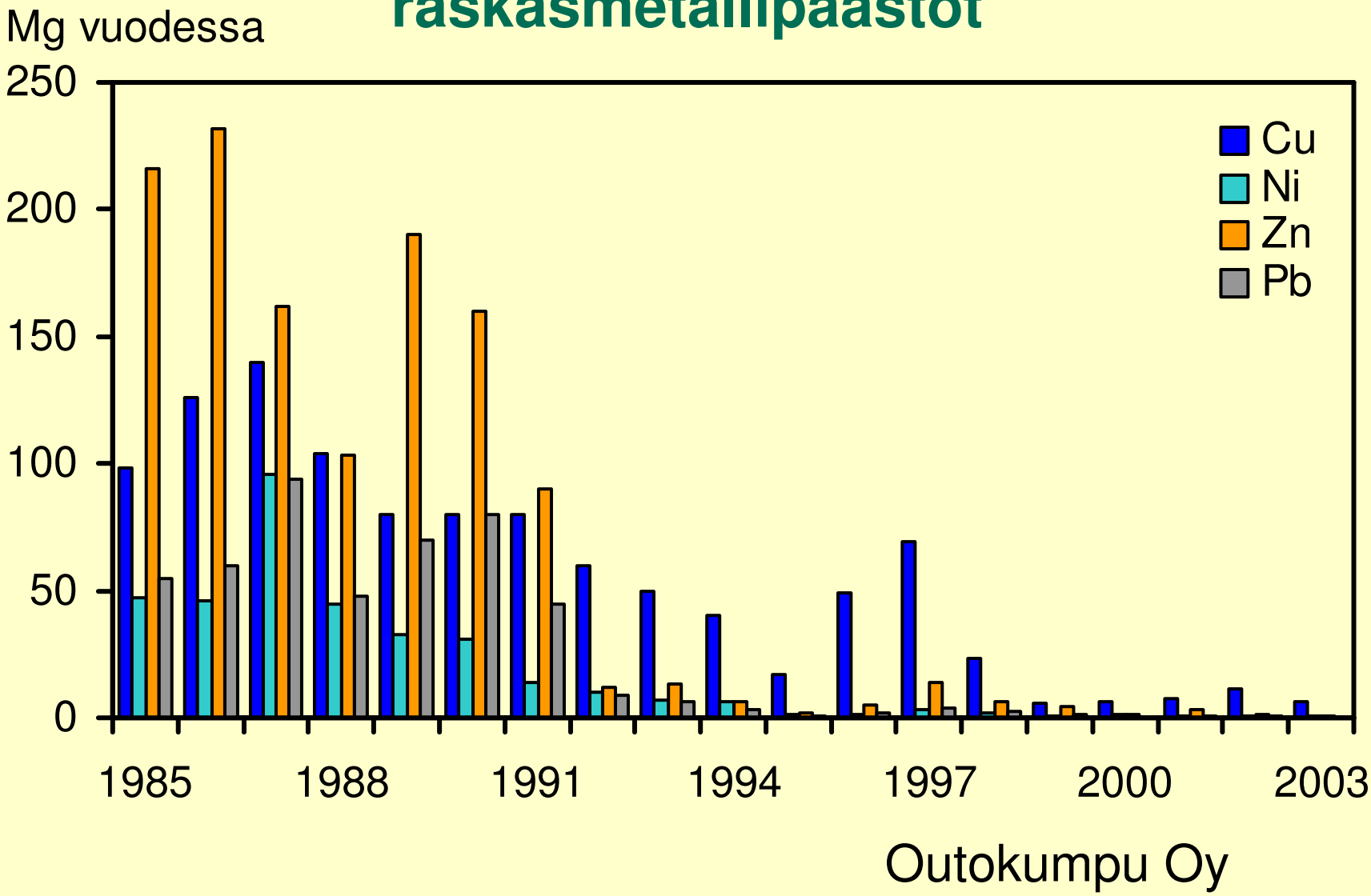
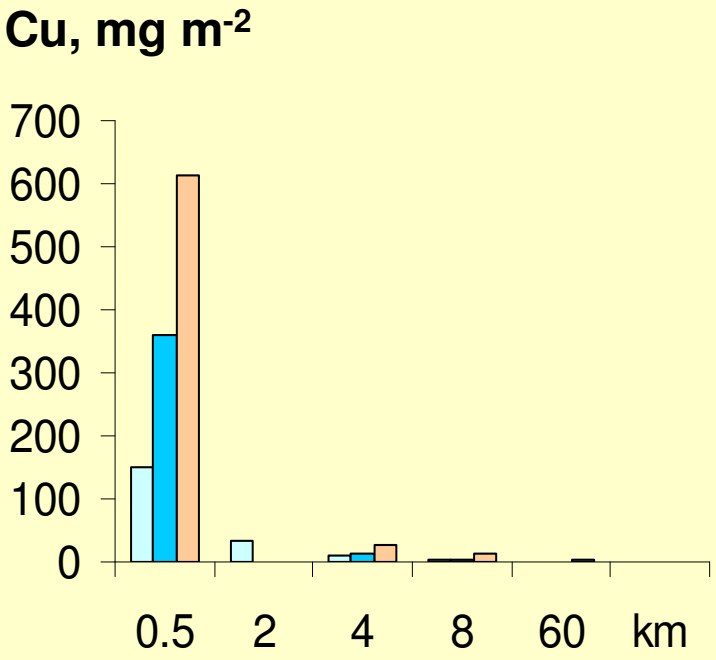
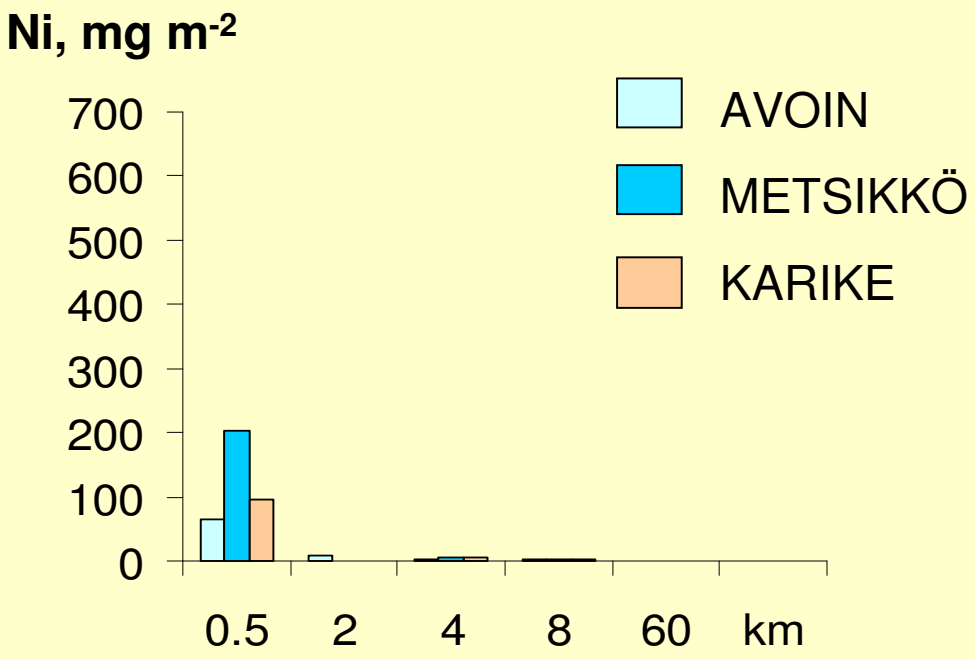
Harjavallan sulaton raskasmetallipäästöt



