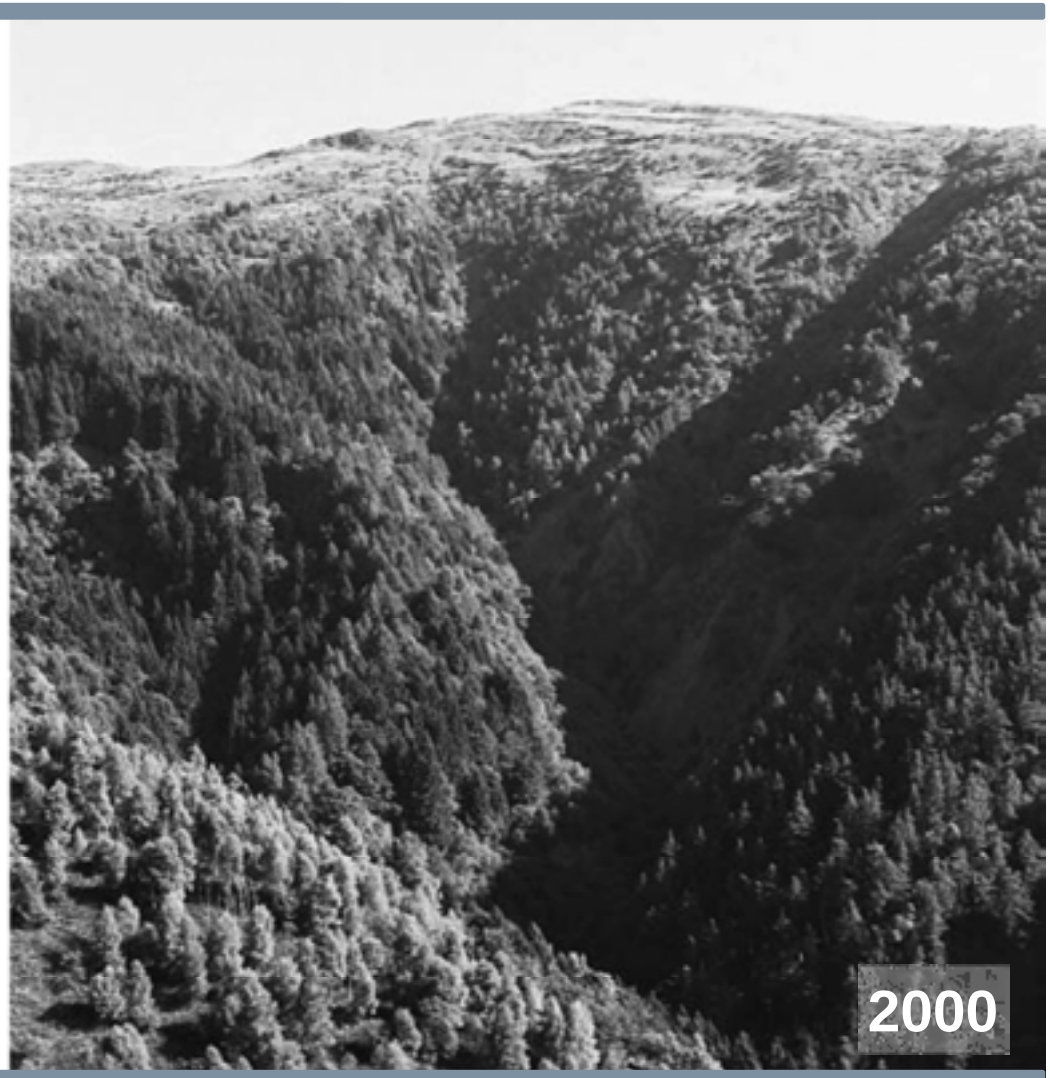
Berner Fachhochschule

Tree roots, probability, and ecosystem services: transfer of experiences from the Alps



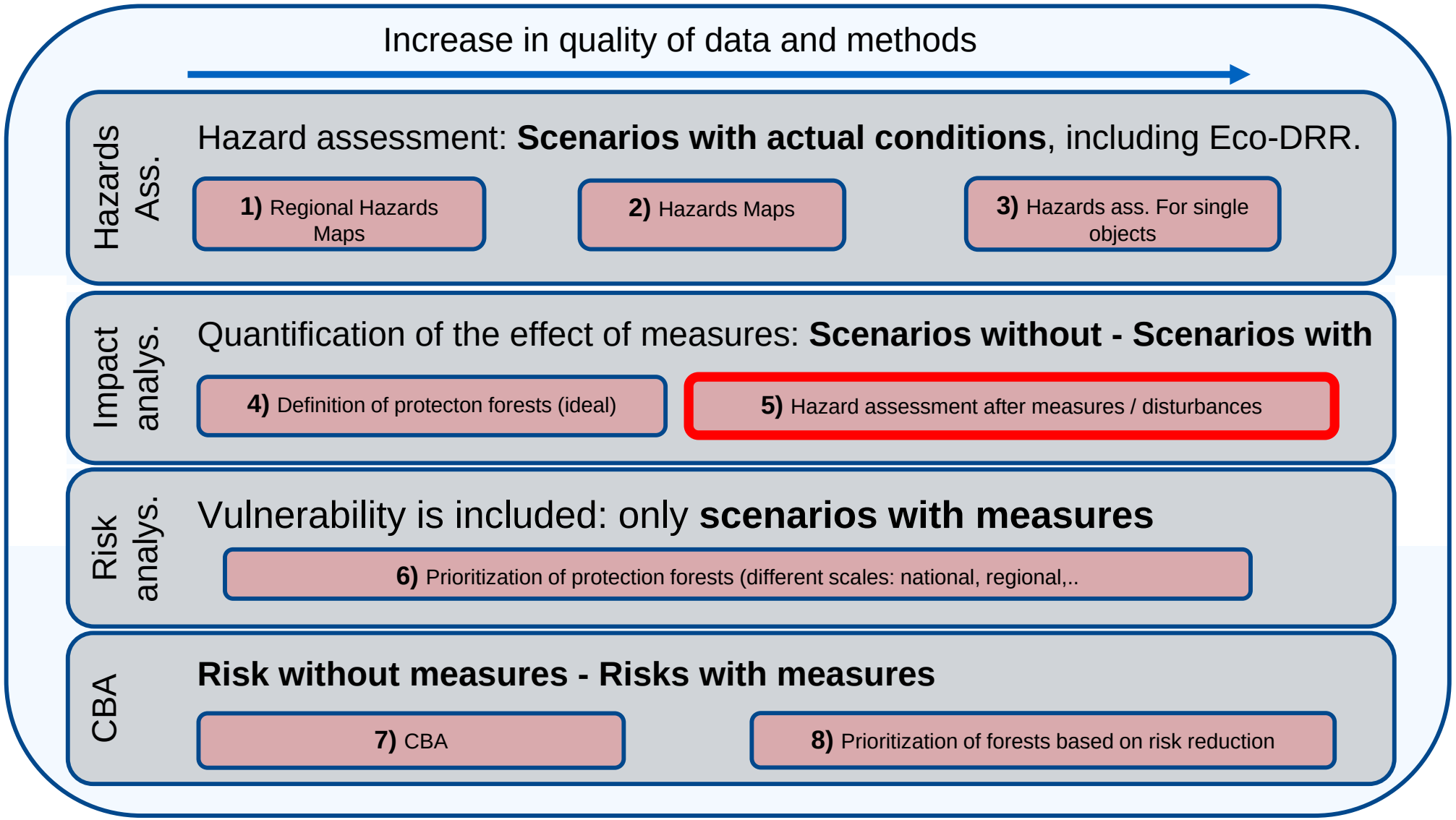
Schwarz M., van Zadelhoff F., Ngo M., Vuaridel M.

