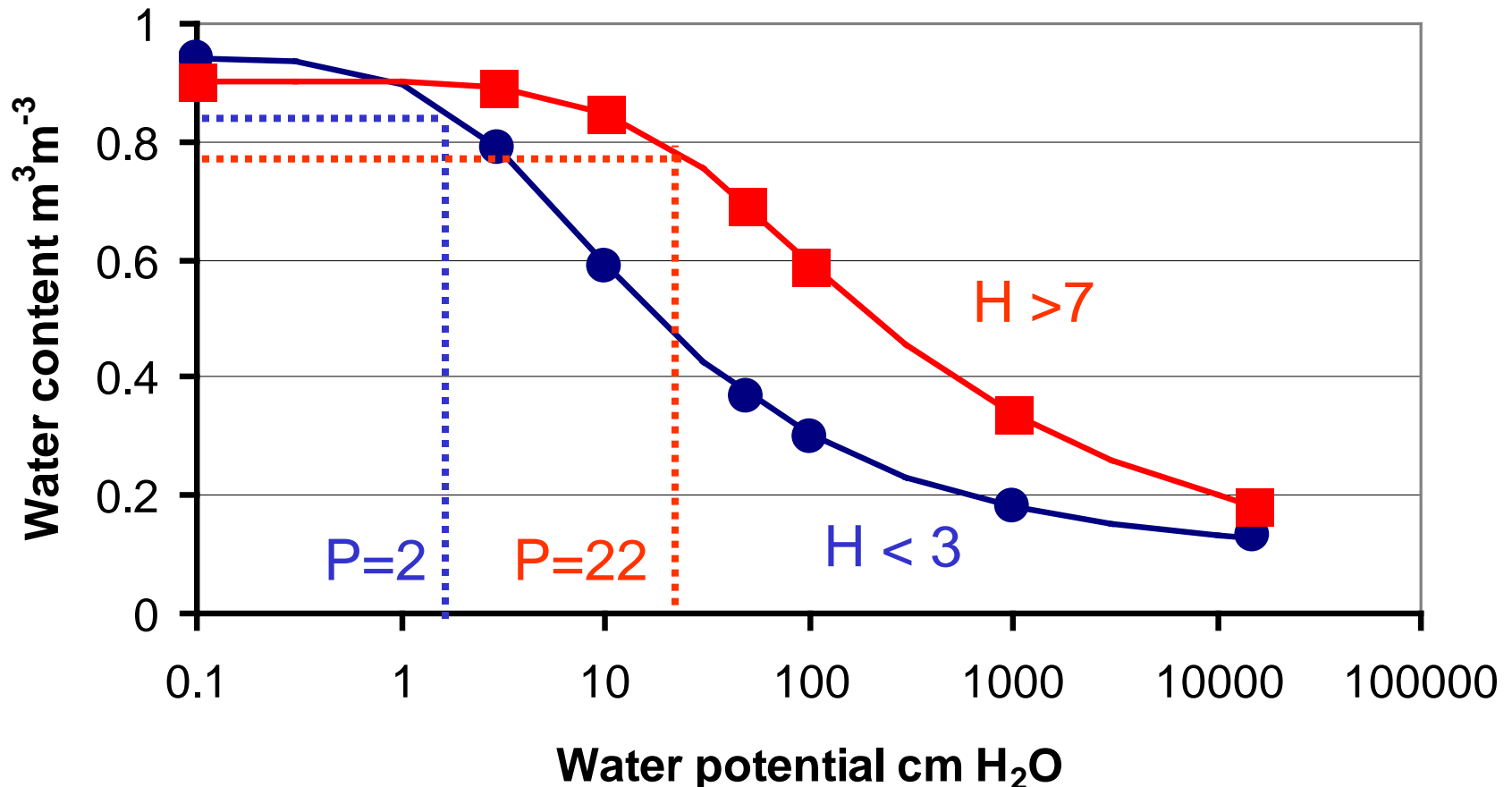


Peat profile and physical properties

- Consists of plant residues in different stages of decomposition
- Degree of decomposition in the top of the profile is low, $H < 3$
- Degree of decomposition in the bottom of the profile, $H > 7$
- Depth of the peatlayer can vary from 0.3 m to 10 m.



Water retention characteristics, hydraulic conductivity

- Air-filled porosity of 10 % is reached
 - At potential 2 cm H₂O in low humified peat, K 124 cm/s
 - At potential 20 cm H₂O in high humified peat, K 0.08 cm/s