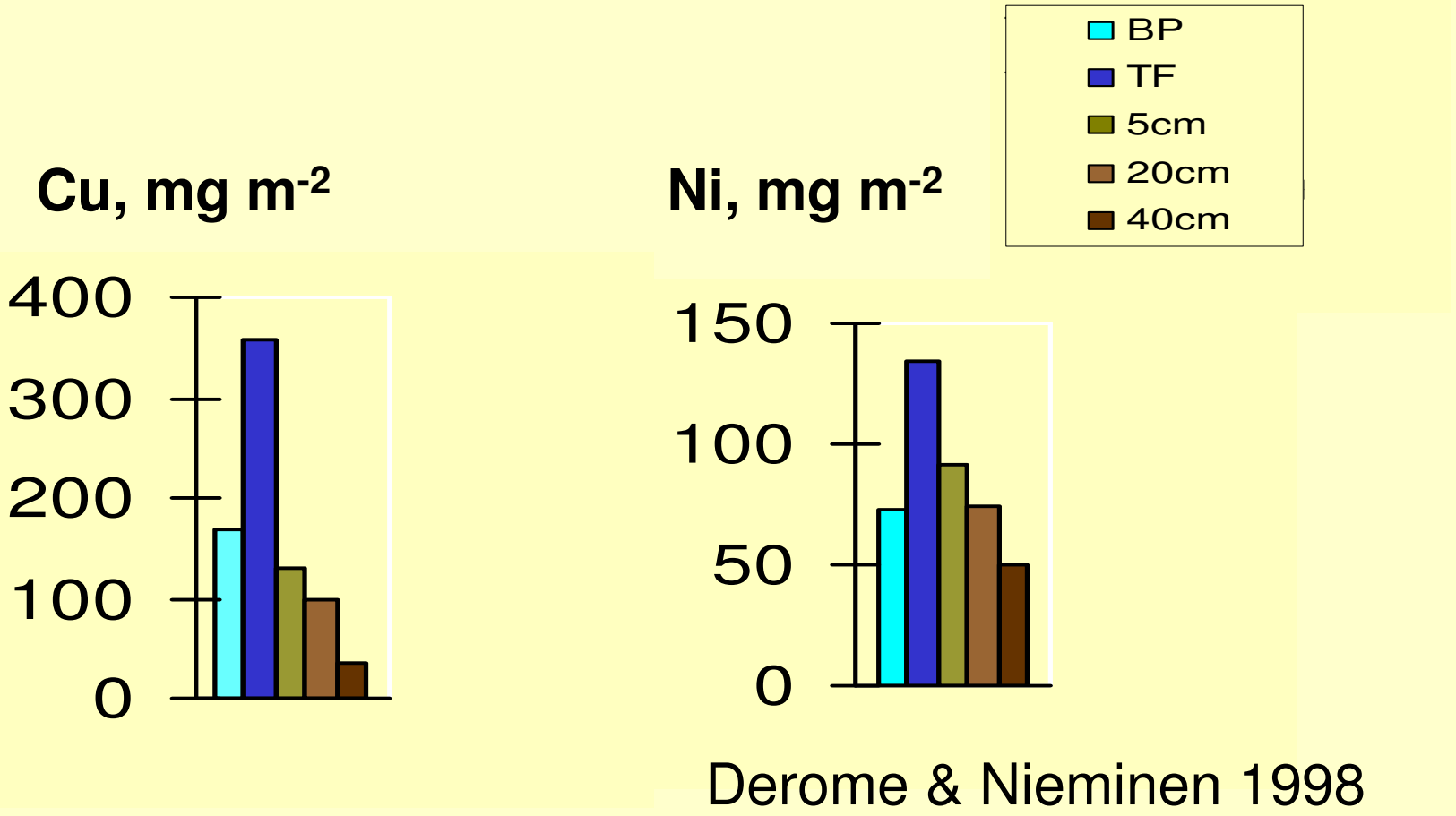
Keskimääräinen vuosilaskeuma Harjavallan tutkimusgradientilla vuosina 1992-1998





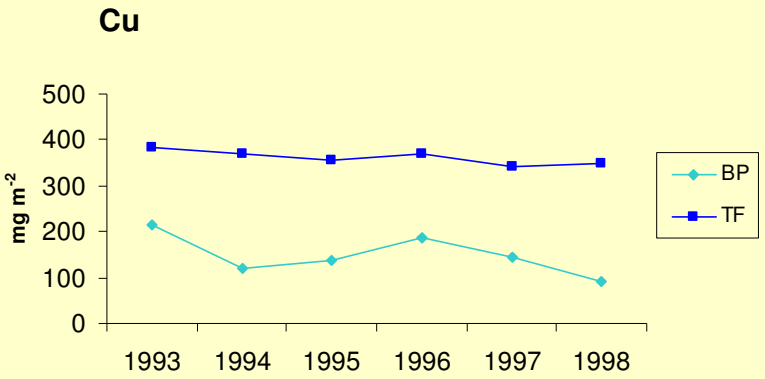
Nieminen & Saarsalmi 1998

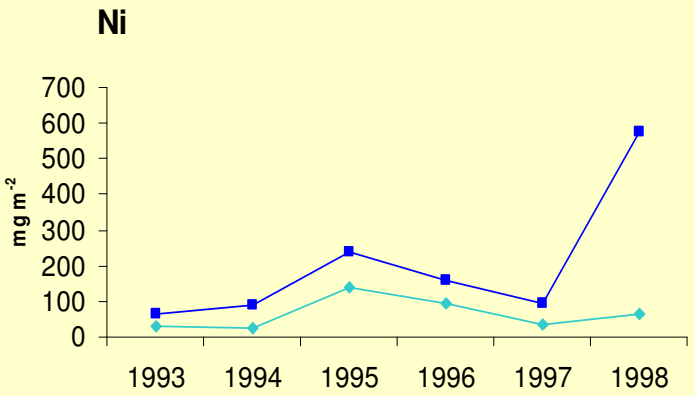
Avoimen paikan sadannan (BP), metsikkösadannan (TF) ja vajoveden keskimääräiset vuotuiset Cu- ja Ni-määrät 0,5 km koemetsikössä vuosina 1992-1996