September 13th, 2023


Vogel L. (1788-1846)


1876 – First forest law
1930
1933
1953
1983
1991 – Protection forests law, first subsidies
2005 – Guidelines for forest management, NaiS
2008 – SilvaProtectCH, national map of protection forests
2010

Different levels of hazard and risks analysis in CH

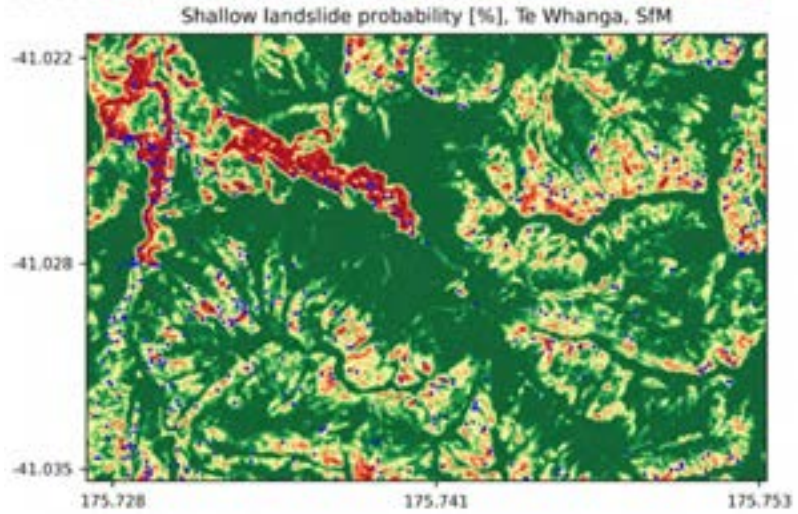


STEC's Activities:
How could the CH approach apply to NZ?

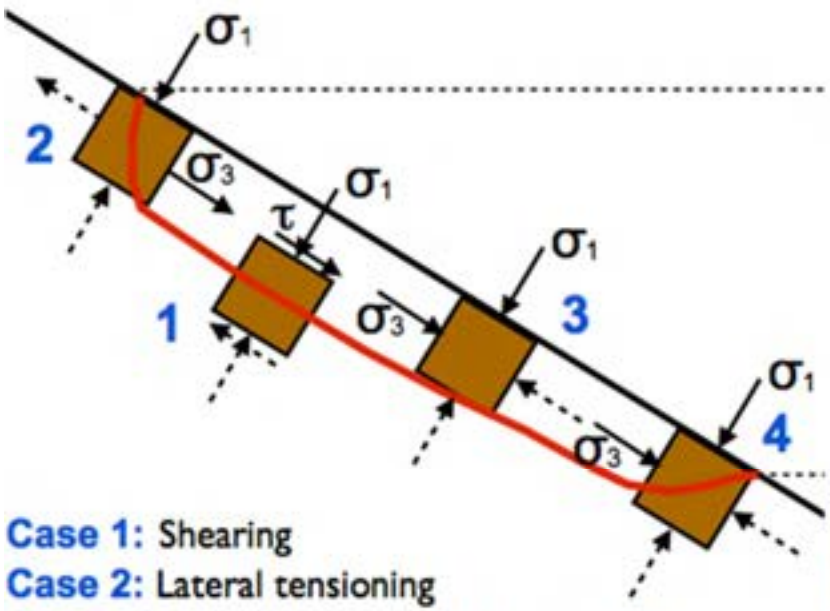
- **Upscaling of root reinforcement** (**Feiko + My**): Poplar (+Radiata)

- **Validation of slope stability and bank erosion models in NZ** (**Feiko**): Waikoukou and Te Whanga.

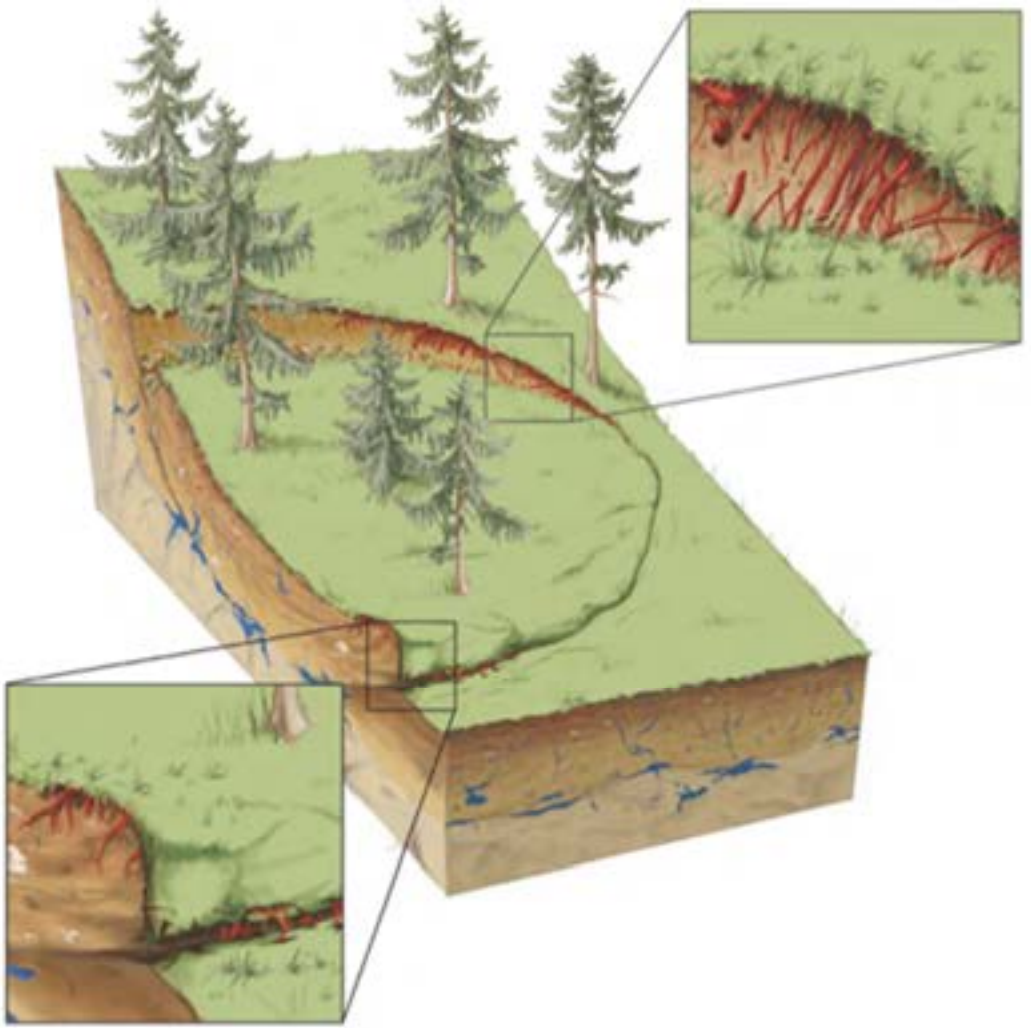
- **Impact analysis of bioengineering measures at catchment scale** (**Marceline + My + Feiko**): Te Whanga case study



