Risk assesment of wind and snow induced damage related to forest management under climate change (mechanistic approach)

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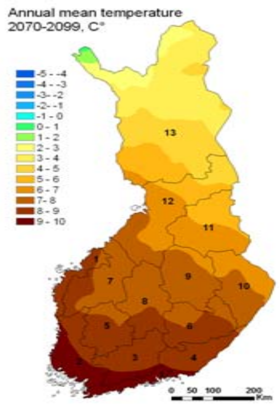
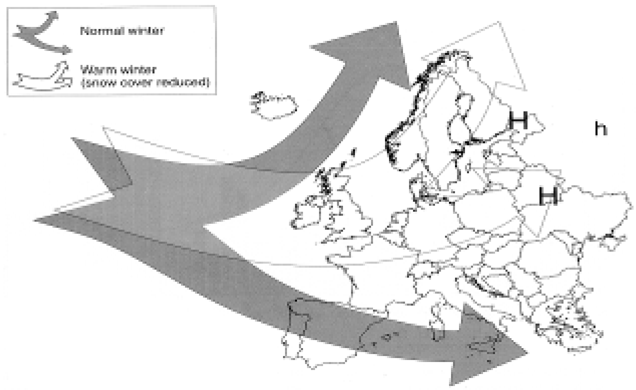
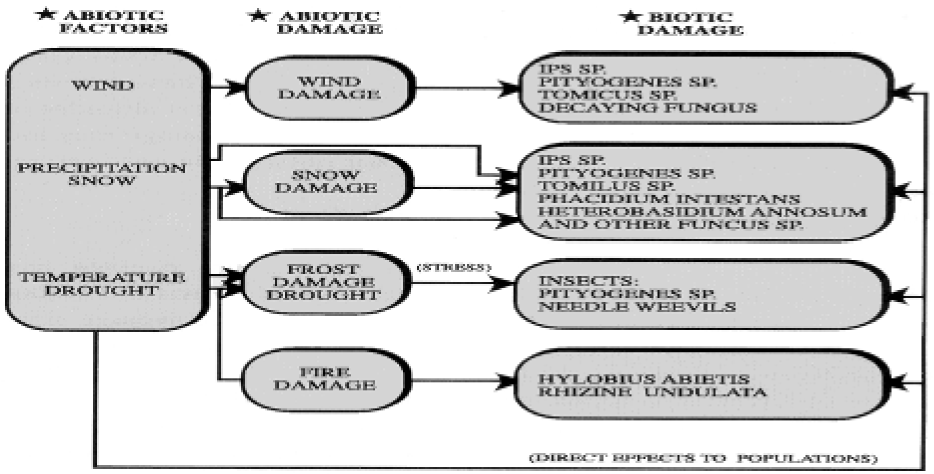






Recent wind damage and occurrence of strong winds in Finland

Storm	Damage, million m^3	Mean and gust windspeed, $m\ s^{-1}$	Main region affected
Aarno (1978)	2,5	12–24 ja 18–36	Etelä-Pohjanmaa, Pirkanmaa (Southern Finland)
Mauri (1982)	3	12–23[1)] ja 18–33	Lappi (Northern Finland)
Manta (1985)	4	12–20 ja 18–30	Savo, Pohjois-Karjala ja Länsi-Lappi (Whole Finland)
Pyry ja Janika (2001)	7,3	14–17[1)] ja 20–40 (Pyry) 14–27[1)] ja 20–40 (Janika)	Etelä-Pohjanmaa, Häme (Central, southern Finland)
Unto (2002)	1	8–14 ja 30–50	Savo(Central, southern Finland)

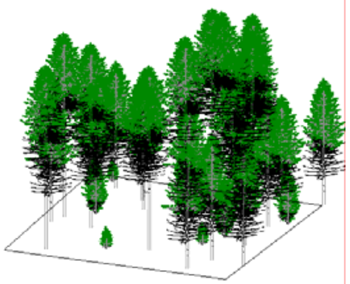
1) Max mean windspeed of 2 min instead of 10 min: Mauri (Pohjoisen Vaala ja Yli-tornio, max 2 min mean windspeed of 23 $m\ s^{-1}$), Pyry (Vaasa airport, max 2 min mean windspeed of 27 $m\ s^{-1}$) ja Janika (Vaasa airport, max 2 min windspeed of 27 $m\ s^{-1}$).