Derome & Nieminen 1998

Avoimen paikan sadannan (BP) ja metsikkösadannan (TF) Cu- ja Ni-määrät 0,5 km koemetsikössä

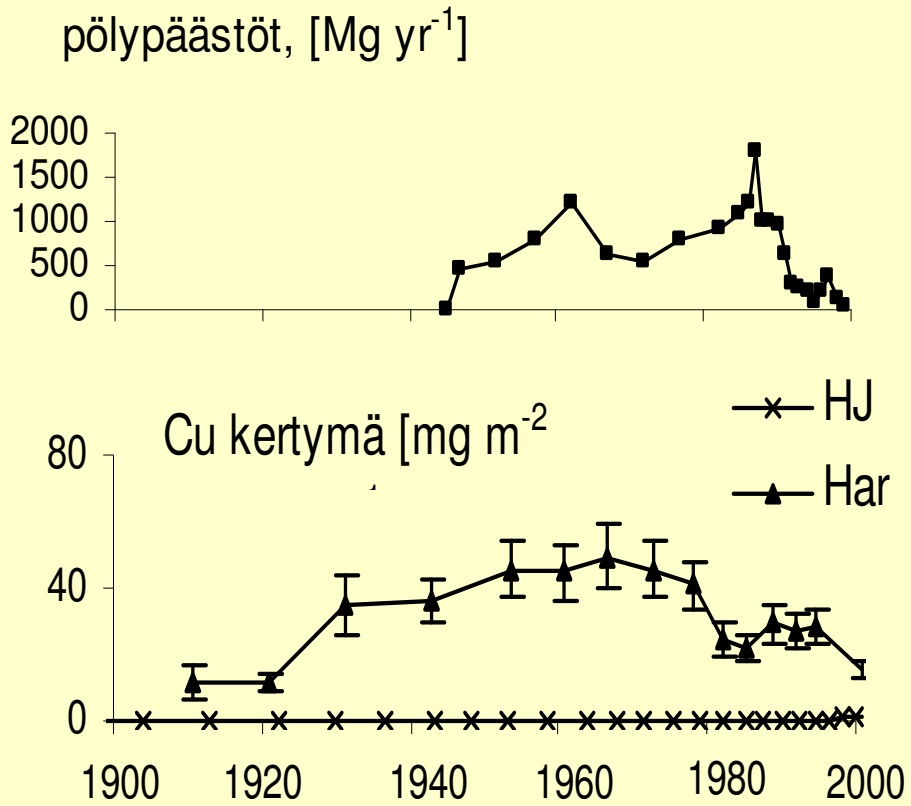




Derome 2000

Turpeen Cu-kertymäsarja

Harjavalta

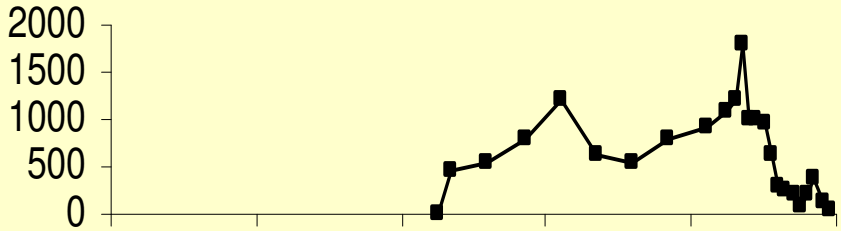


Rausch et al. 2005

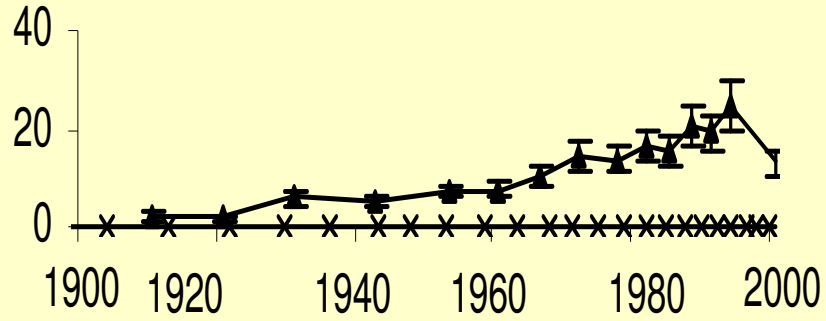
Ni-kertymäsarja

Harjavalta

pölypäästöt, [Mg yr^{-1}]



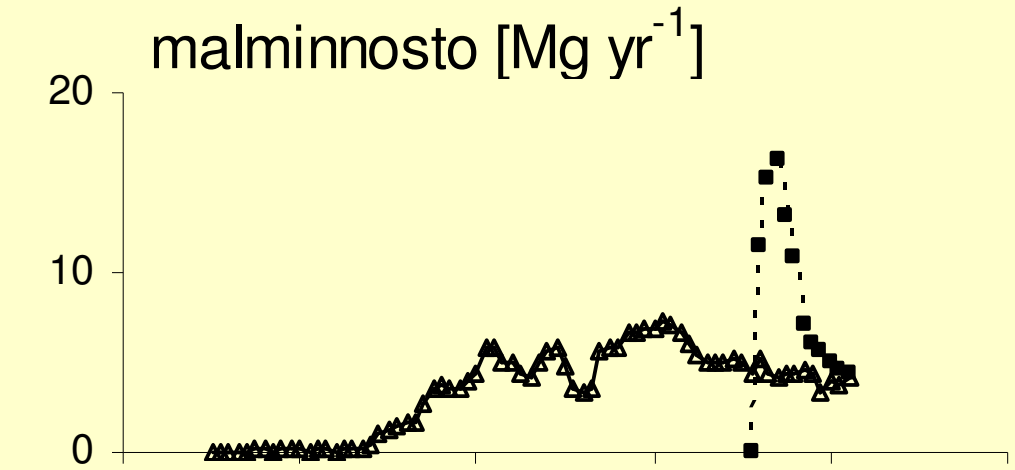
Ni-kertymät [mg m^{-2} yr^{-1}]