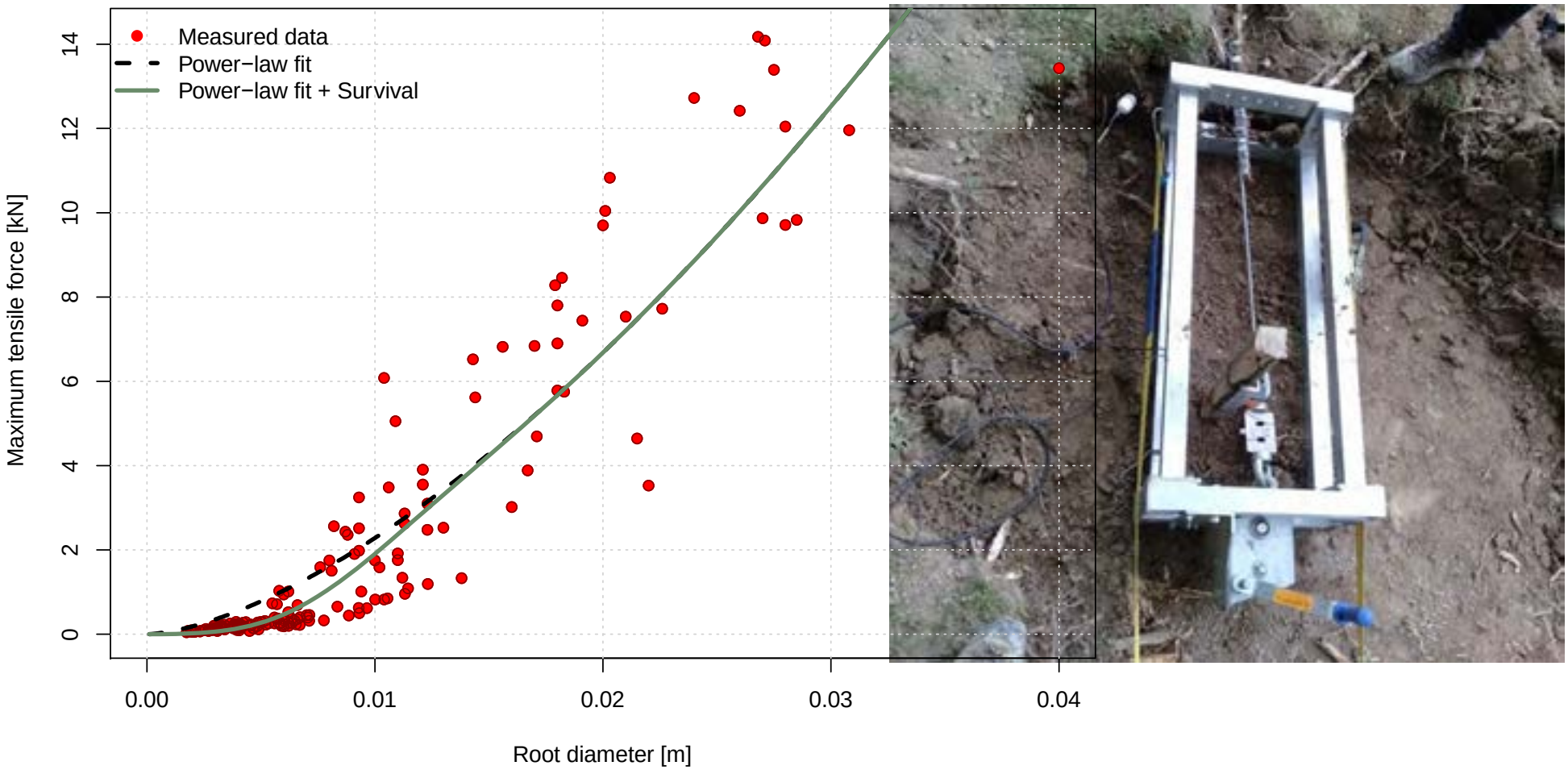
Mechanisms of root reinforcement



Case 1: Shearing
Case 2: Lateral tensioning
Case 3: Lateral compression before failure
Case 4: Lateral compression after failure