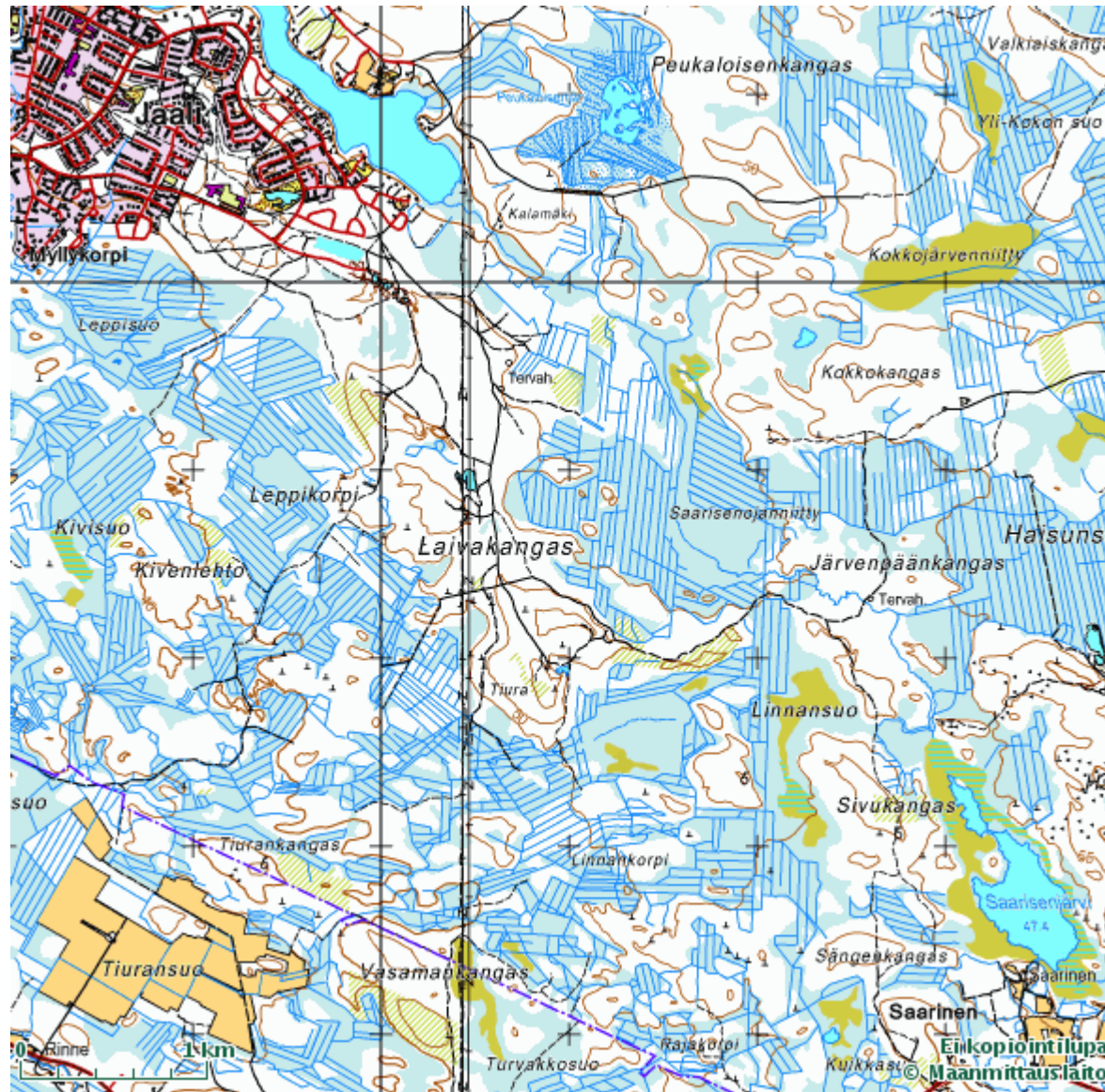
Implications of the hydraulic properties

- Assume: depth of the profile 160 cm, homogeneous throughout

	$H < 3$	$H > 7$
		
Water content in prof	1412 mm	1441 mm
Air filled pore space	60 mm	13 mm
Air filled porosity in root zone	34 %	8 %
10 mm rain raises GWT	2 cm	10 cm

Ditch drainage

- Technique
 - 30-60 m spacing
 - 50-100 cm depth
 - Spade, plough, excavator
 - Maintenance required
- Sites:
 - Forested medium fertility sites