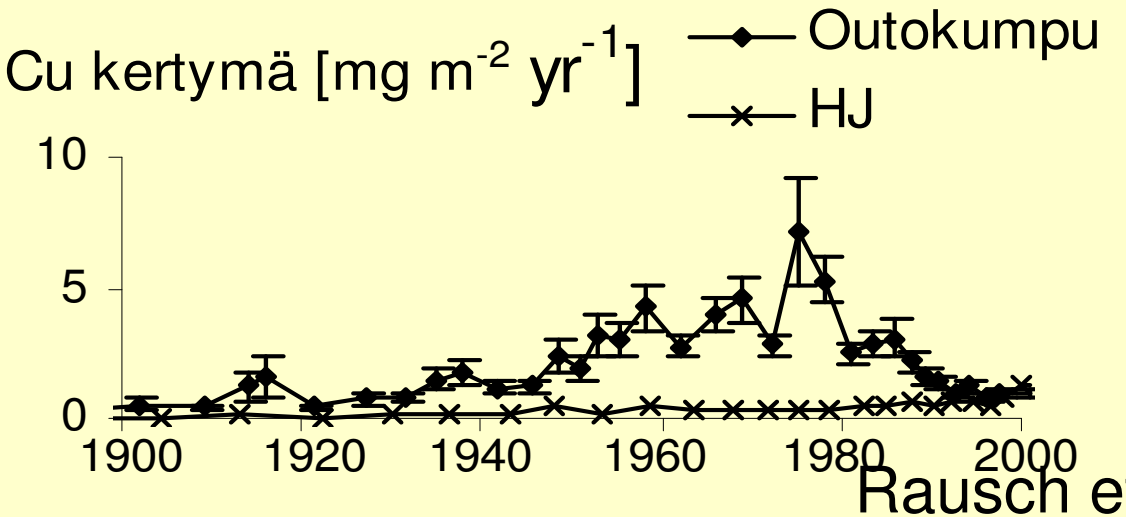


Rausch et al. 2005

Turpeen Cu- kertymäsarja

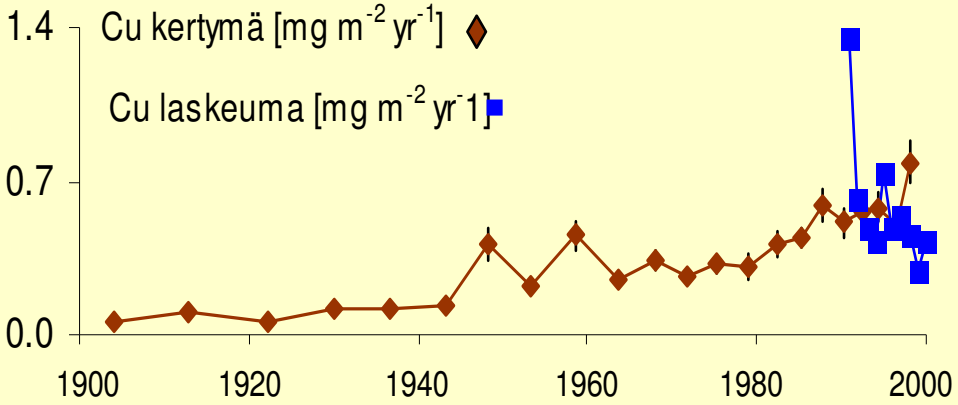
Outokumpu





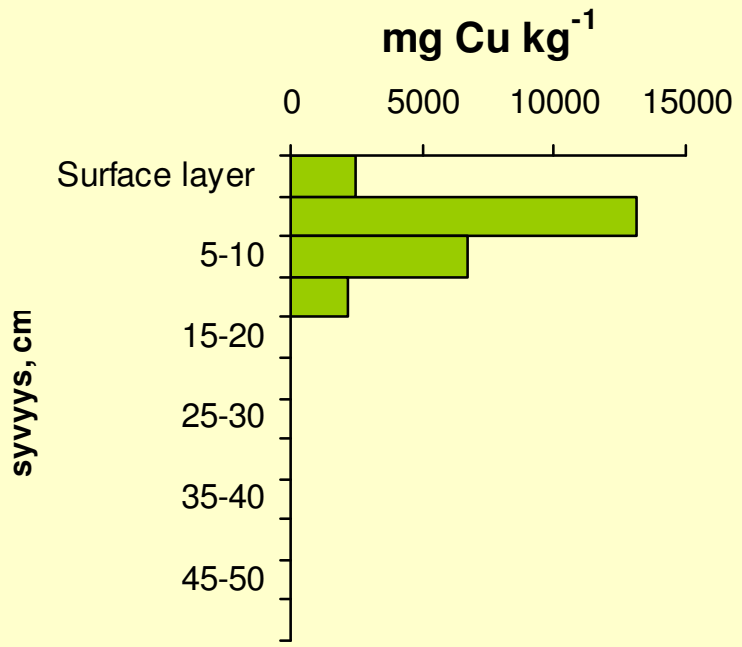
Rausch et al. 2005

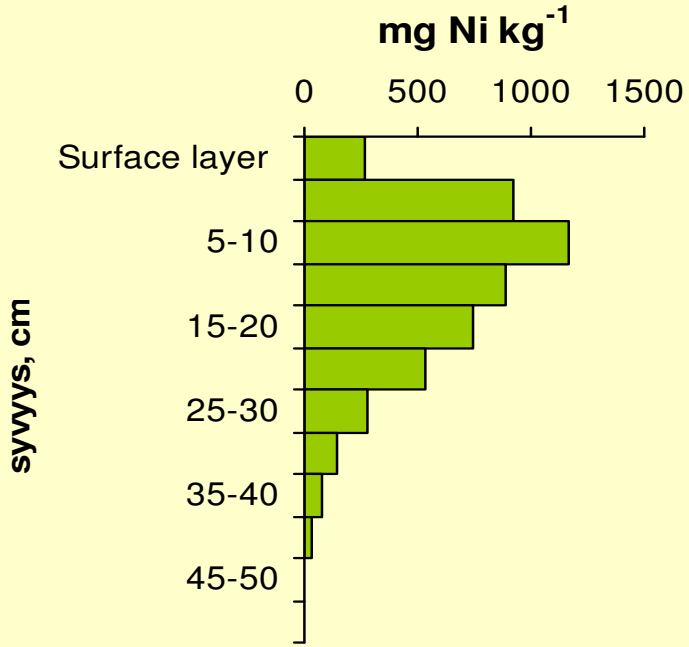
Cu kertymäsarja ja avoimen sadannan Cu-määrä
Hietajärvi