Upscaling of root reinforcement: Root mechanical properties

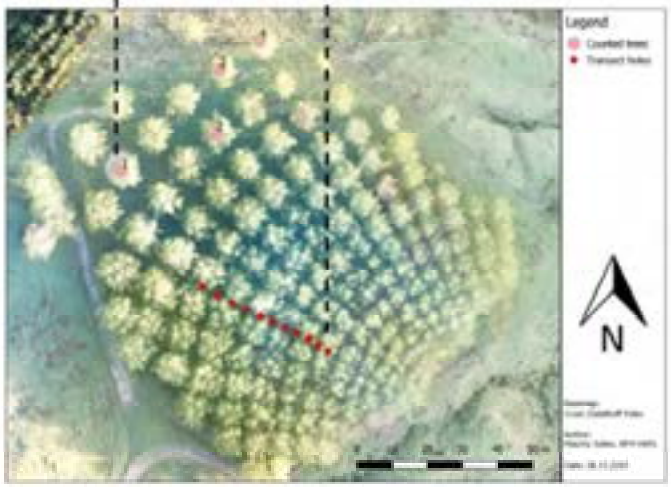


Upscaling of root reinforcement: Root distribution

Measured tensile force
124 laboratory tensile tests
66 field pull-out tests

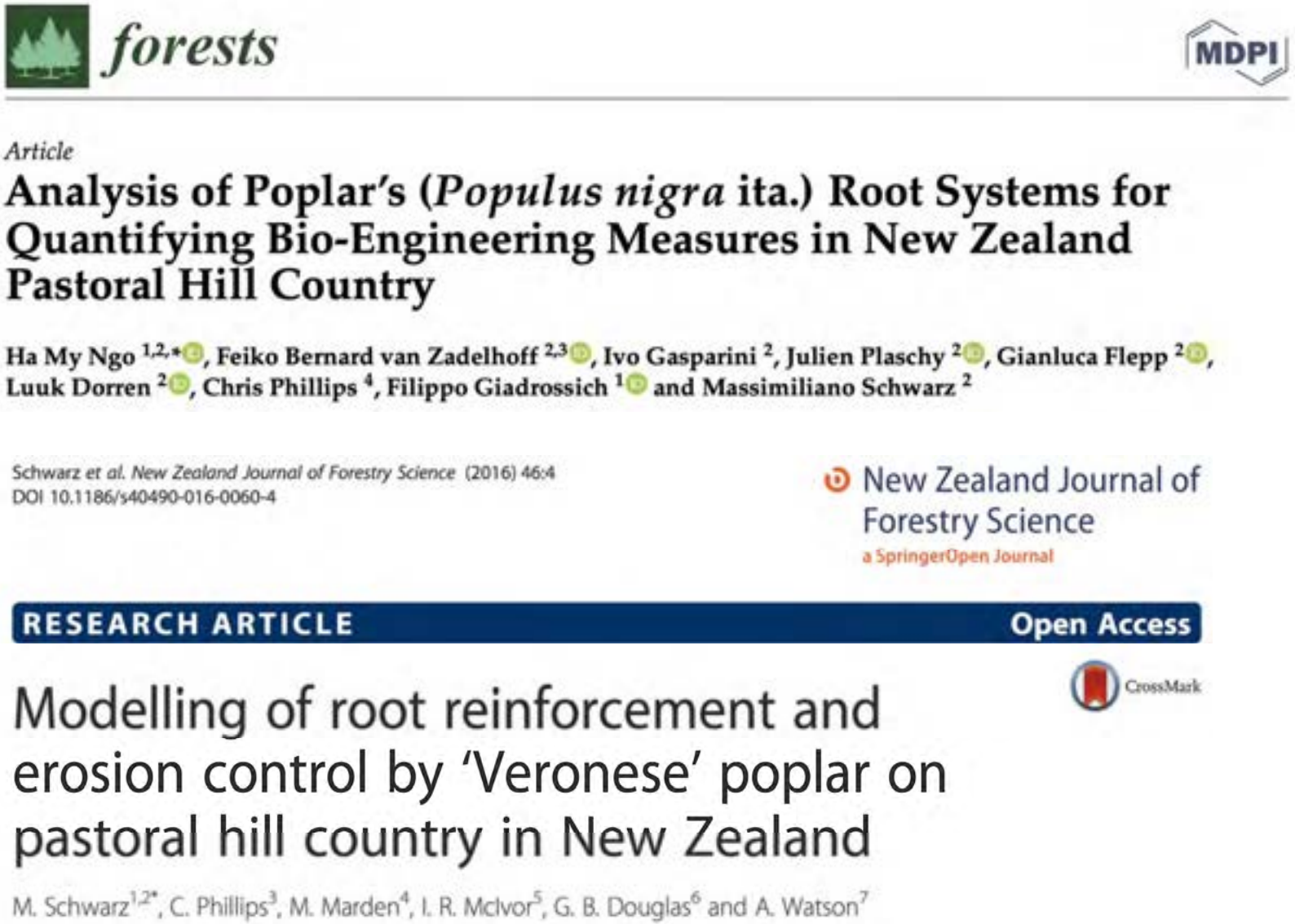
Root Bundle Model with Weibull survival function

Measured root distribution
Root distribution in trenches at 1.5, 2.5, 3.5, and 4.5 m distances from the steam of 4 poplar trees located in the sparse zone.
Root distribution in 11 transect holes located in a sparse to the dense zone.



Upscaling of root reinforcement: Root distribution

Berner Fachhochschule



forests

MDPI

Article

Analysis of Poplar's (*Populus nigra* ita.) Root Systems for Quantifying Bio-Engineering Measures in New Zealand Pastoral Hill Country

Ha My Ngo [1,2,*], Feiko Bernard van Zadelhoff [2,3], Ivo Gasparini [2], Julien Plaschy [2], Gianluca Flepp [2], Luuk Dorren [2], Chris Phillips [4], Filippo Giadrossich [1] and Massimiliano Schwarz [2]

Schwarz et al. New Zealand Journal of Forestry Science (2016) 46:4
DOI 10.1186/s40490-016-0060-4

New Zealand Journal of Forestry Science
a SpringerOpen Journal

RESEARCH ARTICLE Open Access

CrossMark

Modelling of root reinforcement and erosion control by 'Veronese' poplar on pastoral hill country in New Zealand

M. Schwarz[1,2*], C. Phillips[3], M. Marden[4], I. R. McIvor[5], G. B. Douglas[6] and A. Watson[7]

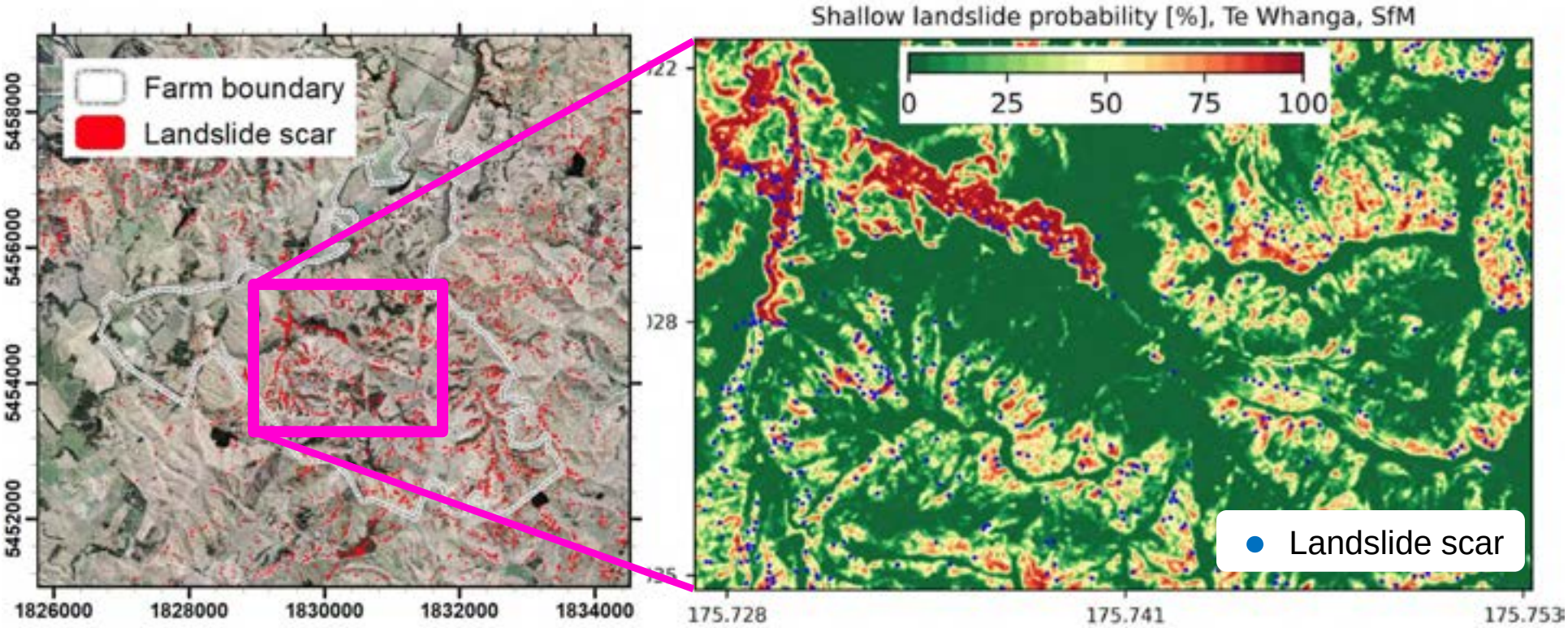
Modelling of shallow landslides: Validation in NZ