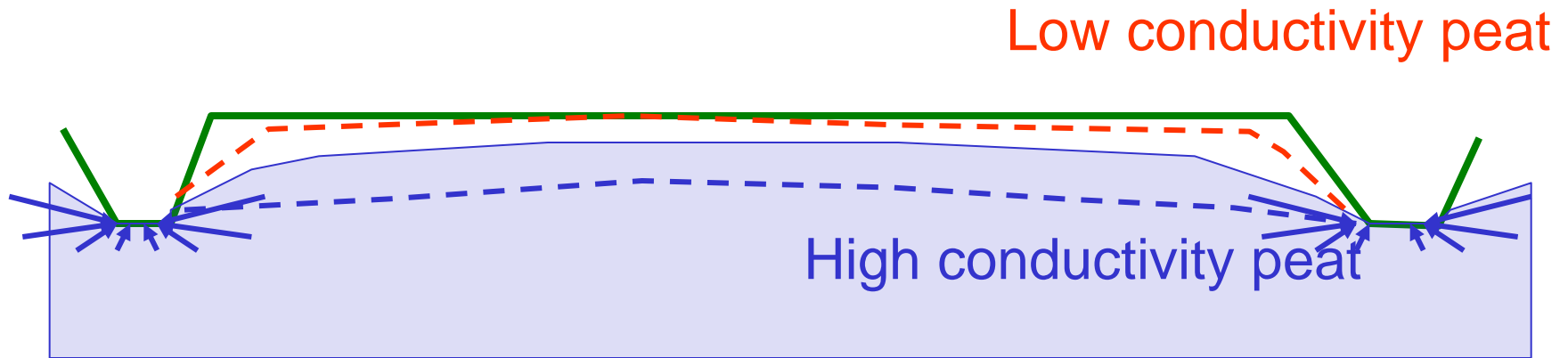
Machinery



Photos: Juhani Päivänen

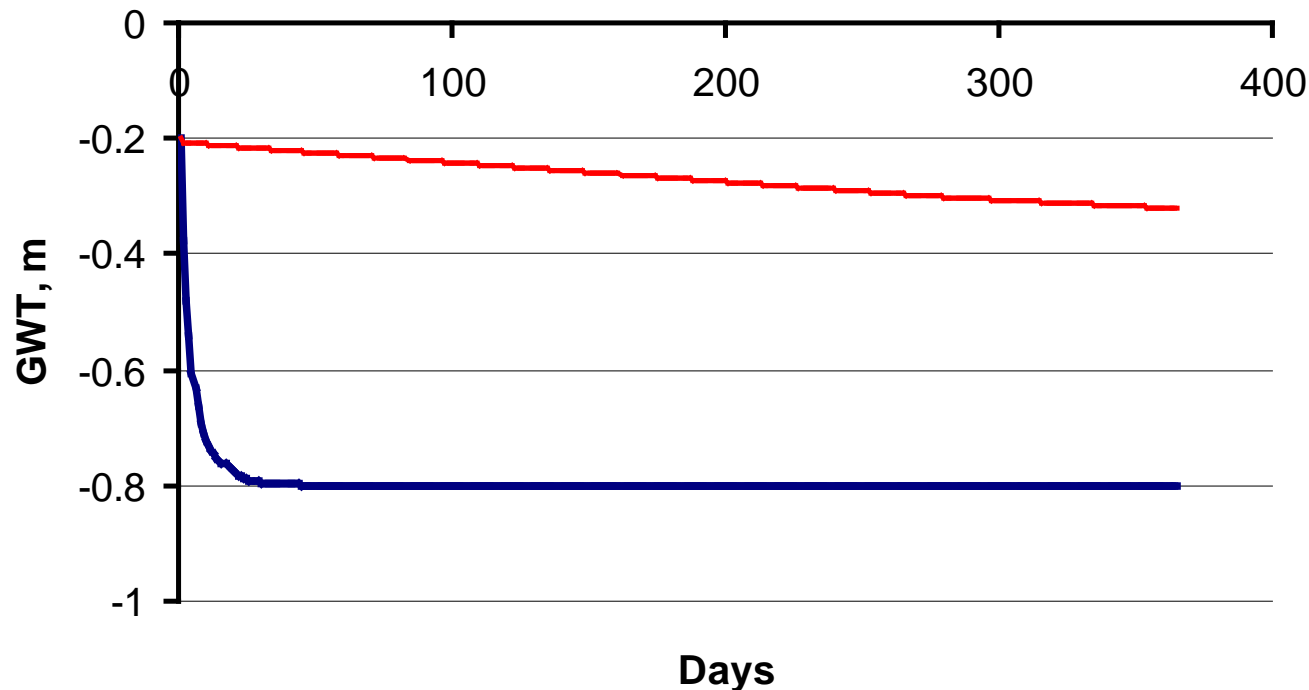
Drain flow

- Ground water table higher between the ditches
- Curvature of the GWT between the ditches depends on hydraulic conductivity



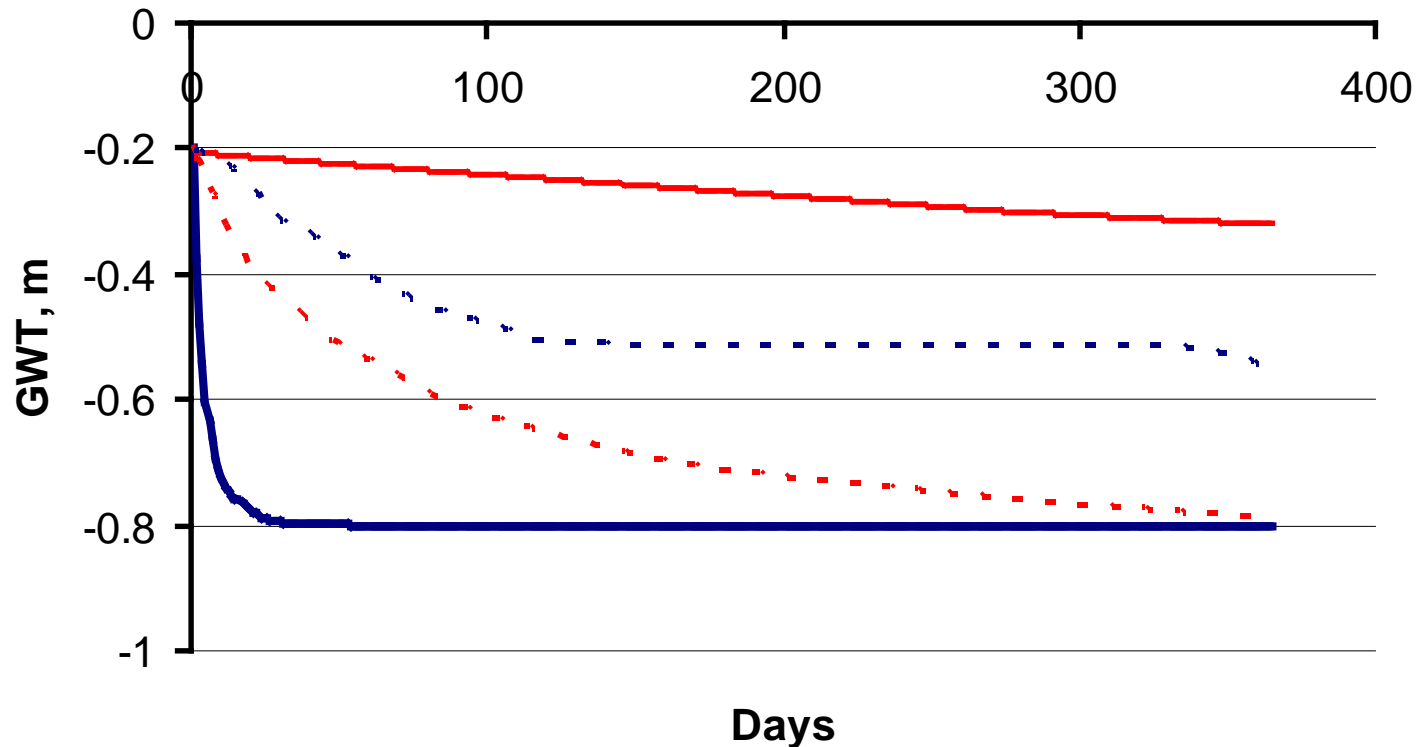
Comparison of the two peats: assuming homogeneous profile

- Drain flow (drain depth 80 cm, 40 m ditch spacing) no evaporation, no percolation, no precipitation, initial GWT at 20 cm
 - $H < 3$: in 10 days, GWT at 72 cm
 - $H > 7$: in one year, GWT at 32 cm