Objectives

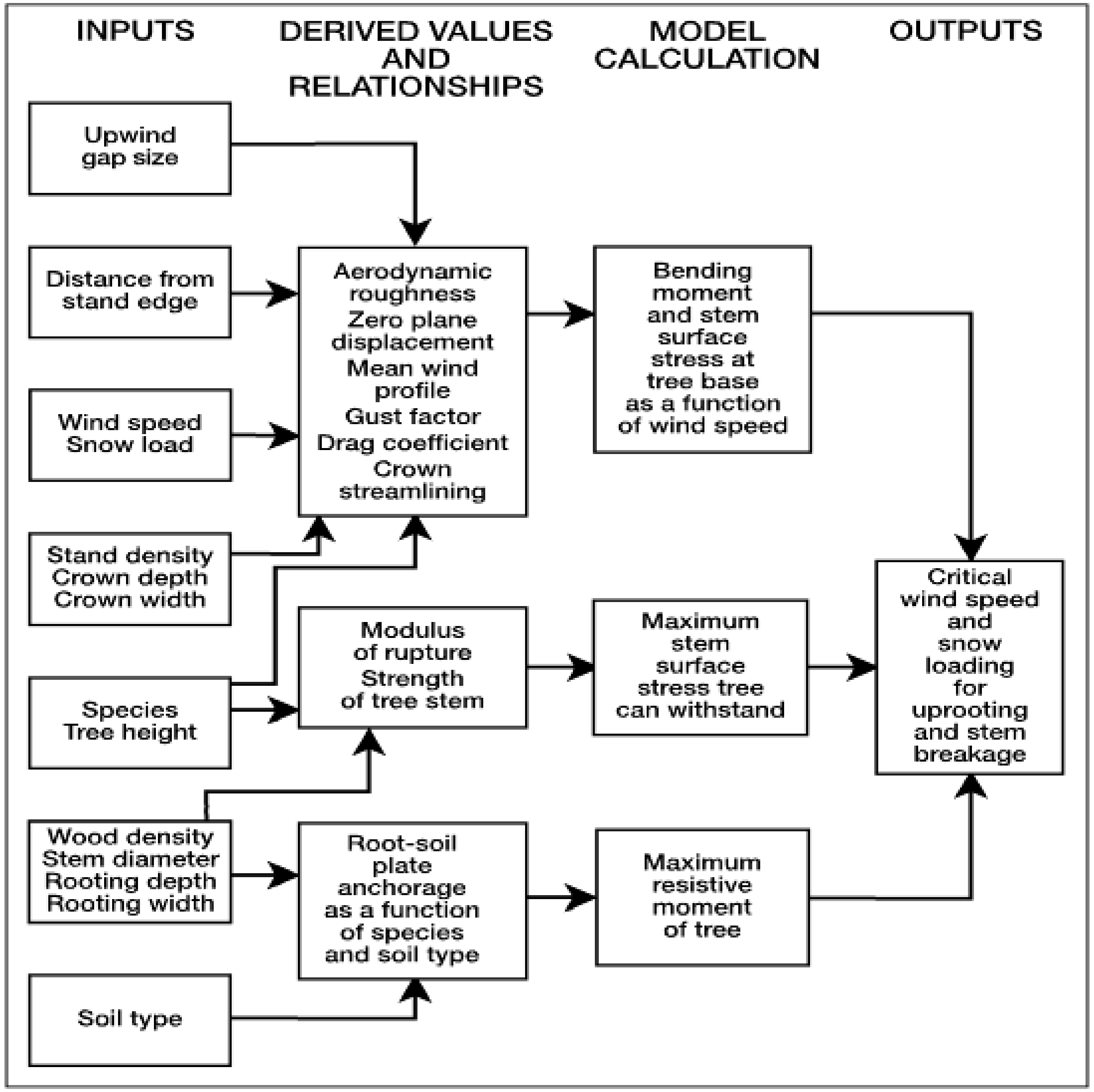
- To evaluate possible impacts of tree/stand characteristics, silvicultural management and climate change on the risks of wind- and snow-induced damage to forests in Finland.

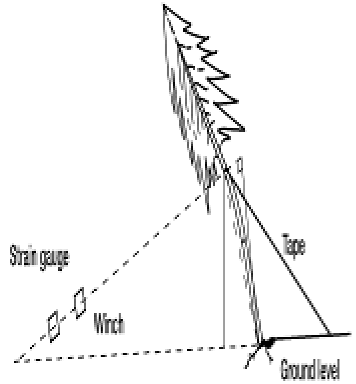
- Work is based on integrated use of:

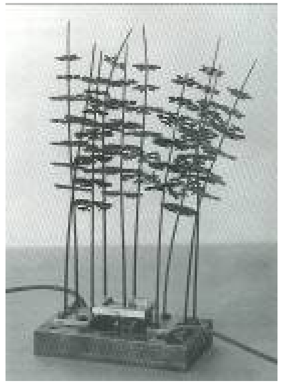
i) climate change scenarios (FinAdapt),
ii) forest growth and yield modeling (SIMA, FinnFor, MONSU),
iii) mechanistic modeling for wind and snow induced damage (HWIND),
iv) probabilities and return periods of critical weather events (wind and snow extremes) and
v) model tree characteristics and forest inventory data (at management unit and national level).

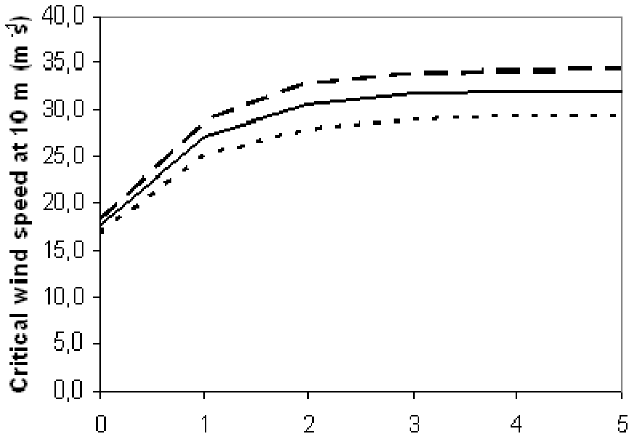


Modeling the mechanism of wind and snow damage- HWIND (at new edges)

