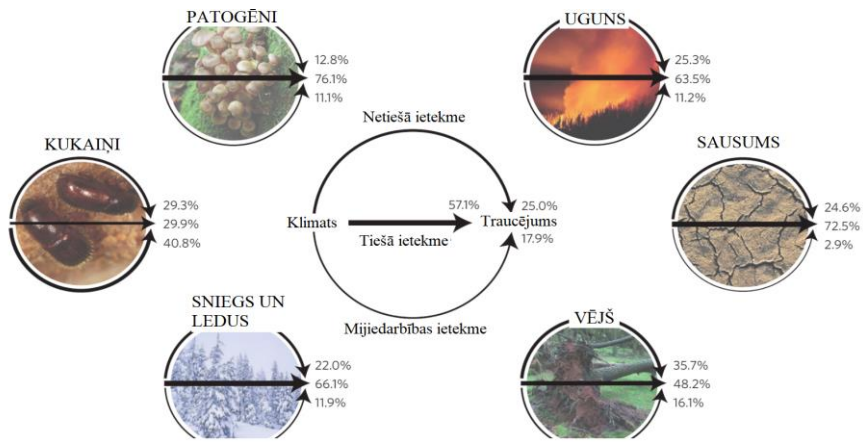




# Forest protection and management

(Aris Jansons, Silava/LBTU)





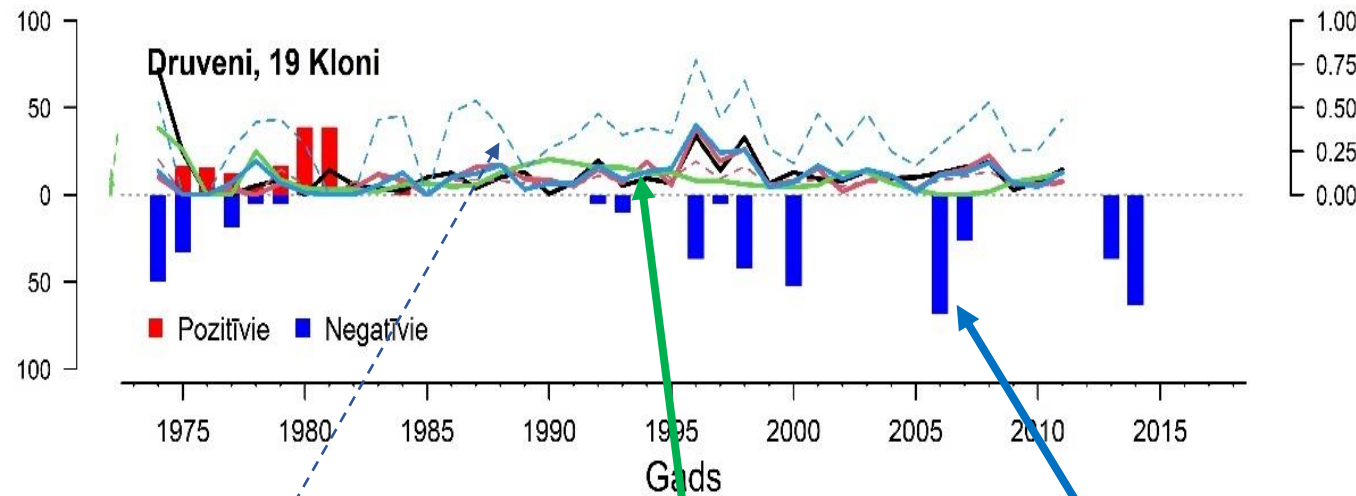
Seidl et al., 2017

- ✓ Climate change have direct influence to survival and increment of trees as well as amplifies the influence of natural disturbances
- ✓ Influence of climate change on disturbances (and consequently on damages in forest) is mostly direct (especially *via* climate extremes), but also indirect and interaction effects are significant
- ✓ Alterations of disturbance regimes have the potential to strongly impact the ability of forests to provide ecosystem services to society
- ✓ Different regions will experience different effect at different degree
- ✓ Climate change is global, but adaptation is local