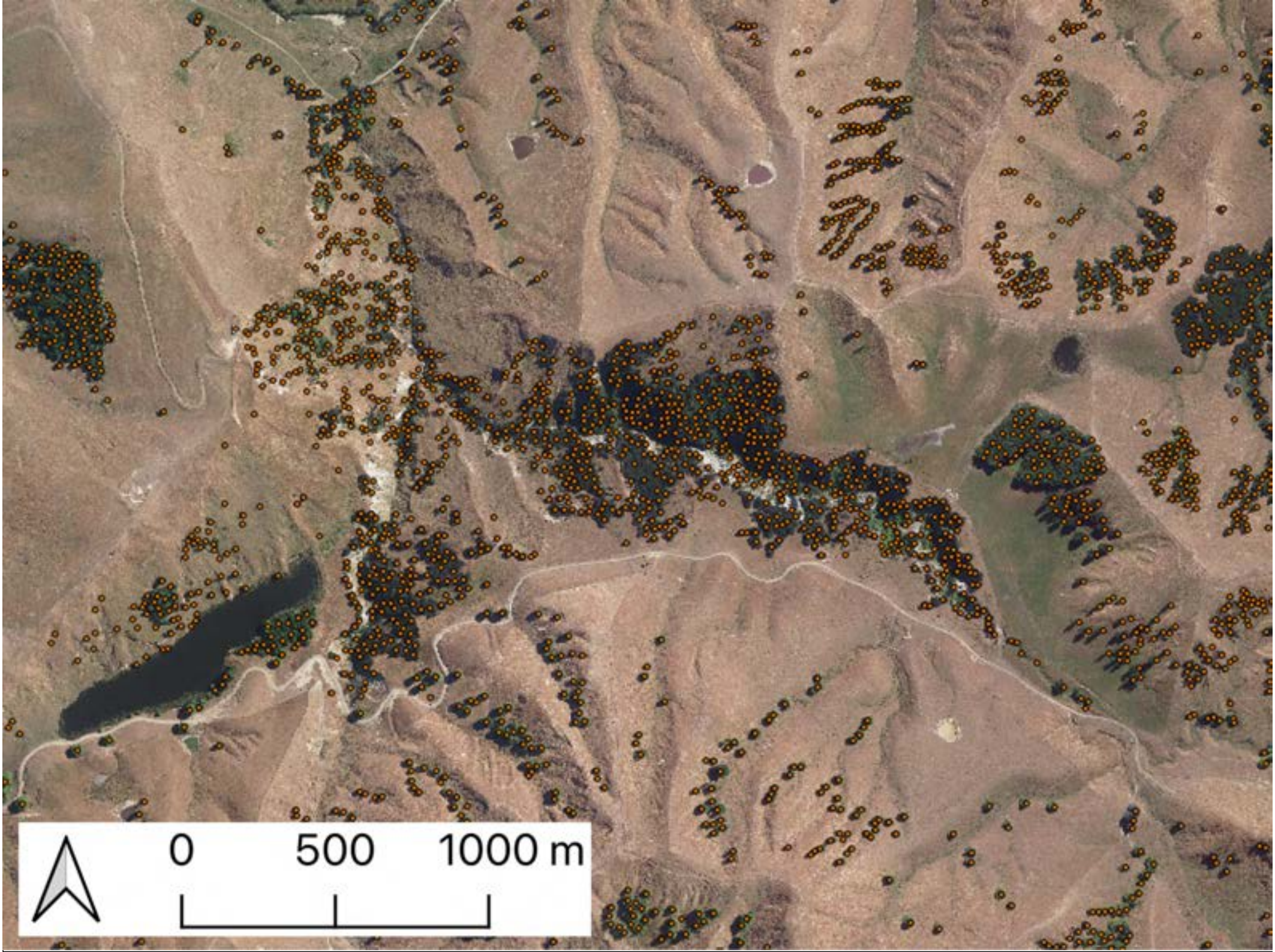
Berner Fachhochschule

Application and validation of SlideforMAP for assessing shallow landslide probability in New Zealand hill country

Feiko Bernard van Zadelhoff*[1,2], Bettina Schaefli[2], Chris Phillips[4], Massimiliano Schwarz[1,3]

Ecological engineering (Elsevier journal)
Submitted, under review, preprint DOI: 10.5281/zenodo.7615348