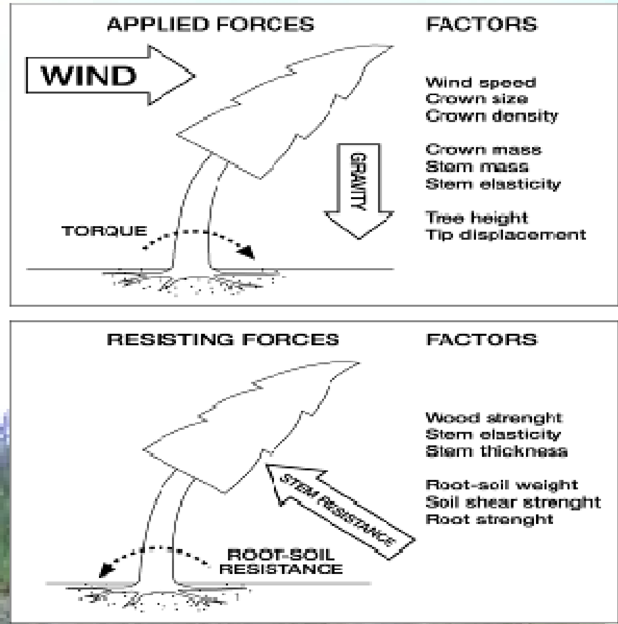


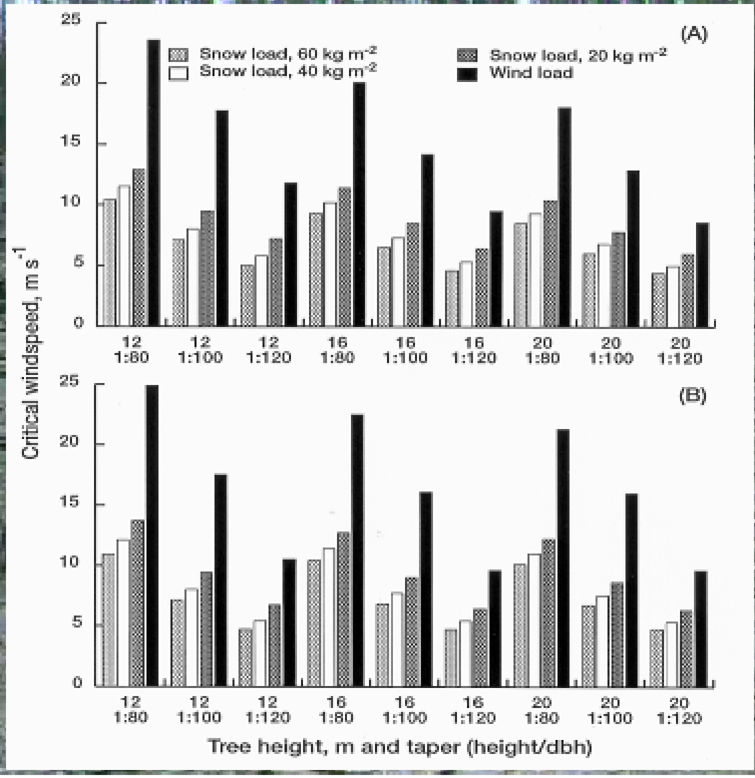




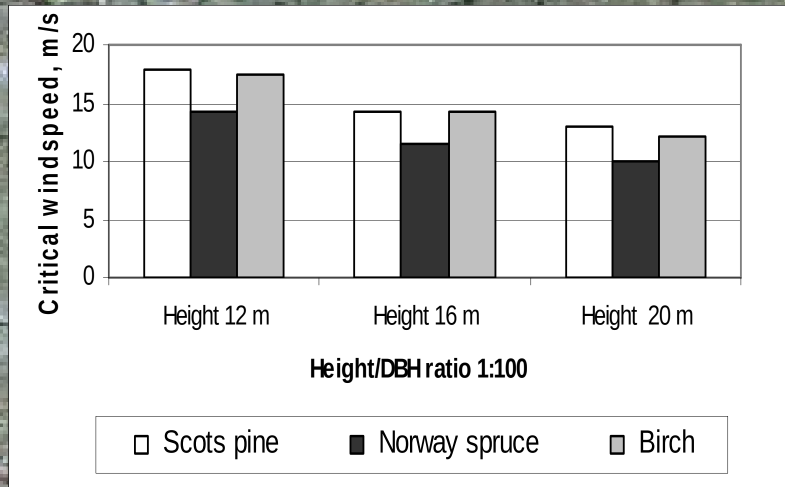


Effects of tree species and stand characteristics on wind- and snow-induced damage