# Effect of weather (and weather extremes)



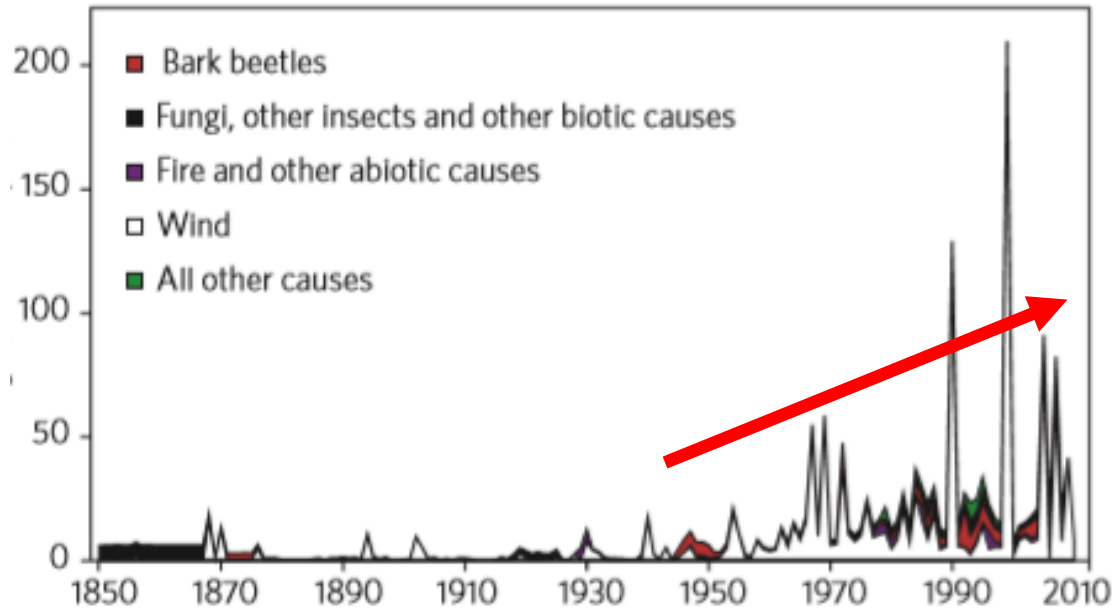
Genetic variation (CVa)

Heritability ( $H^2$ )

Number of genotypes (clones) affected by the extremes at particular year

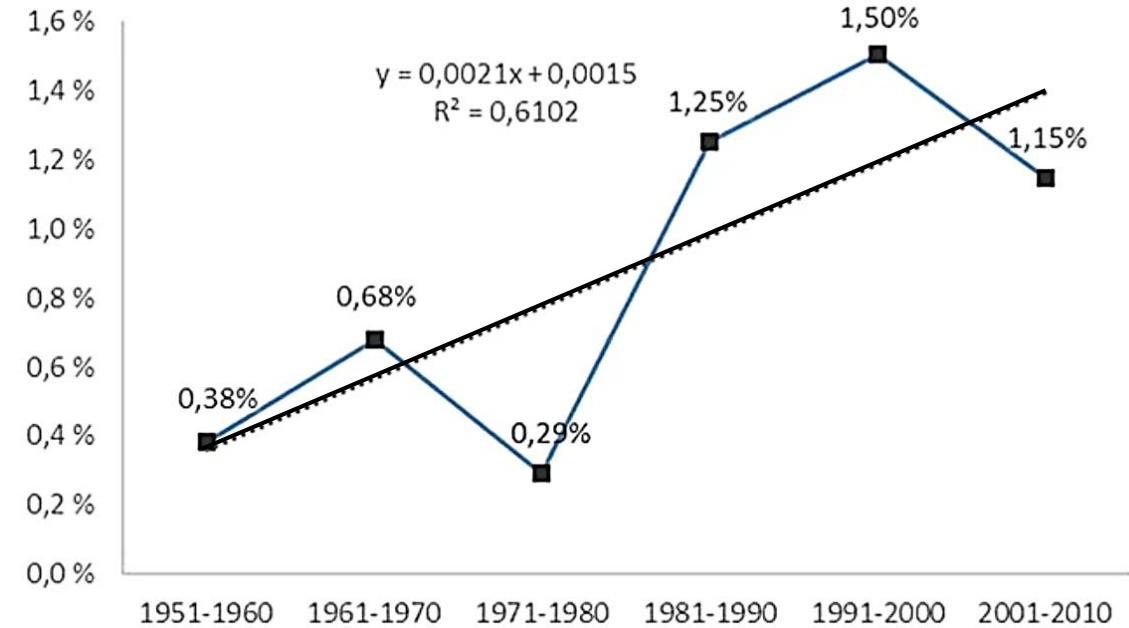
Suitable genotypes are essential for adaptation of managed forests

## Effect of natural disturbances (abiotic)



- Volume of damaged forests (mil.m<sup>3</sup> annually)
- Main factor – storms (and interaction effects)

Nabuurs et al., 2013



- Stem damaged trees (mil m<sup>3</sup> y<sup>-1</sup>) as proportion from total standing stock demonstrates the increasing influence of this natural disturbance

Gregow et al., 2017, Nature: Sci Rep

Natural disturbances limit carbon pool size in forest and needs to be considered in management. Low-density planting of suitable genotypes reduces the risk(s).