Comparison of the two peats: assuming homogeneous profile

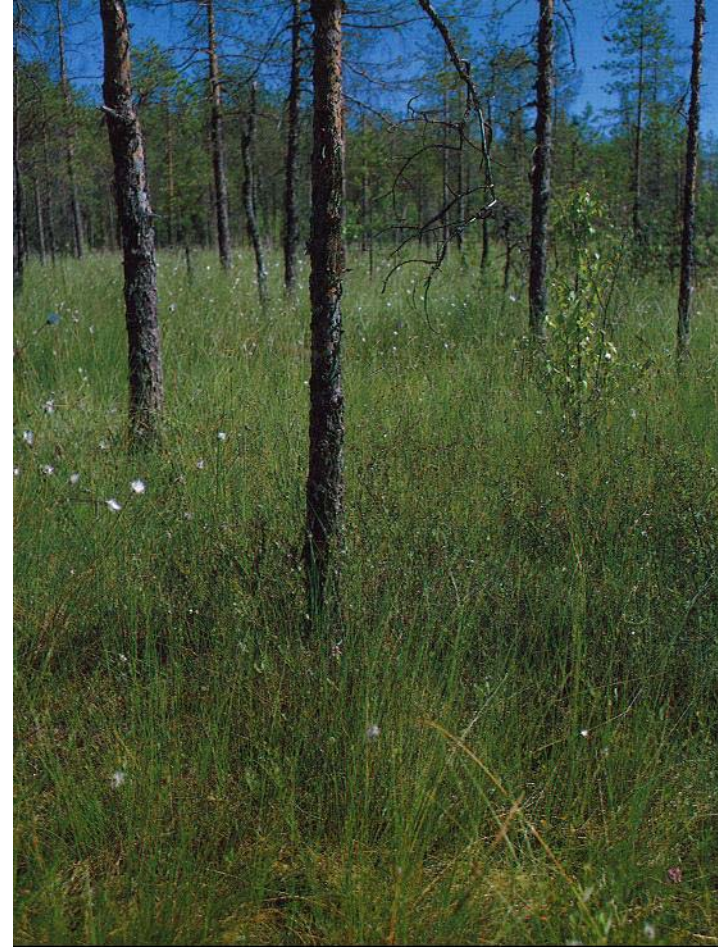
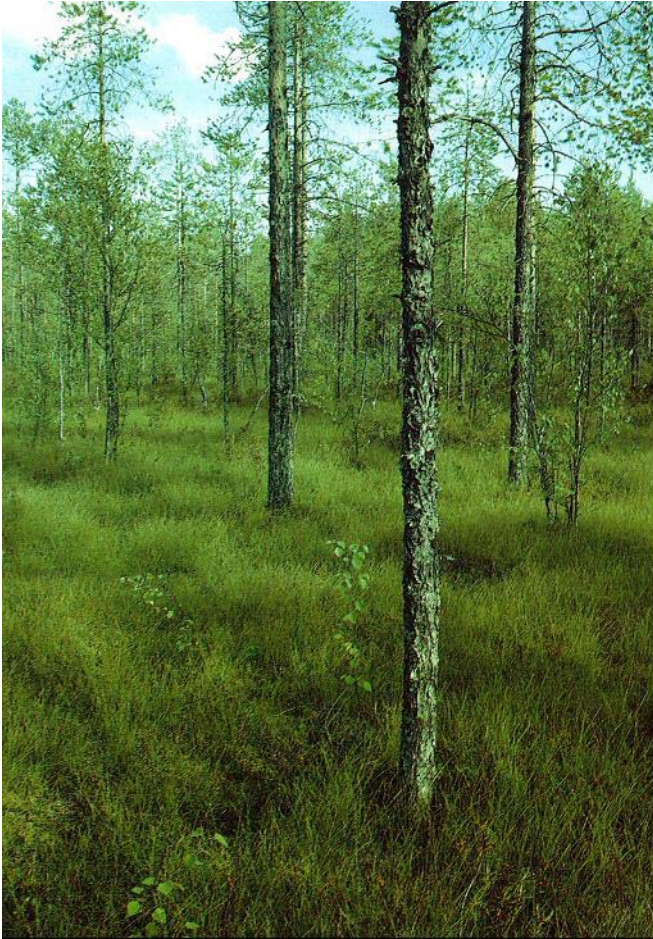
- Transpiration flow (no drain flow, no percolation, no precipitation, initial GWT at 20 cm
 - $H < 3$: in 100 days, GWT at 50 cm, Δ Water storage 152 mm
 - $H > 7$: in 100 days, GWT at 63 cm, Δ Water storage 150 mm



Implications of the peat hydraulic properties

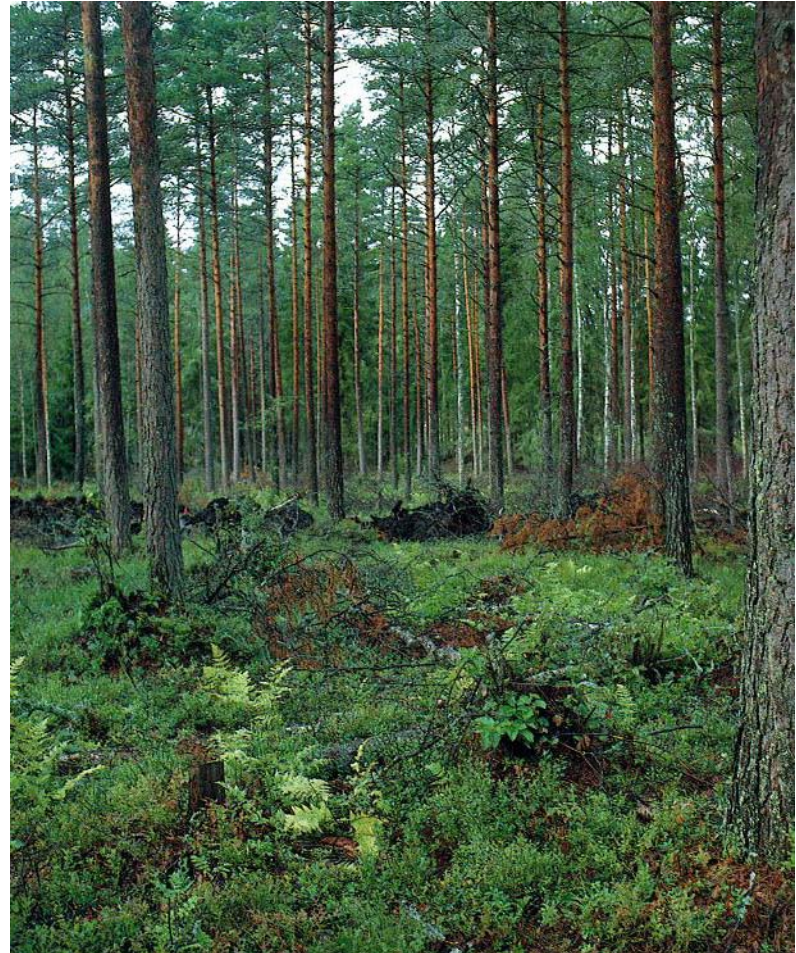
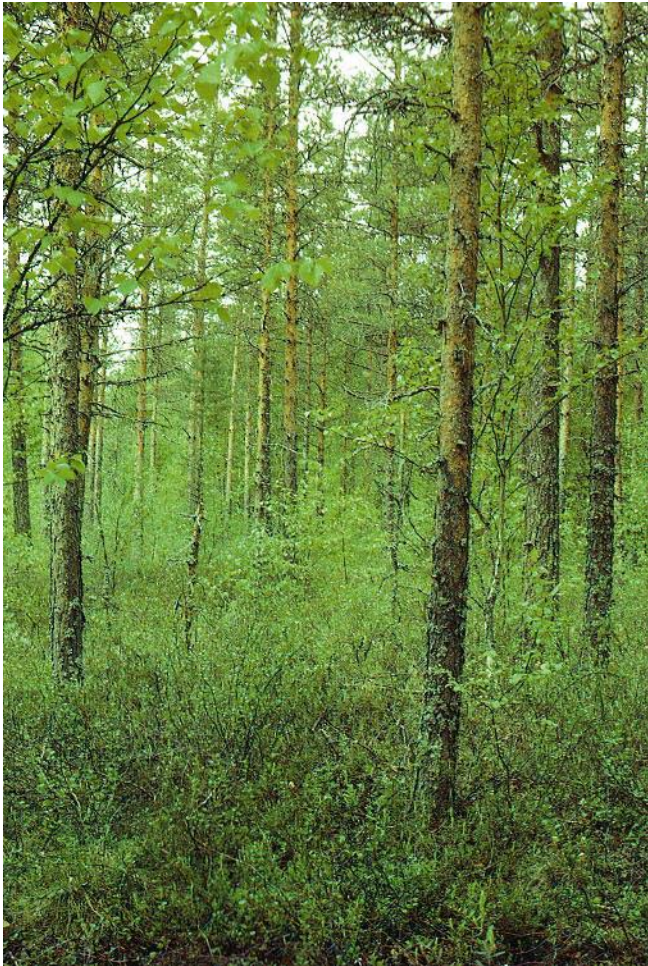
- Depth of the border between the conductive and low-conductive layers is important in drainage
- Evapotranspiration can drain the low-conductive layers too
 - Role of the tree stand and vegetation increases with increasing stand volume
 - Water table level at the end of summer correlates with growth
- Areas close to the ditches grow better than the areas farther away