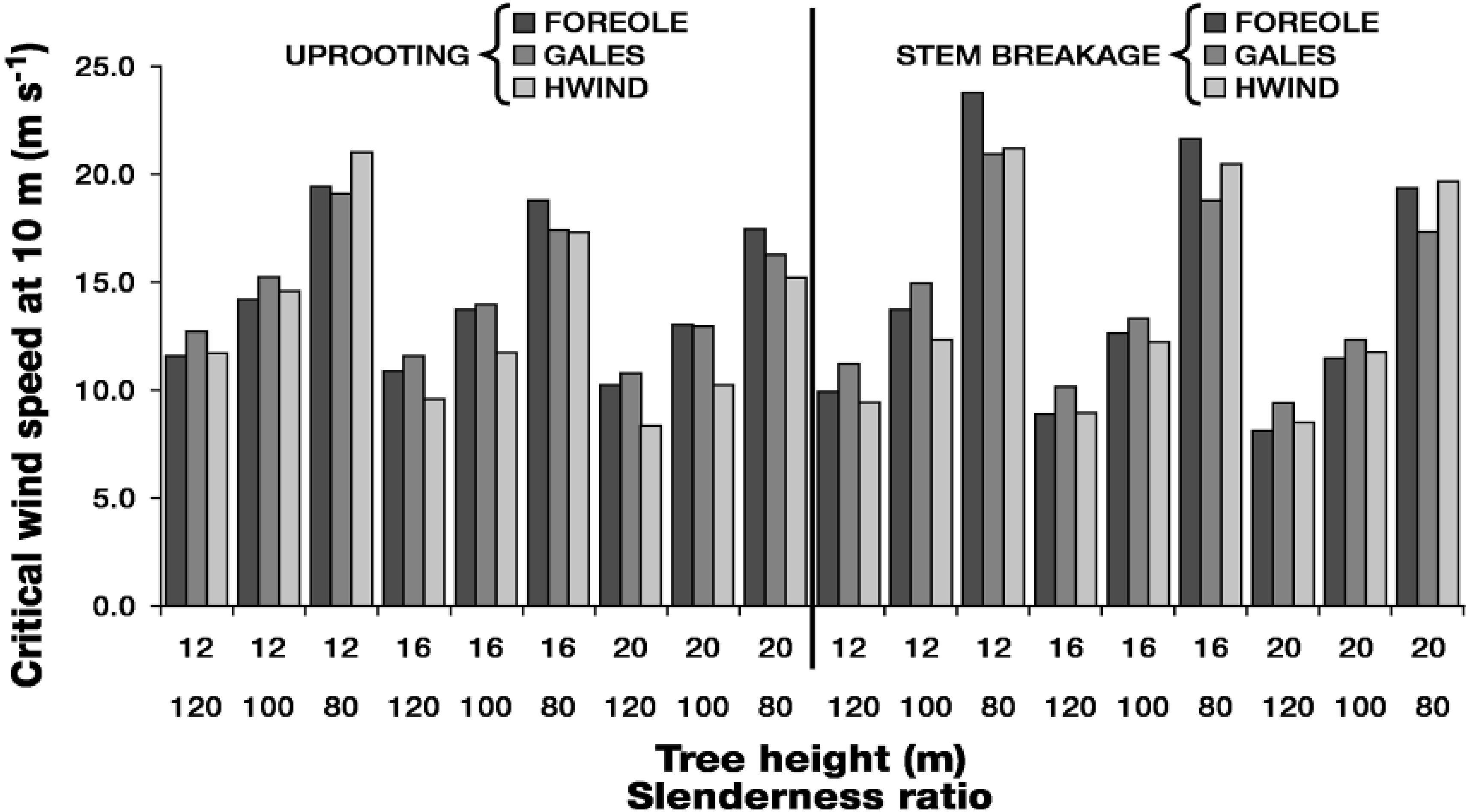


Examples on critical windspeeds needed for uprooting (A) and stem breakage (B) of Scots pine at stand edge



Example computations on critical windspeeds needed for uprooting at stand edge

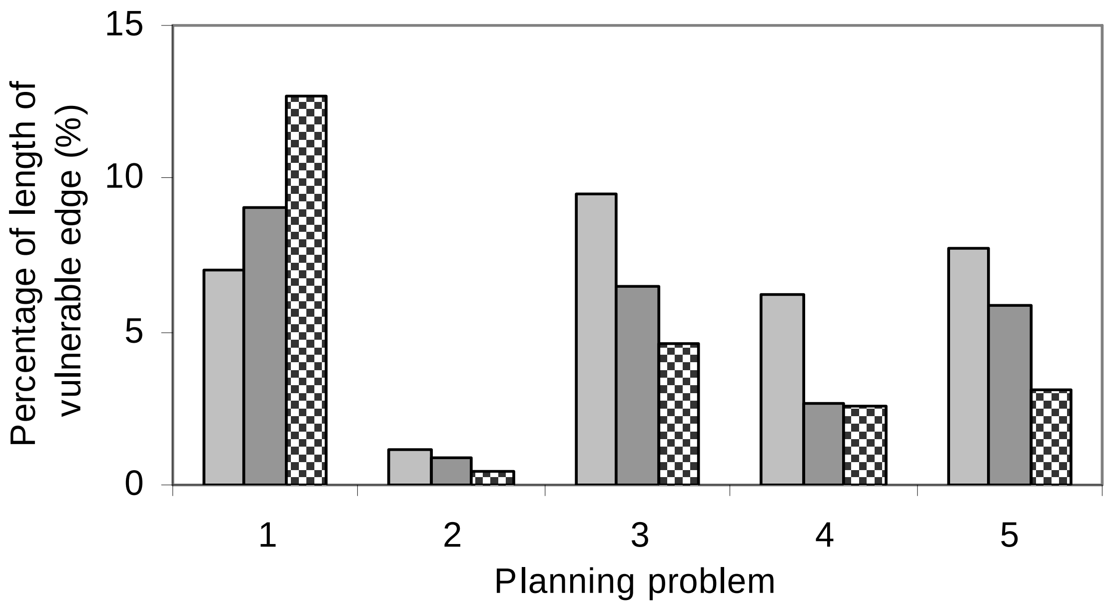
Comparison of HWIND, GALES and FOREOLE (Norway spruce)



(Ancelin et al. 2004, Peltola 2006)

Example of risk management of wind damage in forest planning

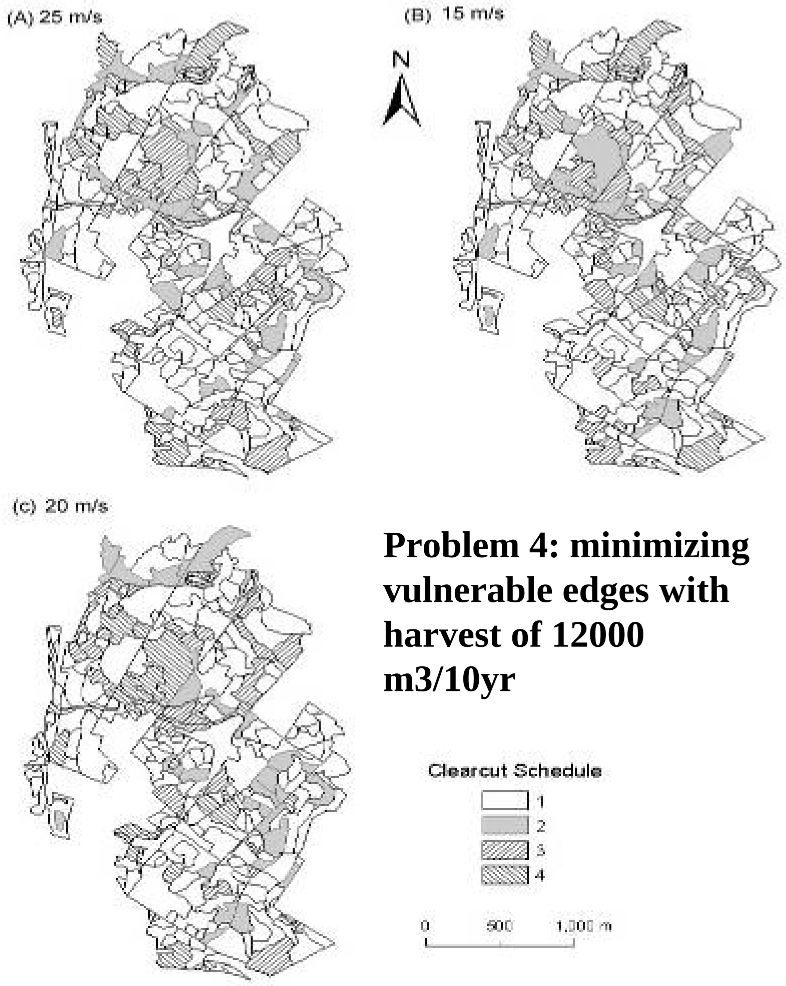
(criteria for critical windspeed < 20 m/s at 10 m above ground)