## Wind

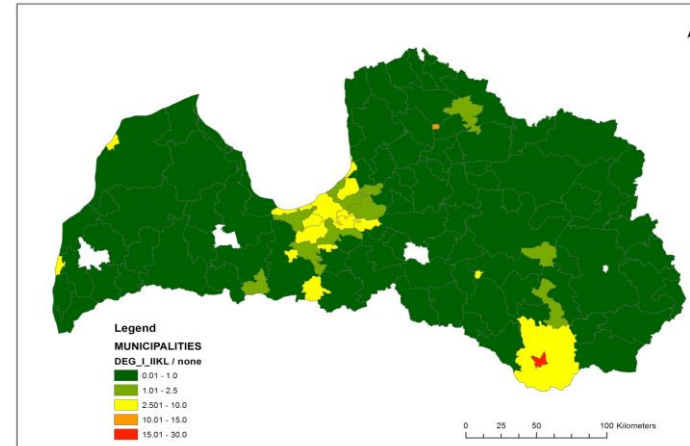
- Enhanced individual tree stability is the key to reduction of damages (in most cases)
- In heterogenous stands larger (valuable/carbon containing) trees are affected first, therefore with stand structural heterogeneity resilience can be introduced in ecological sense, but not in managed forests (in economic sense)
- Biotic stem damages have significant negative effect on wind resistance of trees





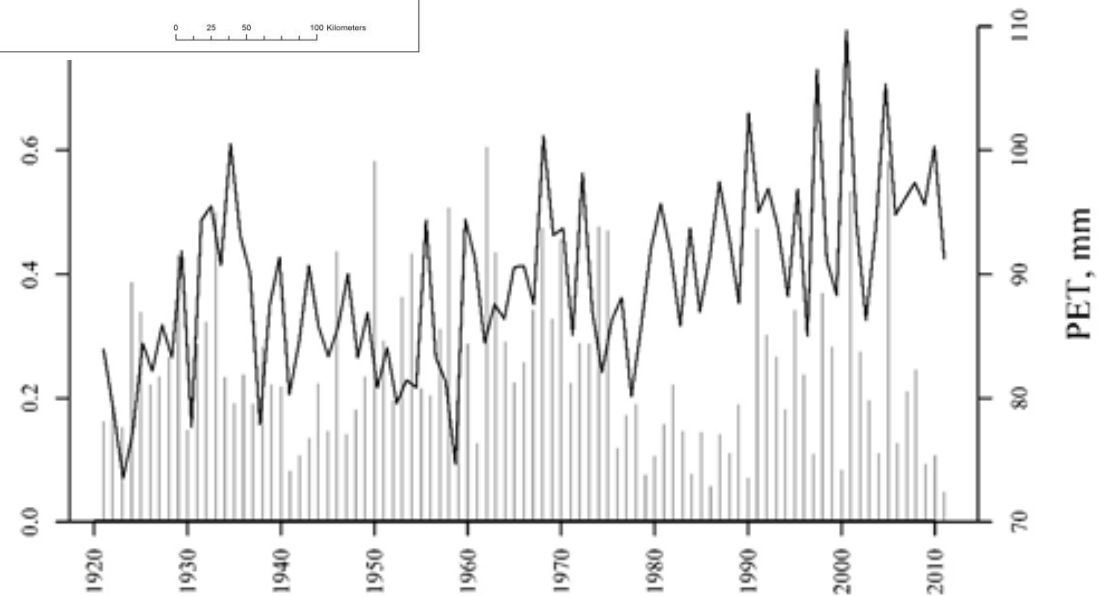
## Fire

Main ignition source (humans) is not likely to change, the potential for ignition (weather) is likely to get worse – we have to shape forest management accordingly



Mean annual number of forest fires per year per 1000 ha of sands with highest fire hazard class (1, 2)