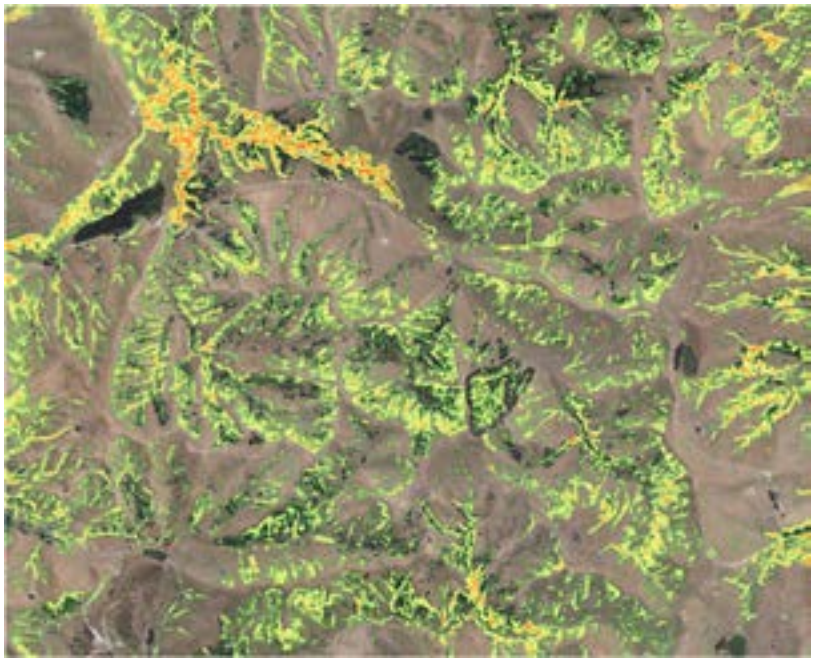

0
500
1000 m

Impact analysis of bioengineering measures: **Te Whanga** case study

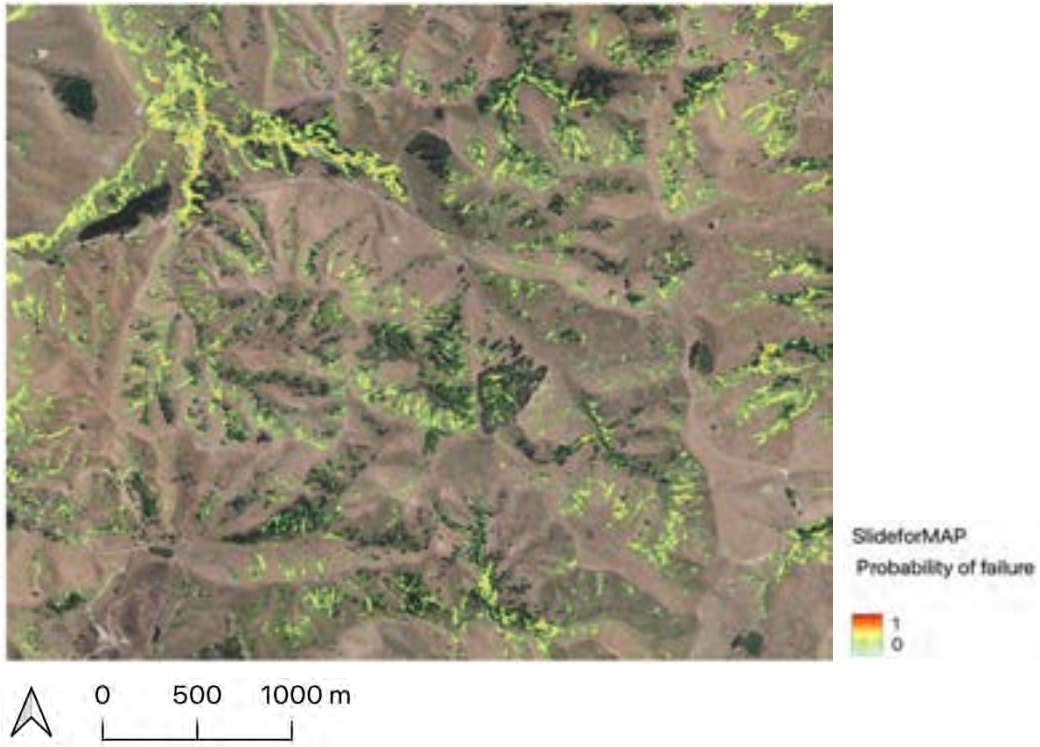
Berner Fachhochschule

- **Example of simulation for a 250 y. return period**

Actual vegetation



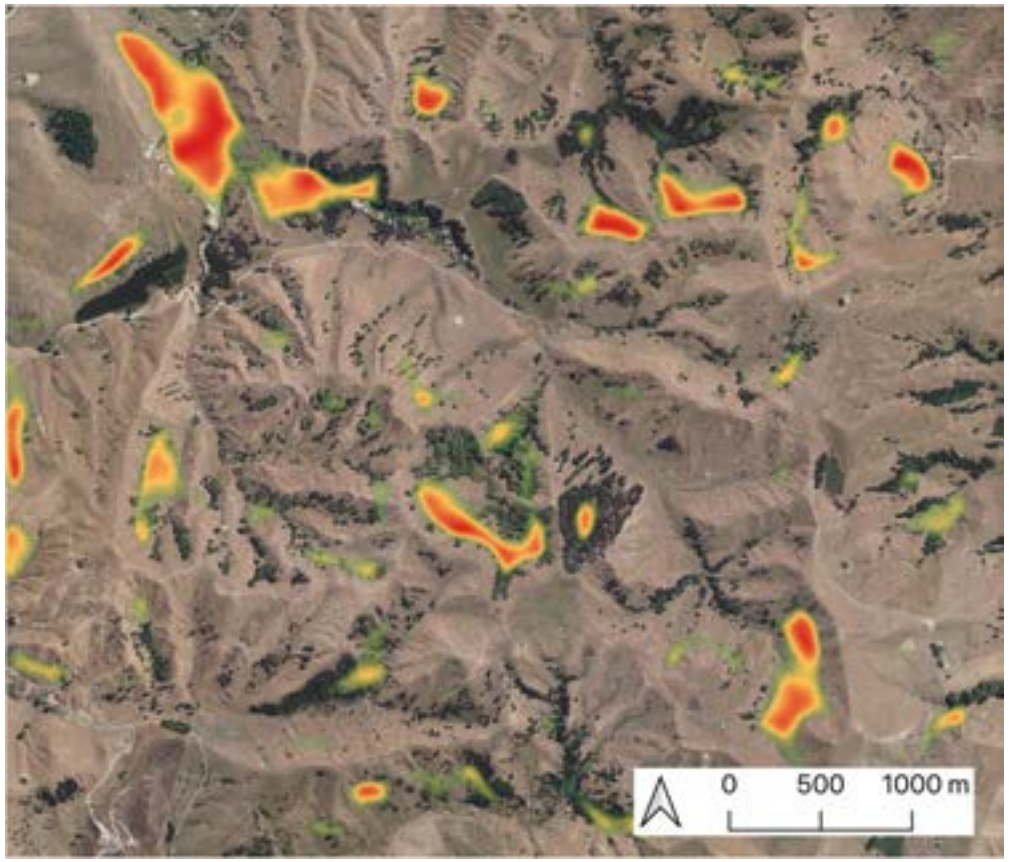
Ideal vegetation



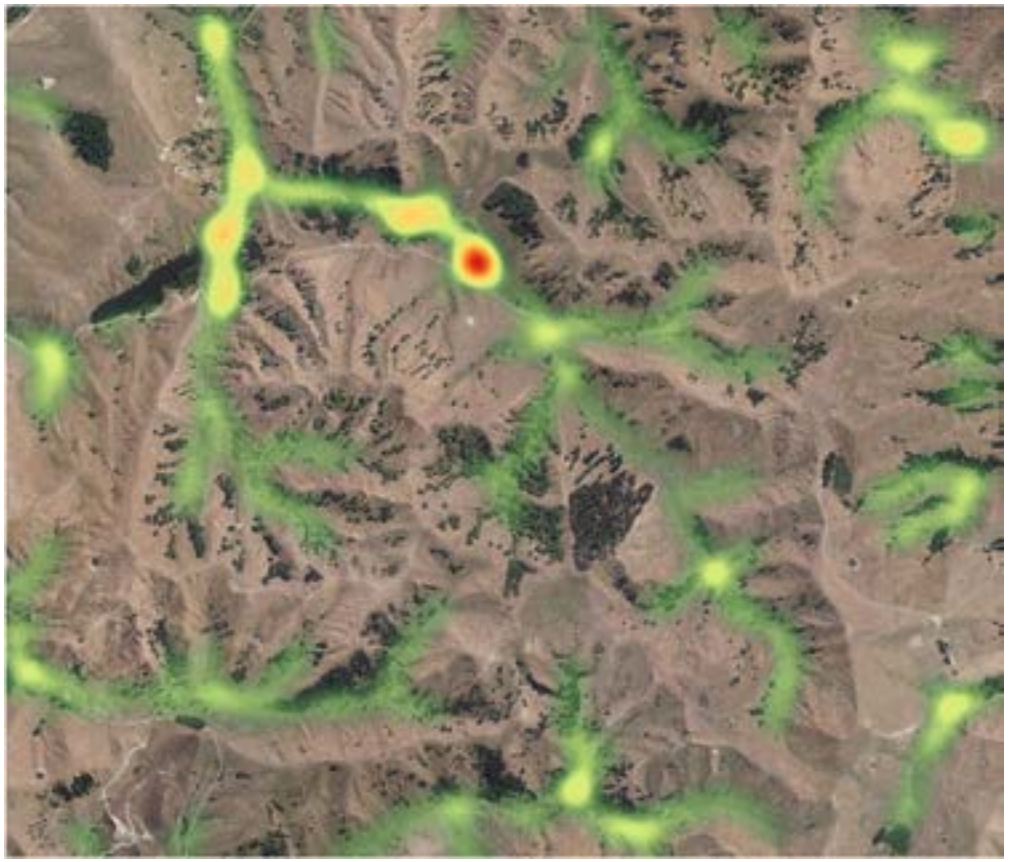
Impact analysis of bioengineering measures: **Te Whanga** case study