Planning problems (395 ha of forest unit)	Prob 1: Max risk edges	**Prob 2: Min risk edges**	Prob 3: Max risk edges, cut 12000m^3/10yr	**Prob 4: Min risk edges, cut 12000m^3/10yr**	**Prob 5: Cut 12000 m^3/10yr**
Total harvest, 1-3 periods (m^3)	31800	**15400**	36000	**35900**	**36000**
Final volume (m^3)	67500	**81900**	64100	**64600**	**64900**
<u>Gaps no (size, ha)</u> 1-3 period	17-45 (1.4-2.4)	9-10 (2.0-3.6)	24-33 (1.7-2.3)	19-25 (2.1-3.1)	20-27 (2.0-3.2)

(Zeng et al. 2007)

Risk consideration for wind damage in forest planning (Zeng et al. 2007)

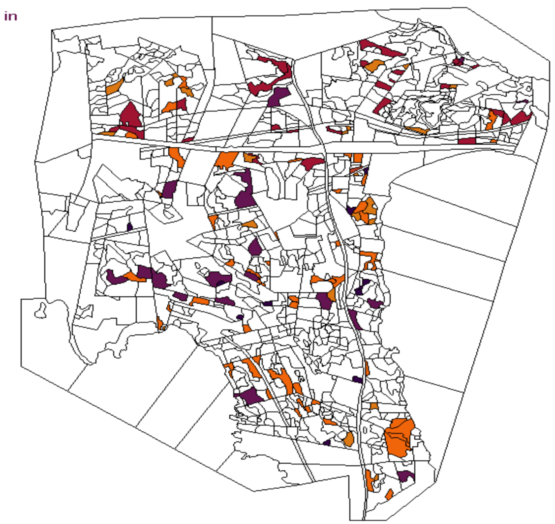


Problem 4: minimizing vulnerable edges with harvest of 12000 m3/10yr

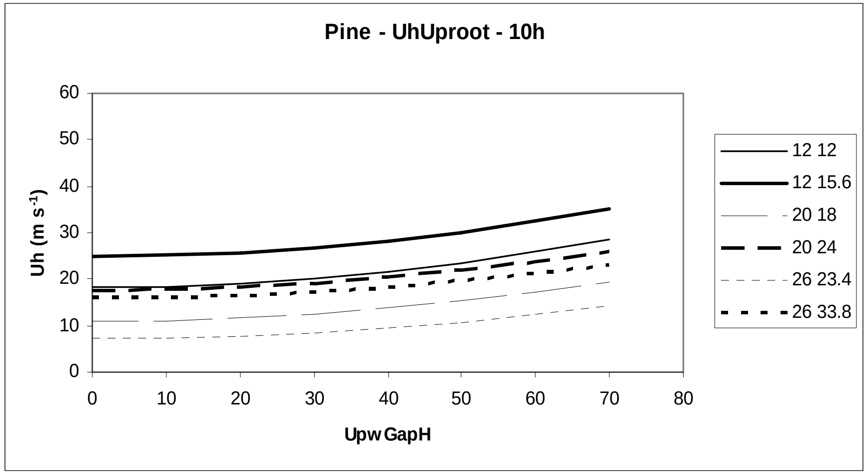
- <u>Optimization</u> is sensitive to the criterion of critical wind speed used to classify stands into risky and non-risky stands, and to timber harvest objective.

- The risk could be reduced by aggregating the clear cuts and by avoiding them at the edge of stands with high possibility to be damaged.

- Even-flow timber harvesting objective will limit the possibility of minimizing the risk of damage.

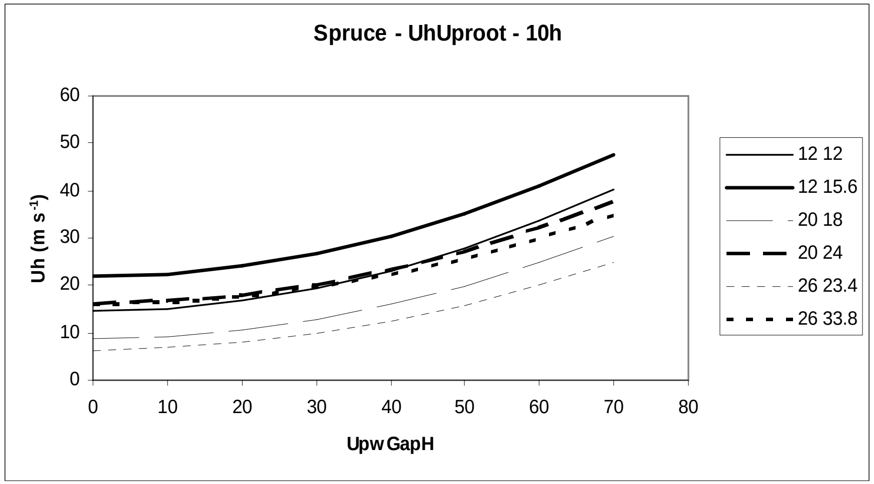


Use of regression models for critical wind speeds related to risk assesment of wind damage in forest planning (ongoing work)