Rausch et al. 2005

Cu- ja Ni-pitoisuudet Alkkian turpeessa 40 vuotta metallisulfaattien levityksen jälkeen

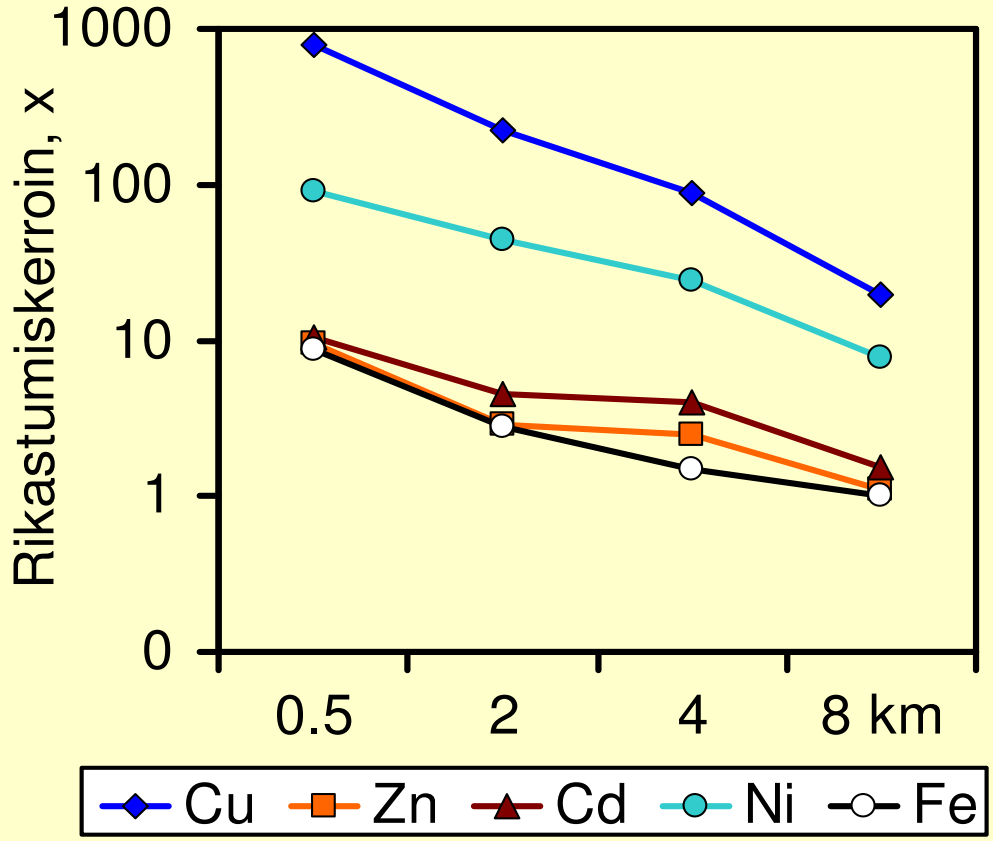




Totaalimäärä,15 cm kerros	199 kg Cu ha^{-1}	127 kg Ni ha^{-1}
Totaalimäärä, 50 cm kerros	200 kg Cu ha^{-1}	203 kg Ni ha^{-1}

Nieminen et al. 2006

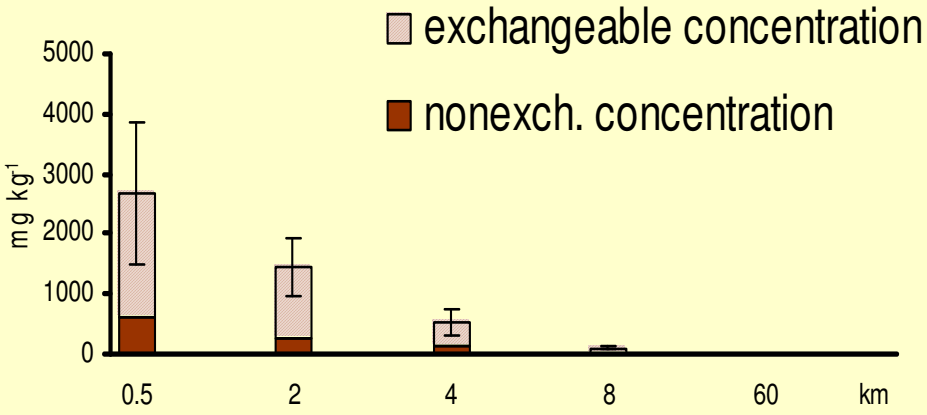
Metallien rikastuminen humuskerroksessa



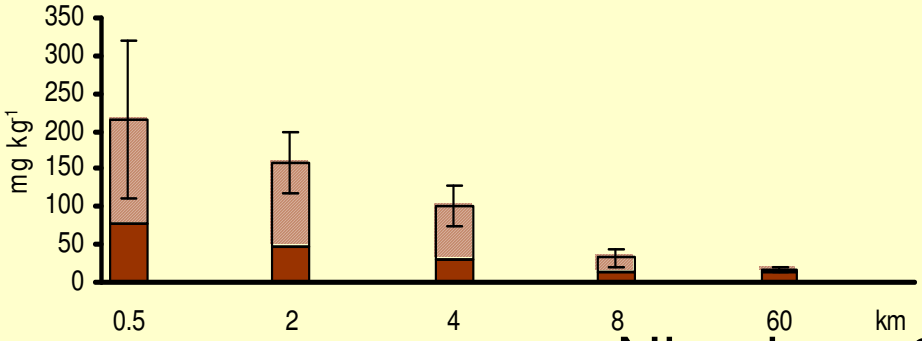
Derome et al. 2000

Humuskerroksen Cu- ja Ni-pitoisuudet

Cu



Ni



Nieminen & Saarsalmi 2002

Ennallistamiskokeet:

1. Lannoitus
2. Biokompostikate

TAVOITTEET:

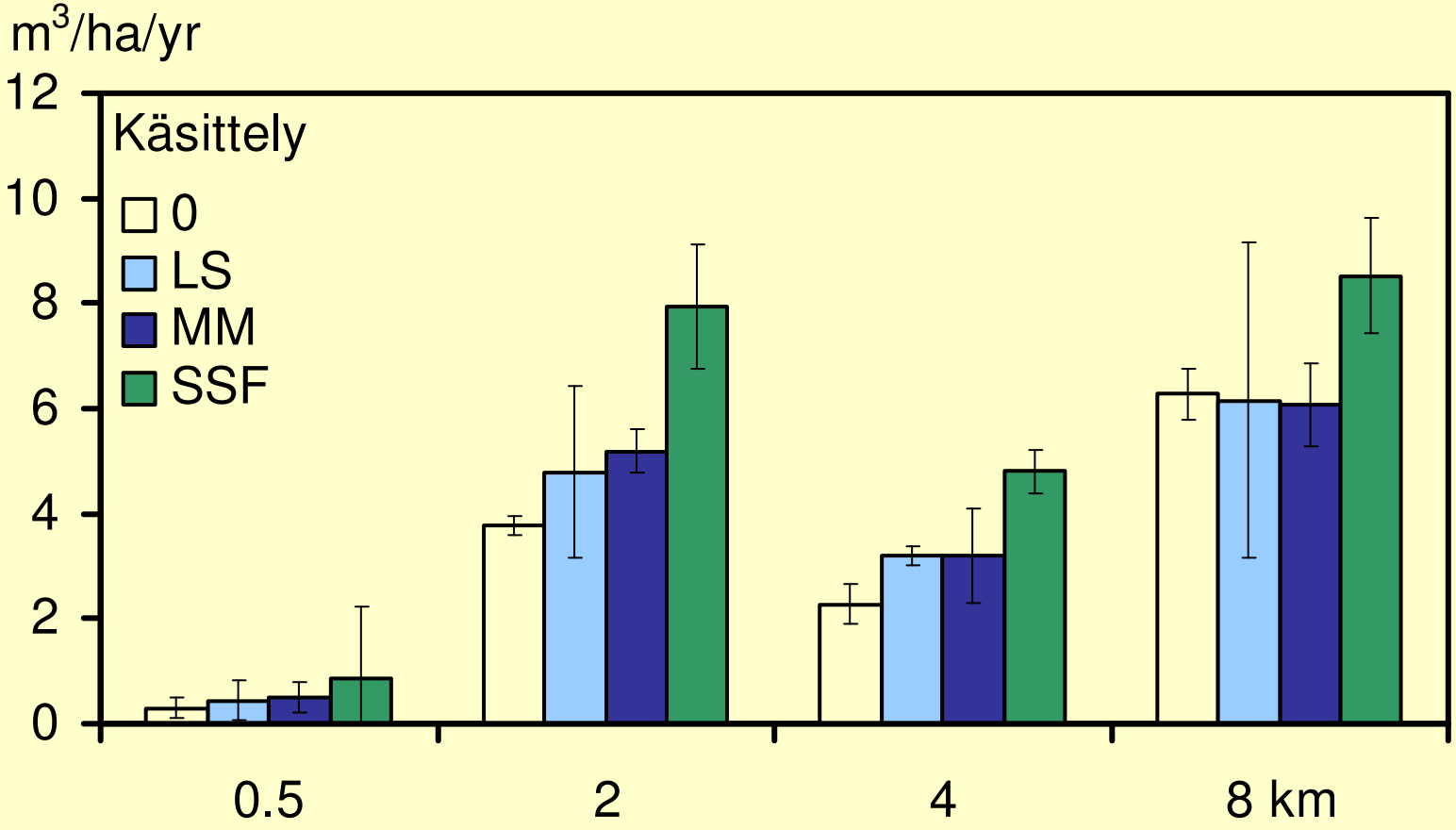
- puuston elpyminen
- mikrobitoiminnan elpyminen
- aluskasvillisuuden elpyminen

Lannoituskäsittelyt

Käsittely	N	P	K	Ca	Mg	S	B
			kg ha^{-1}				
1. Kontrolli							
2. Kalkitus (**LS**)				420	100		2
3. Mineraali sekoitus (**MM**)		31	56	98	61	37	1.3
4. Metsikkökohtainen lannoitus (**SSF**)	60-75 (urea)			315	50		
	60-75 (ammonium nitraatti)						