Before ditching, examples



Photos: Laine & Vasander 1990, Suotyypit

After ditching, changing character



Photos: Laine & Vasander 1990, Suotyypit

Statistics about forest drainage

- About half of the peatland area (10 000 000 ha) in Finland is ditched
- One fourth of managed forests in Finland are located on peatlands
- Length of ditches 1 300 000 km
 - Rivers 53 000 km
 - Lake shoreline 215 000 km
 - Sea shoreline 6 000 km

Forest drainage as a national project

- Annual drainage areas 1950-1995

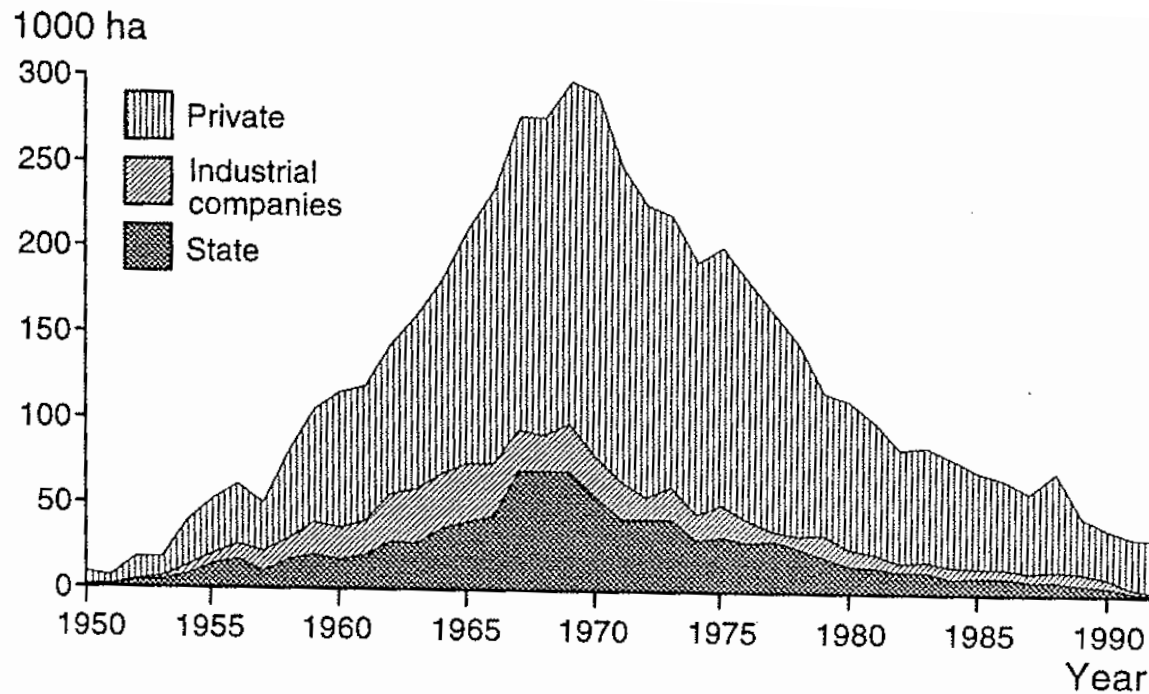


Fig. 4.6. Forest drainage in 1950-1993 by forest owner groups in Finland. (Data from Aarne 1993)

Has the drainage been succesful?

- With respect to the original target, increasing wood production:
 - Nationally yes, very: The current annual forest growth in Finland is 100 millions m³, 25 millions m³ are at drained peatlands, annual benefit ca 10 millions m³
 - Most of the ditched peatlands are privately owned by individual citizens, the income is distributed
 - Locally:
 - Not everywhere: 1/3 of the ditched area have been unsuccessful in increasing forest production

Has the drainage been successful?