Return levels for average wind speed (10 min avg)
based on observations 1961-2007 at Joensuu airport

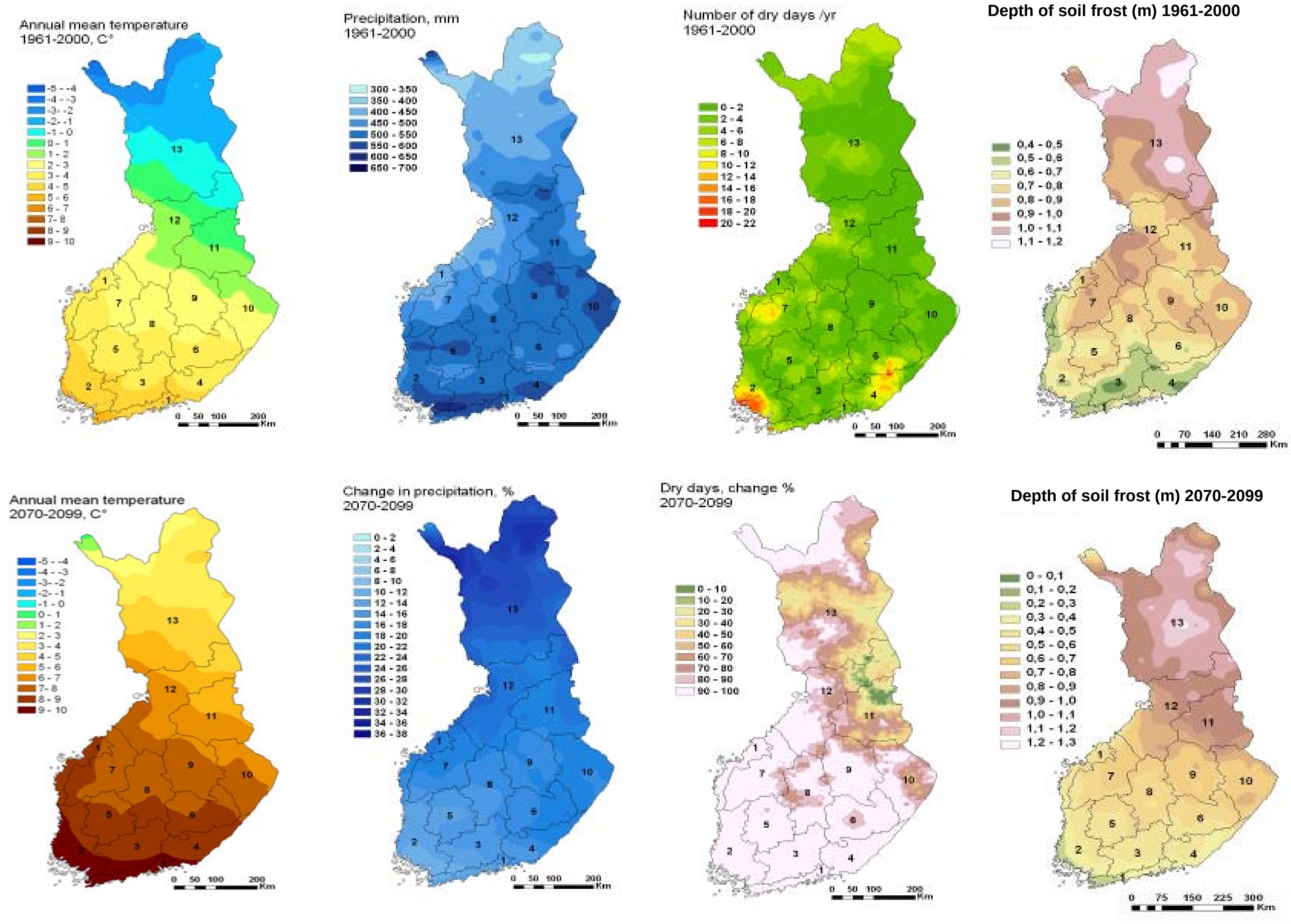
return per.	NW		
(years)	95%	mean	95%
10	11,3	11,9	13,3
50	12,4	13,6	15,7
100	12,7	14,3	16,6
500	13,4	15,8	18,7



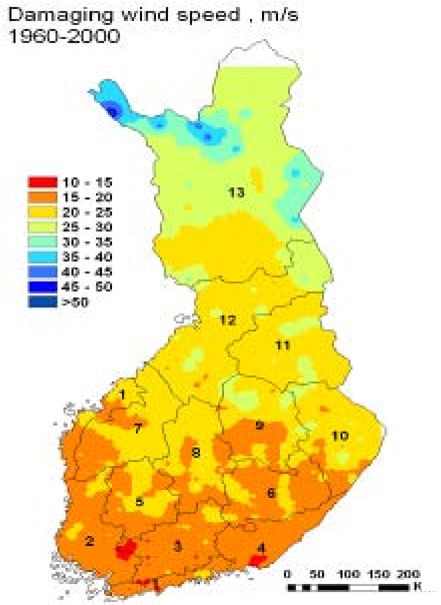
Return levels for average wind speed (10 min avg)
based on observations dec1998-may2008 at Joensuu airport