Berner Fachhochschule

Shallow landslides



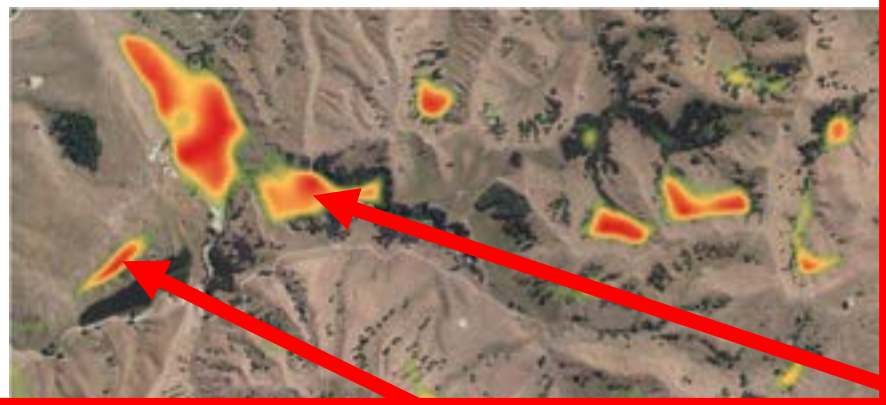
Bank erosion



Impact analysis of bioengineering measures: **Te Whanga** case study

Berner Fachhochschule

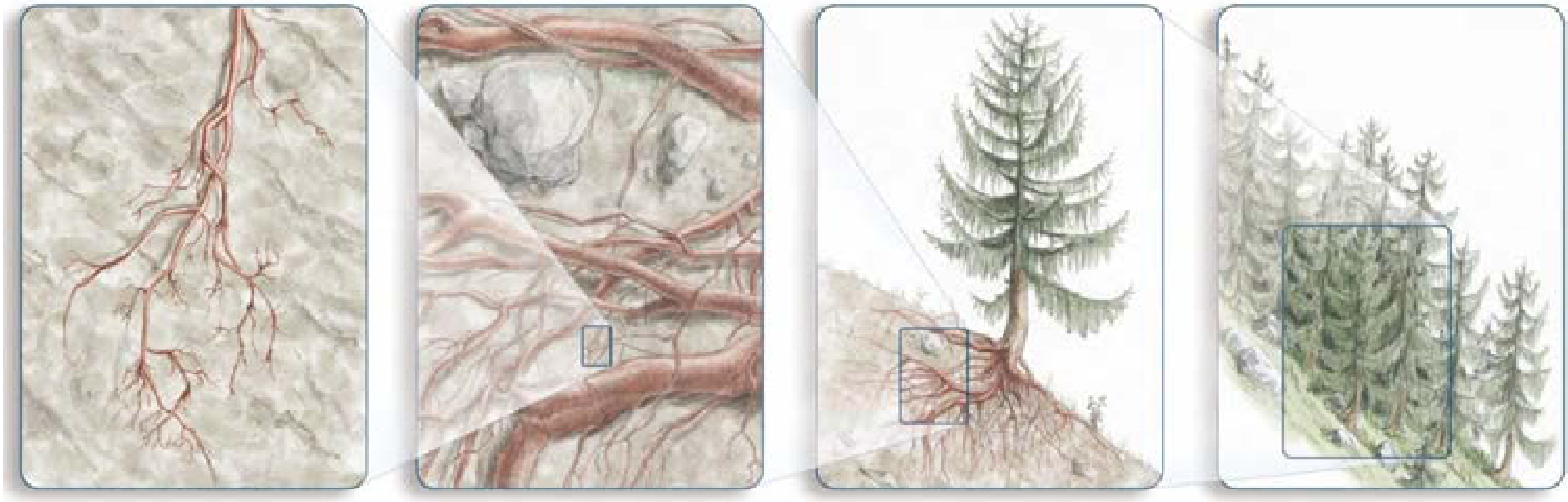
Shallow landslides




Thanks for your attention…….