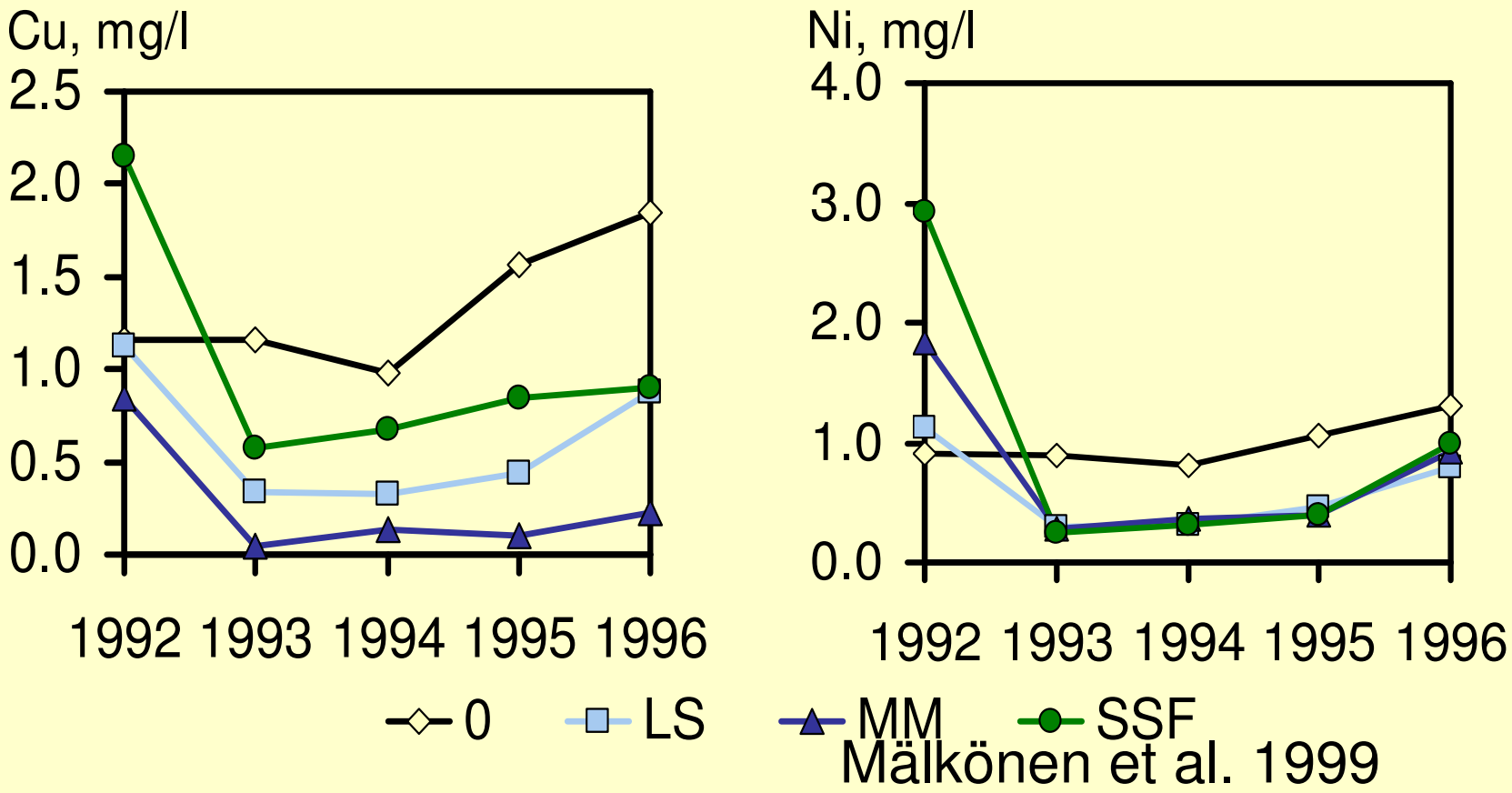
Mälkönen et al. 1999

Puiden tilavuuskasvu 1992-1996



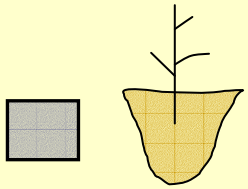
Mälkönen et al. 1999

Lannoituksen vaikutus maaveden Cu- ja Ni-pitoisuuteen 0,5 km etäisyydellä sulatosta

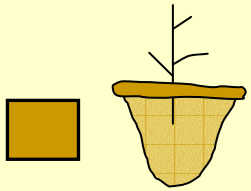


Mälkönen et al. 1999

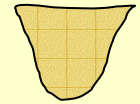
Biokompostikate -koe
0,5 km etäisyydellä



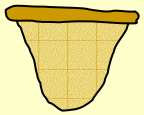
Maataskut
+ taimien istutus



Kate, maataskut
+ taimien istutus



Maataskut



Kate, maataskut

Ei käsittelyä

Kate

Koejärjestely:

Arctostaphylos uva-ursi

49	49	49
49	49	49

Pinus sylvestris

49	49	49
49	49	49

Empetrum nigrum

49	49	49
49	49	49

Betula pubescens

49	49	49
49	49	49

Ei istutettu taimia

49	49	49
49	49	49

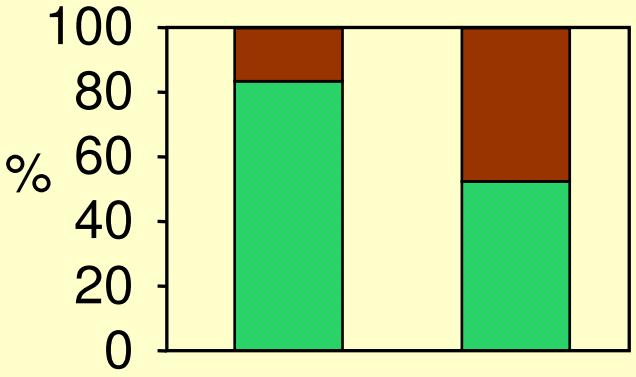
Maaveden laatu

	Ei käsittelyä	Biokompostikate
Vesimäärä, ml	960 (302)	640 (300)
pH	4.3 (0.2)	4.3 (0.1)
DOC, mg L^{-1}	23 (6)	32 (4)
Cu_{tot}, mg L^{-1}	1.6 (0.6)	1.1 (0.3)
Cu_{comp}, mg L^{-1}	0.11 (0.03)	0.15 (0.04)
Cu^{2+}, mg L^{-1}	2.0 (0.78)	0.79 (0.34)
Ni_{tot}, mg L^{-1}	0.78 (0.22)	0.63 (0.2)
DI %	36 (4)	29 (3)

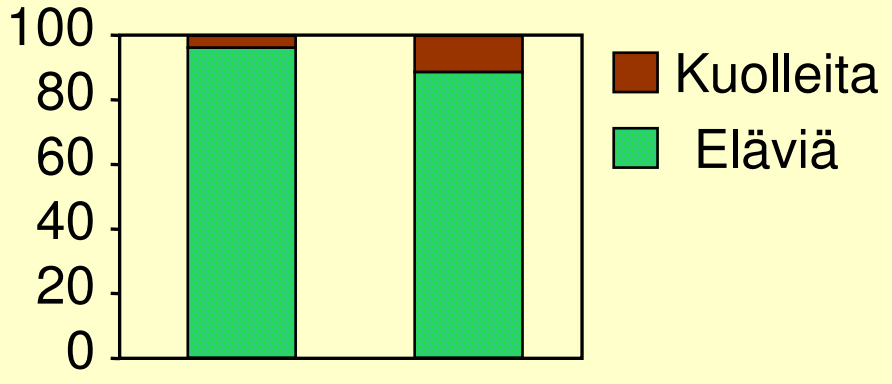
Kiikkilä et al. 2001

Istutettujen taimien elossa säilyminen 1996-2005

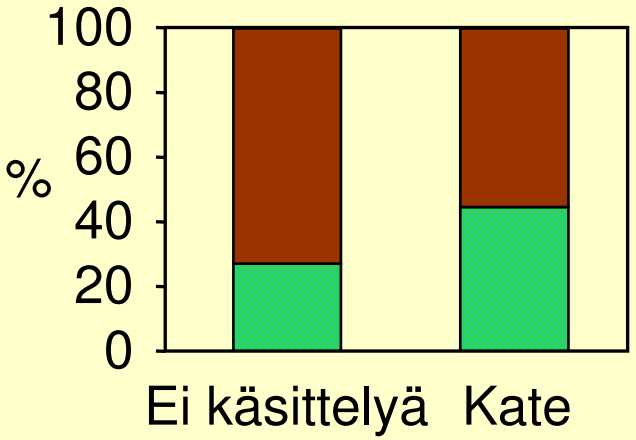
Betula pubescens (68 %)