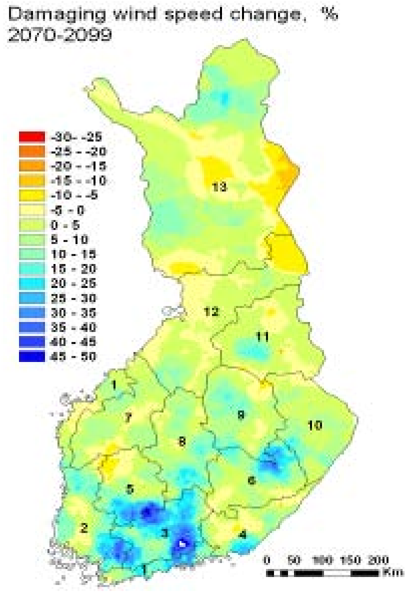
return per.	ALL dir		
(years)	95%	mean	95%
10	17,5	18,2	20,4
50	18,0	19,2	22,0
100	18,1	19,6	22,6
500	18,3	20,4	23,9

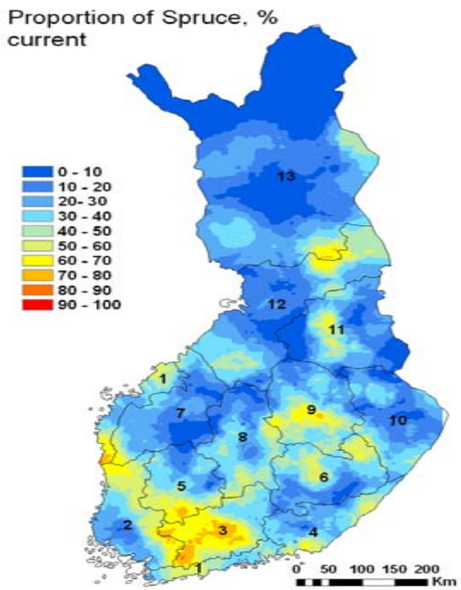
Predicted climate change impacts to forests in Finland – risk assesment of wind and snow damage (FinAdapt scenarios)

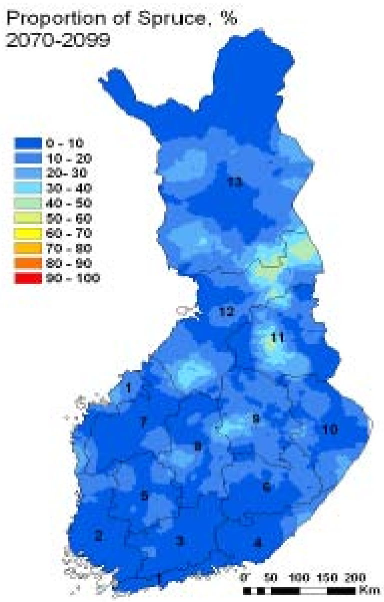


Climatic change and risk of wind damage at regional level







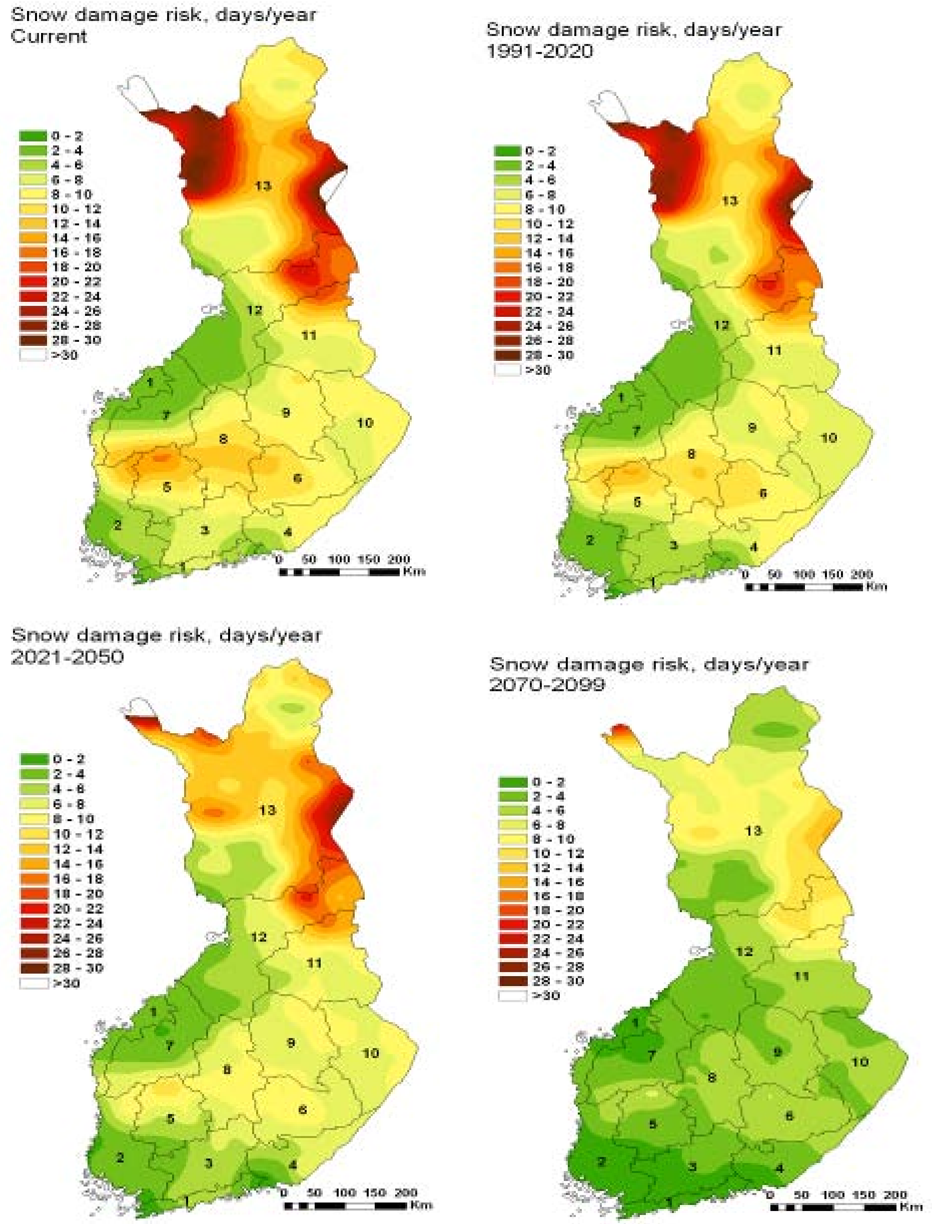


- Decrease of soil frost from late autumn to early spring (e.g. from 4-5 months into 2-3 months) in most windy period and/or increase in frequency of high wind speeds will increase the overall risk.