- Environmentally:
 - No, but ditching is not a nature conservation method
 - Increases sediment transport to water courses
 - Increases export of dissolved N and P
 - The scale of the ditching operation is problematic
- Globally:
 - Perhaps no: pristine peatlands that are sinks for GHG, may turn to source of GHG

Scale of the ditching operations

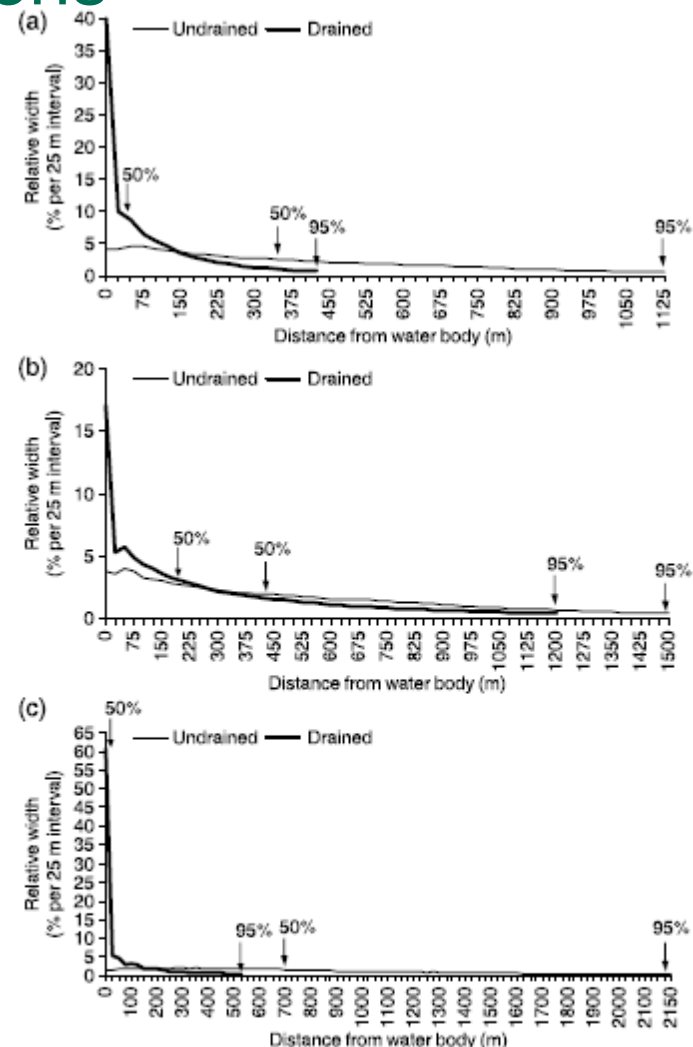
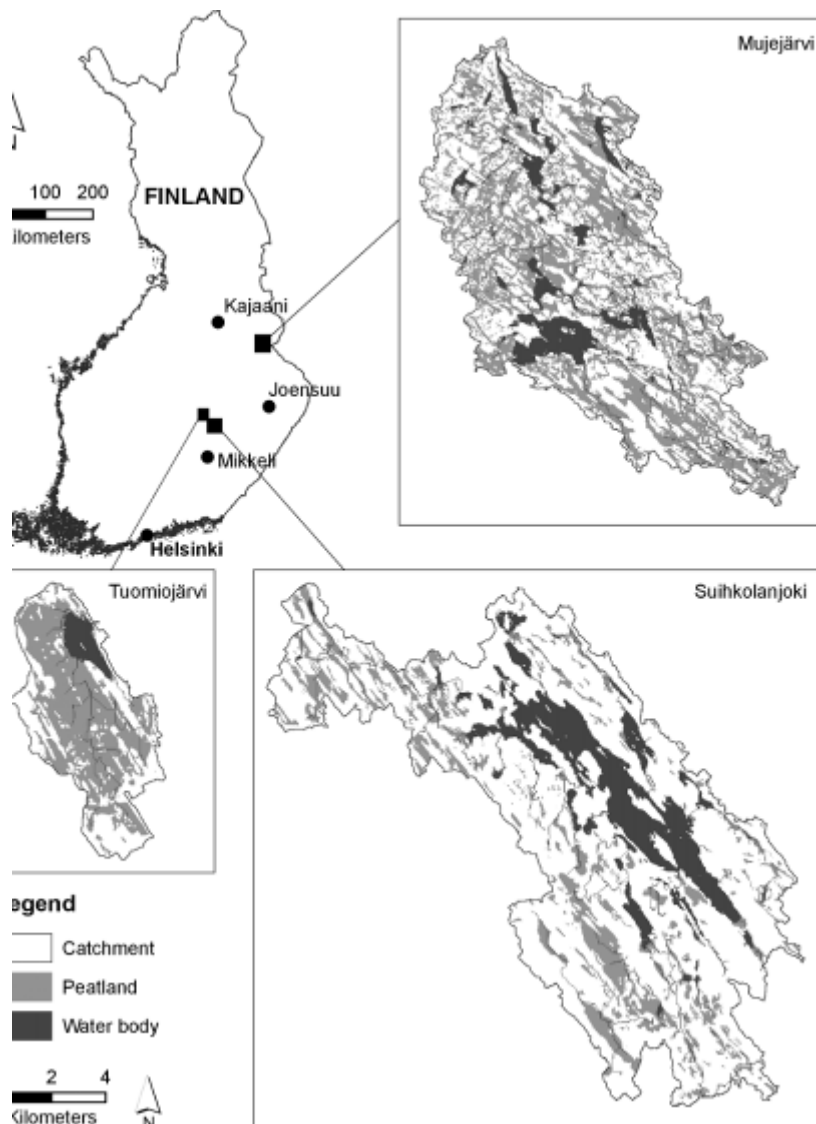
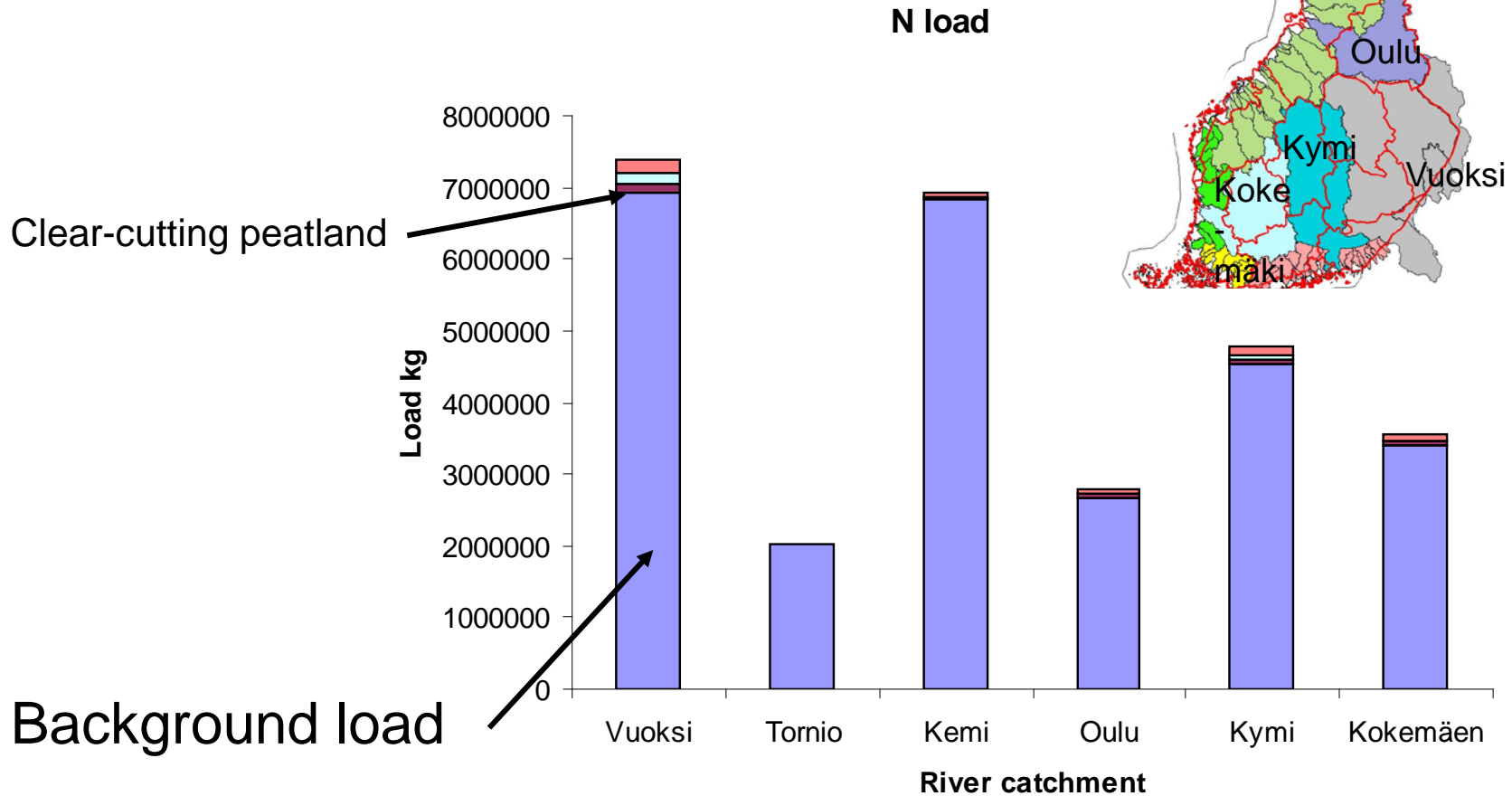