Number of fires per 10000 ha of forests





## Fire

Factors affecting survival of trees

- Intensity and type of fire
- Tree species, age, dimensions (crown continuity, height, bark thickness)

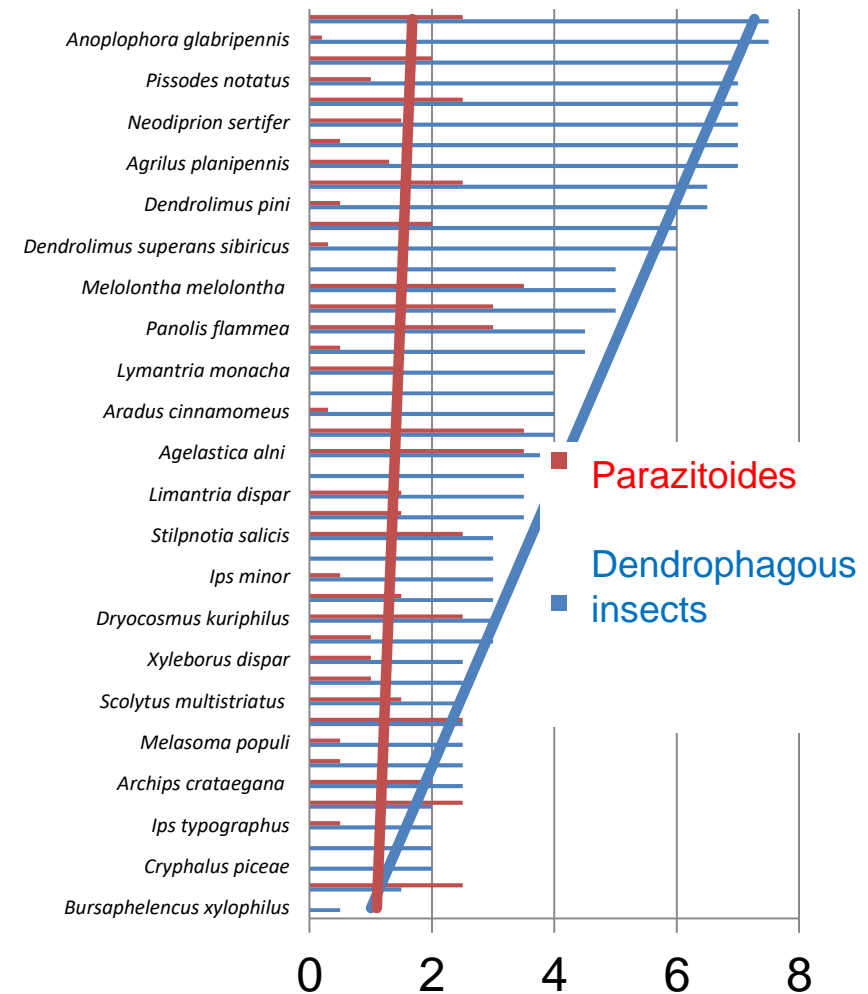




## Effect of natural disturbances (biotic)

Historical data on mass outbreaks in Central Europe (meta-analysis) and information on life-cycles of the species

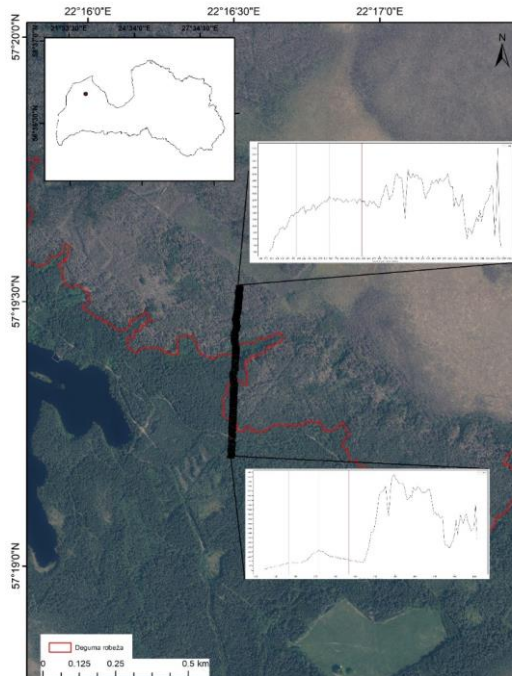
Notable and significant difference between the temperature optimum for reproduction found between dendrophagous insects and their parazitoides: 26,1°C un 22,7 °C, respectively



There will be more (potential) biotic damages in future



## Effect of natural disturbances (biotic)



Spruce (as a model):

- mixed stands do not change the probability of damages, avoiding commercial thinning in summer does,
- And mixture of different stands the forest landscape level does.