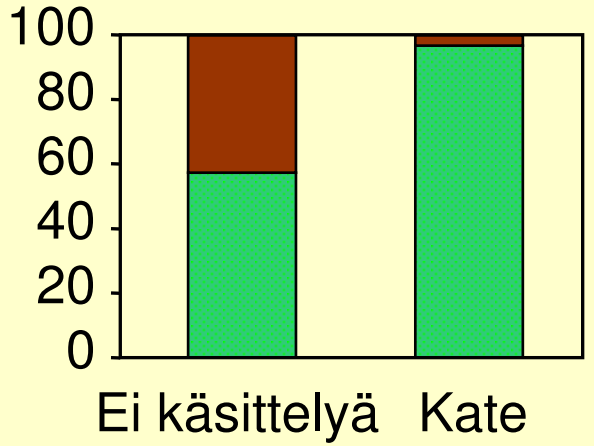
Pinus sylvestris (92 %)



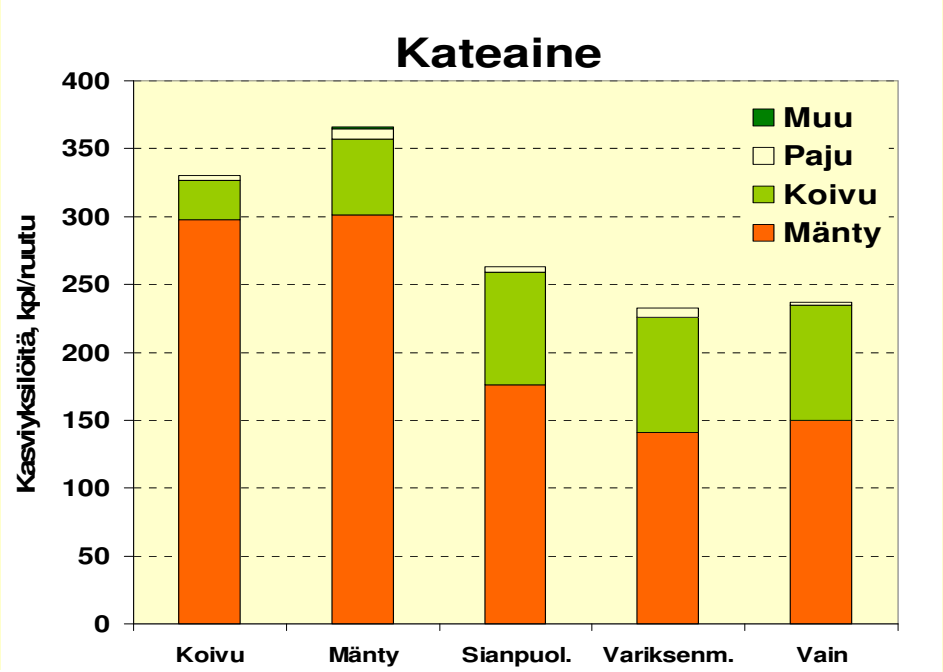
Arctostaphylos uva-ursi (36 %)

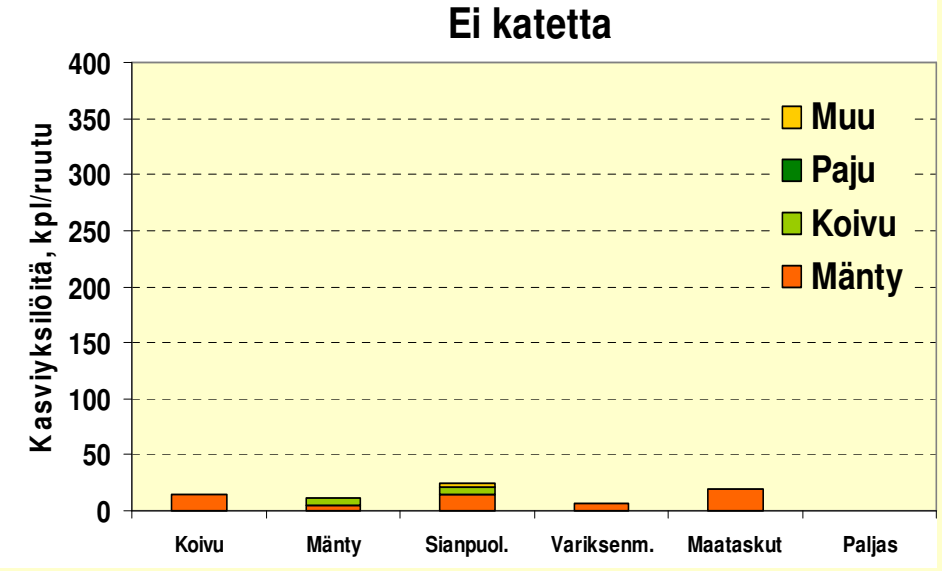


Empetrum nigrum (77 %)



Helmisaari et al. 1999





Kateaineella peitetyille ruuduille ilmestyi runsaasti luontaista kasvillisuutta, etenkin puiden taimia.

Helmisaari et al. 1999

Kirjallisuus:

- Derome, J. & Nieminen, T. 1998. Metal and macronutrient fluxes in heavy-metal polluted Scots pine ecosystems in SW Finland. Environmental Pollution 103: 219-228.
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- Nieminen, T.M. & Saarsalmi, A. 2002. Contents of Cu, Ni and Zn in smelter-polluted soil-plant systems. Geochemistry: Exploration, Environment, Analysis 2: 167-174.
- Nieminen, T.M., Ukonmaanaho, L., Rausch, N. & Shotyk, W. 2006. Availability and toxicity of Cu and Ni to Scots pine in different soils. Forest, Snow and Landscape Research 80(3): 349-360
- Rausch, N., Nieminen, T., Ukonmaanaho, L., Le Roux, G., Krachler, M., Cheburkin, A.K., Bonani, G. & Shotyk, W. 2005. Comparison of atmospheric deposition of copper, nickel, cobalt, zinc, and cadmium recorded by Finnish peat cores with monitoring data and emission records. Environmental Science & Technology 39(16): 5989-5998.