Figure 4 | Relative widths of the profiles at (a) Mujejärvi, (b) Suihkolanjoki and (c) Tuomiojärvi catchments in undrained and drained schemas. Width distribution refers to percentage of total catchment area and is shown as a function of distance along the typical water flow path in 25 m distance intervals. Numbers show proportions (50% and 95%) of the catchment area located closer to a water body than the distance at the arrow tip.

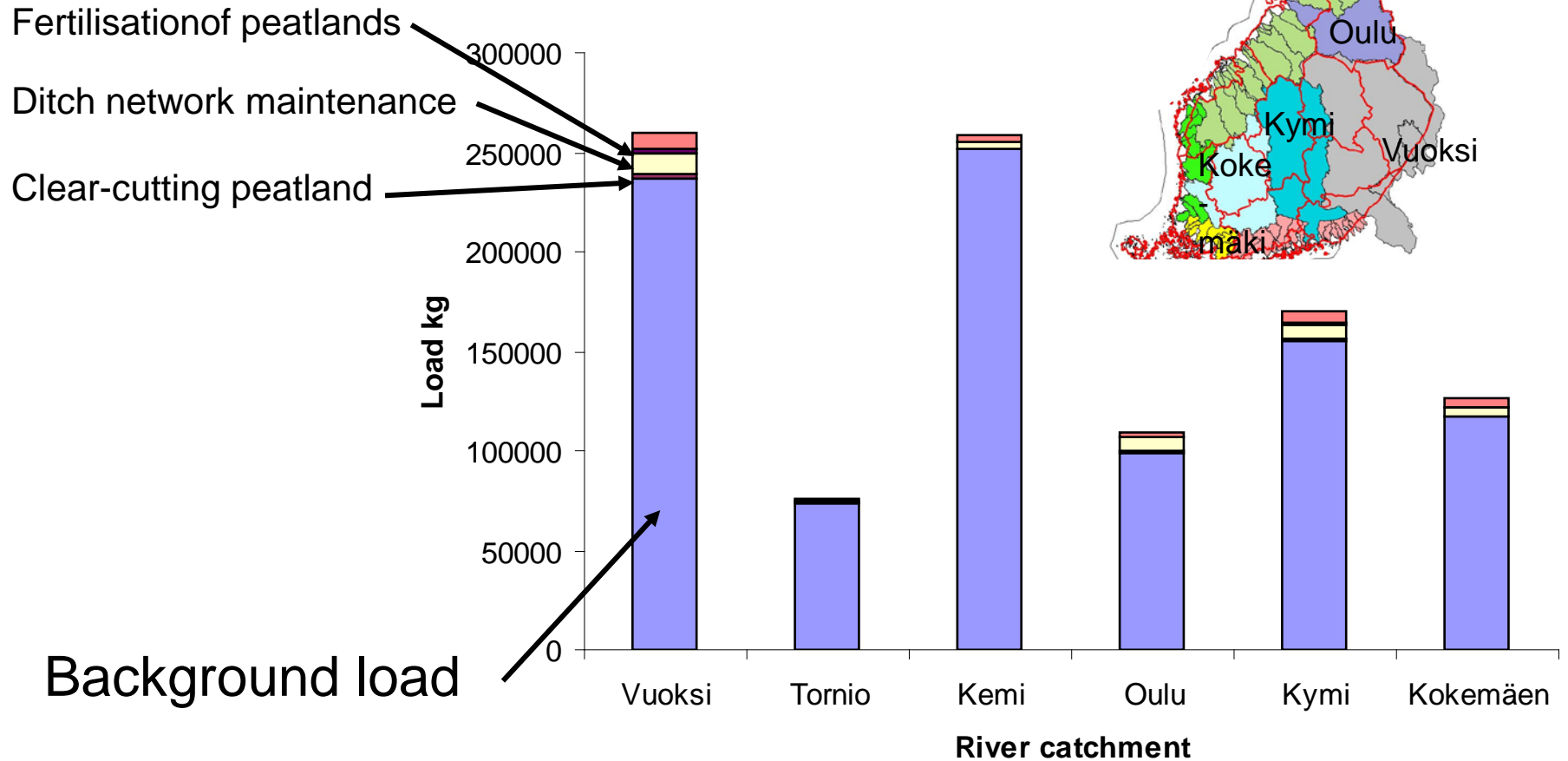
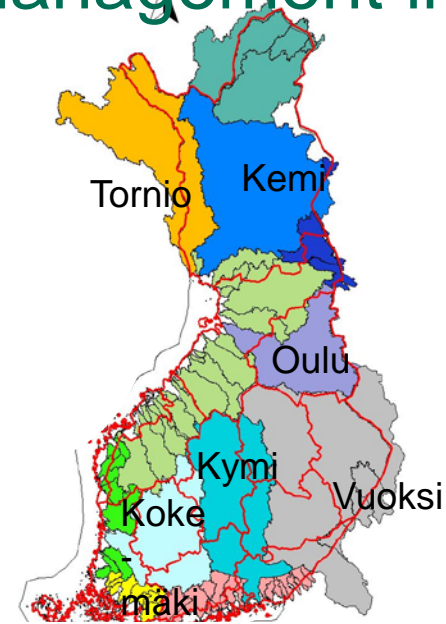
Annual load caused by forest management in national scale