Monitoring and tools for timely detection are crucial





## Future of forest management

Mitigation of climate change and its impact on society and biological diversity

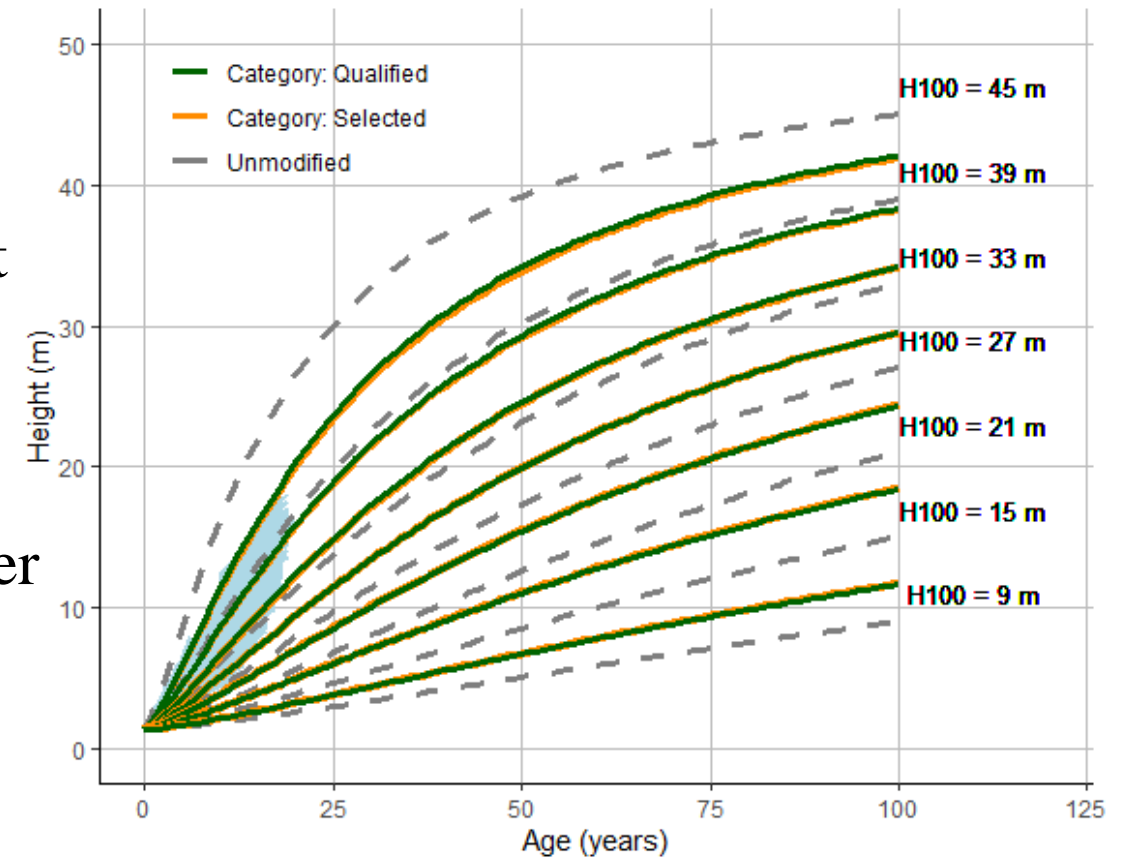
Adaptation of forests and forestry

Main objectives of **climate-smart forestry** is to ensure forest adaptation and resilience to climate change, to rise contribution to climate change mitigation and sustainably increase forest productivity and incomes. (Nabuurs et al., 2017)





- Planting of improved forest reproductive material ensures steeper growth trajectories at young age in comparison to unimproved (*unmodified growth function*)
- Notable differences between genotypes in growth trends, ensuring opportunity for shorter rotation, thus reduced risks, without a significant negative effect on wood quality or diversity (landscape scale)
- Notable differences between genotypes in reaction to meteorological conditions – potential for adaptation