- If the dominance of Norway spruce will decrease in forests located in southern Finland, the risk of wind damage will decrease at regional level (due to overall increase of critical wind speeds).

- The risk could also be reduced both at stand and regional level by proper forest management (e.g. tree species choice in regeneration, tending of seedling stand, type and intensity of thinning, rotation length, temporal and spatial patterns of final cuts).

Climatic change and occurence of snow loads > 20 kg m^2



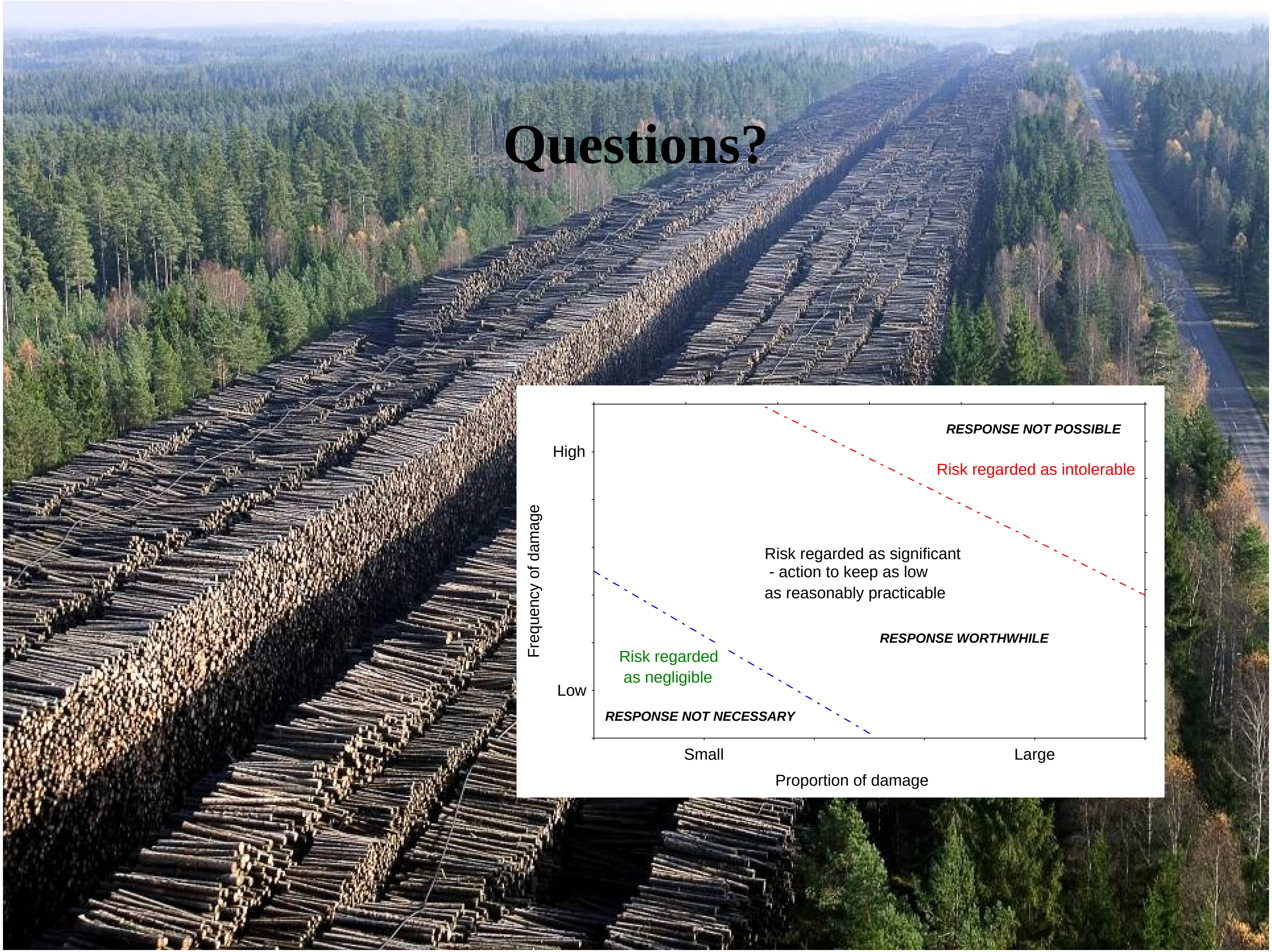
- The risk of damaging snow falls will decrease from today onwards, and most in north-western and north-eastern Finland, where snow-induced damage is nowadays frequent.

- Despite of this, the risk of snow damage is still evident and is affected by the development of forest stands and their management.

- Delayed thinning will increase the risk of snow damage especially in Scots pine and birch stands.

- The risk of snow damage in terms of uprooting will also increase in the future due to the decrease in soil frost.

Questions?


RESPONSE NOT POSSIBLE
Risk regarded as intolerable
High
Frequency of damage
Risk regarded as significant
- action to keep as low
as reasonably practicable
RESPONSE WORTHWHILE
Risk regarded
as negligible
Low
RESPONSE NOT NECESSARY
Small
Large
Proportion of damage