■ N



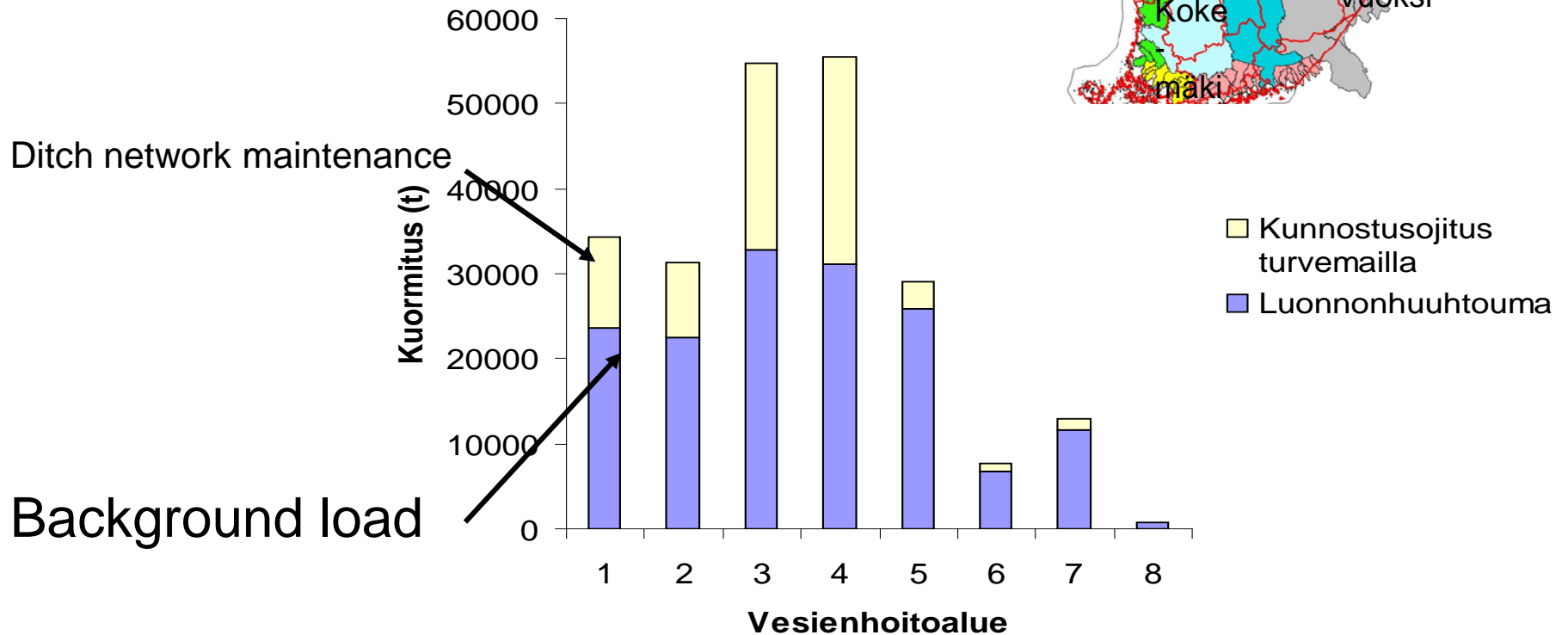
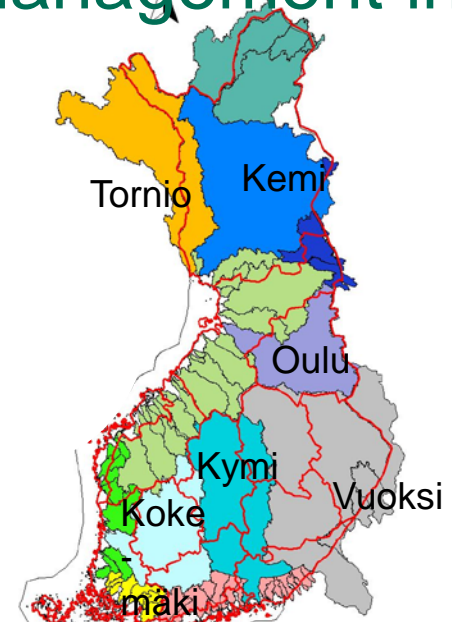
Annual load caused by forest management in national scale

■ P



Annual load caused by forest management in national scale

- Suspended solids



Conclusion

- Peatlands compose a big natural resource
 - Forest production, peat mining, bioenergy
- Removing excess water with drainage is a prerequisite for the production
- Not all sites are suitable for drainage:
 - Physical and chemical constrains
- Peatlands are situated between land and water
 - Impacts on hydrology including water quality