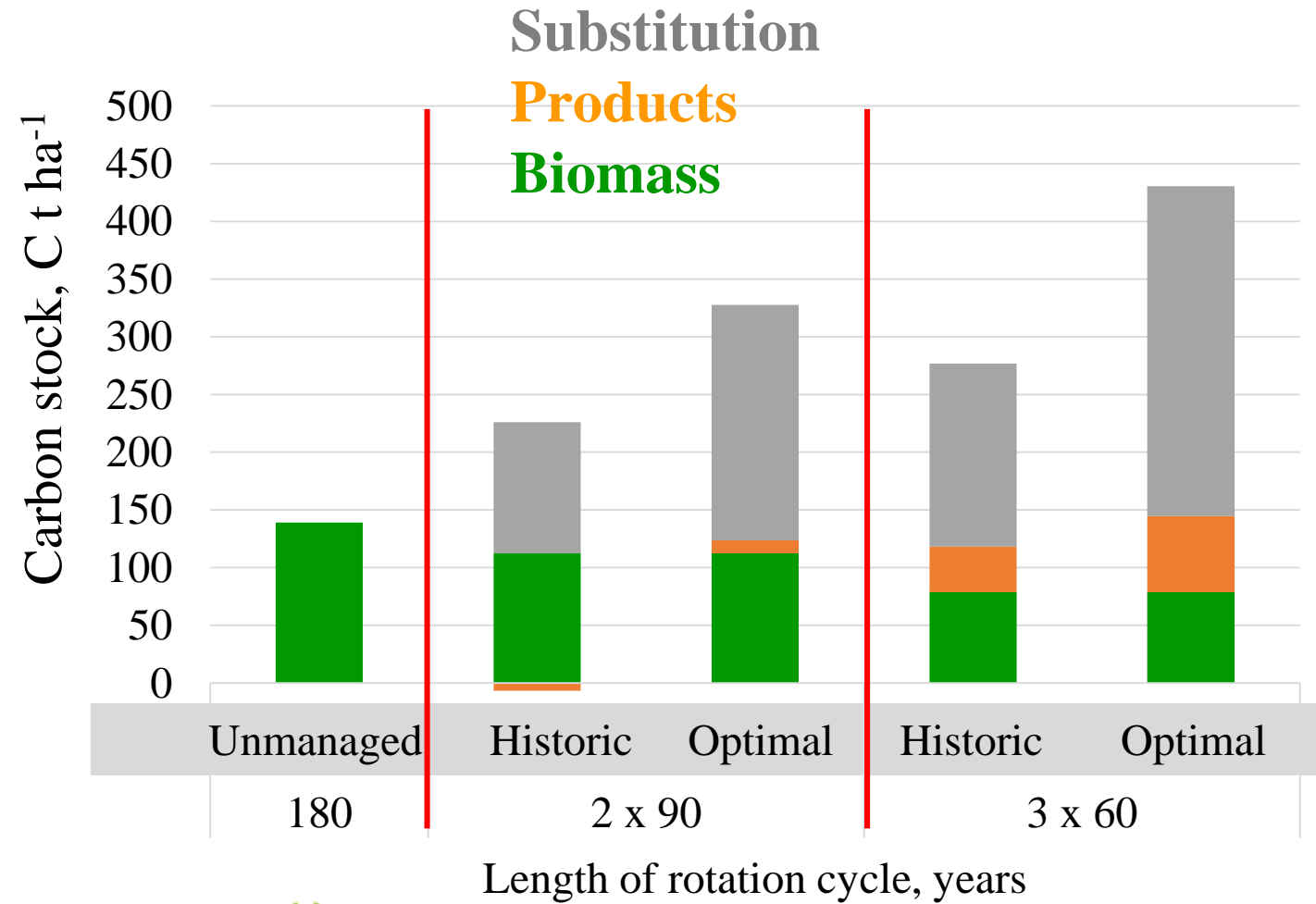


| MRES  | MRES % | AMRE S | RMSE  | RMSE % | MSE   | MEF   | VR    | R2_efron | N     |
|-------|--------|--------|-------|--------|-------|-------|-------|----------|-------|
| 0.077 | 1.527  | 0.441  | 0.717 | 14.298 | 0.514 | 0.052 | 1.040 | 0.945    | 19219 |



Effective use of forest  
land for climate change  
mitigation

Example: Norway spruce





Combining biodiversity maintenance with economics in Northern forests – very much possible, if we would like to (*an avoid extremists*)





# Thank You!

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