Upscaling of root reinforcement

Schwarz et al. (2010), ESPL

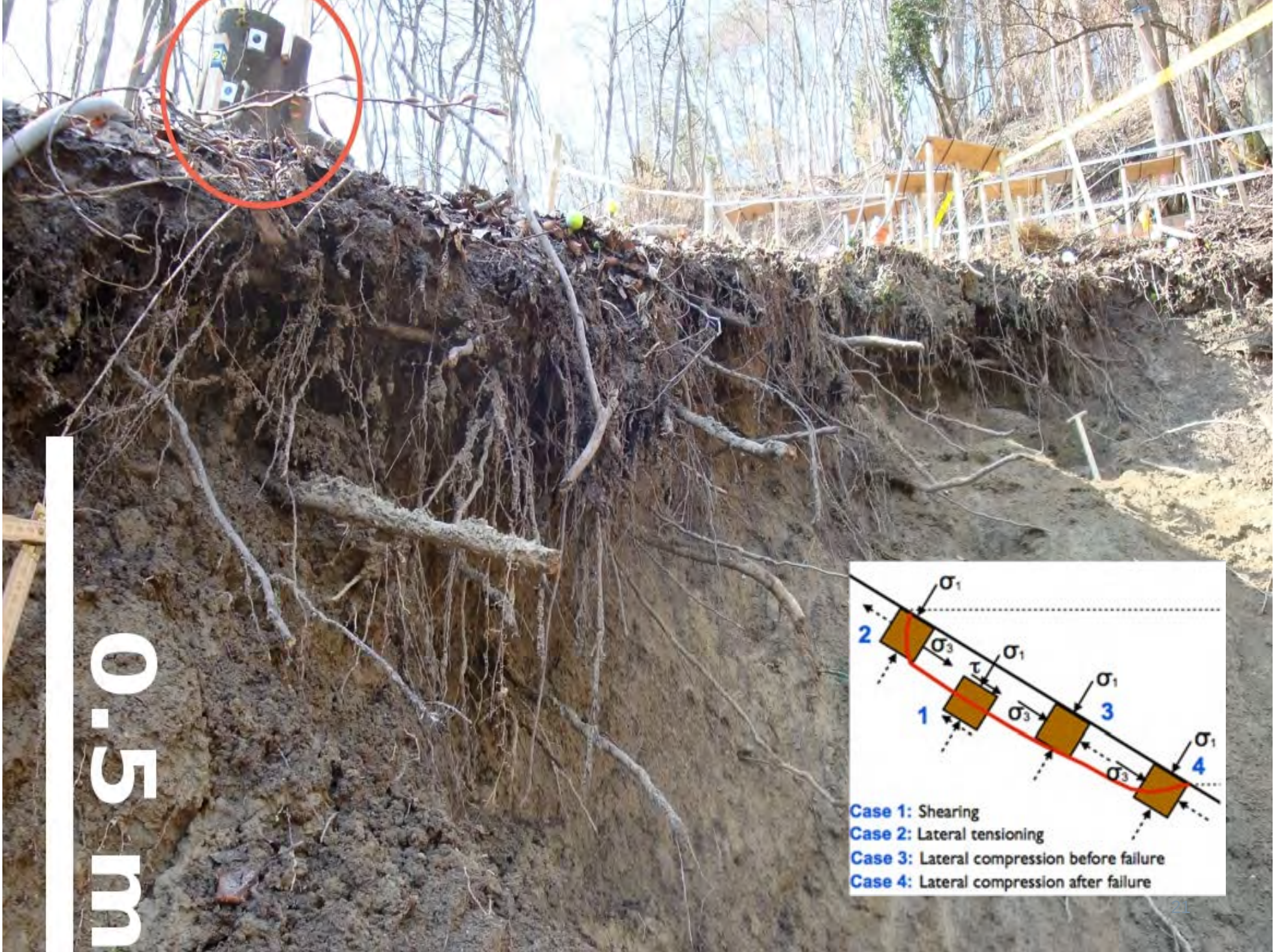


Root Bundle Model

Root Distribution data

Forest stand structure

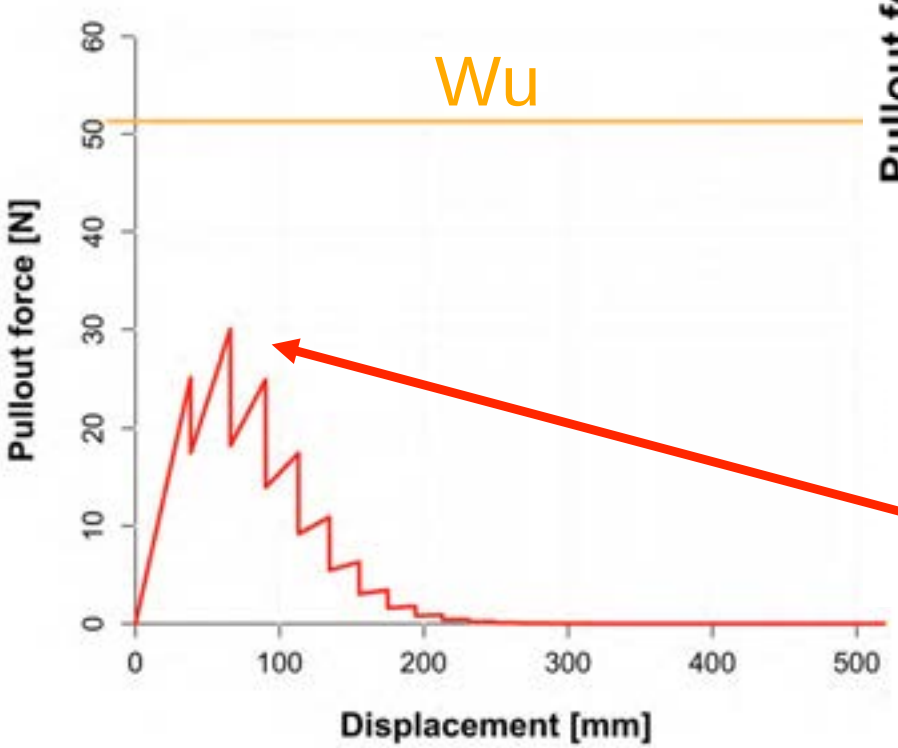

Where , when and how does this forest protect?

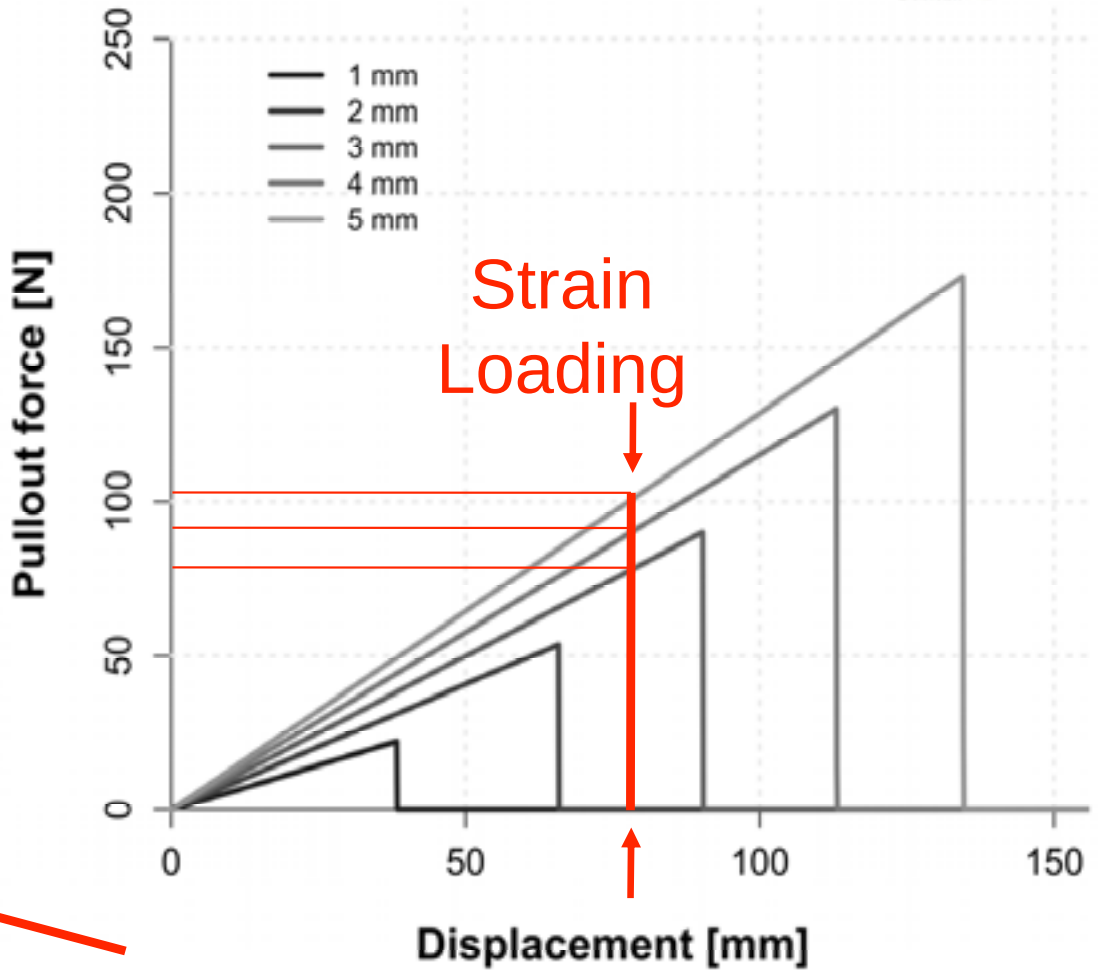

0.5 m
σ1
2
σ3
σ1
τ
σ1
1
σ3
3
σ1
σ3
4
Case 1: Shearing
Case 2: Lateral tensioning
Case 3: Lateral compression before failure
Case 4: Lateral compression after failure

Root reinforcement mechanisms

The “Root Bundle Model - RBM”:

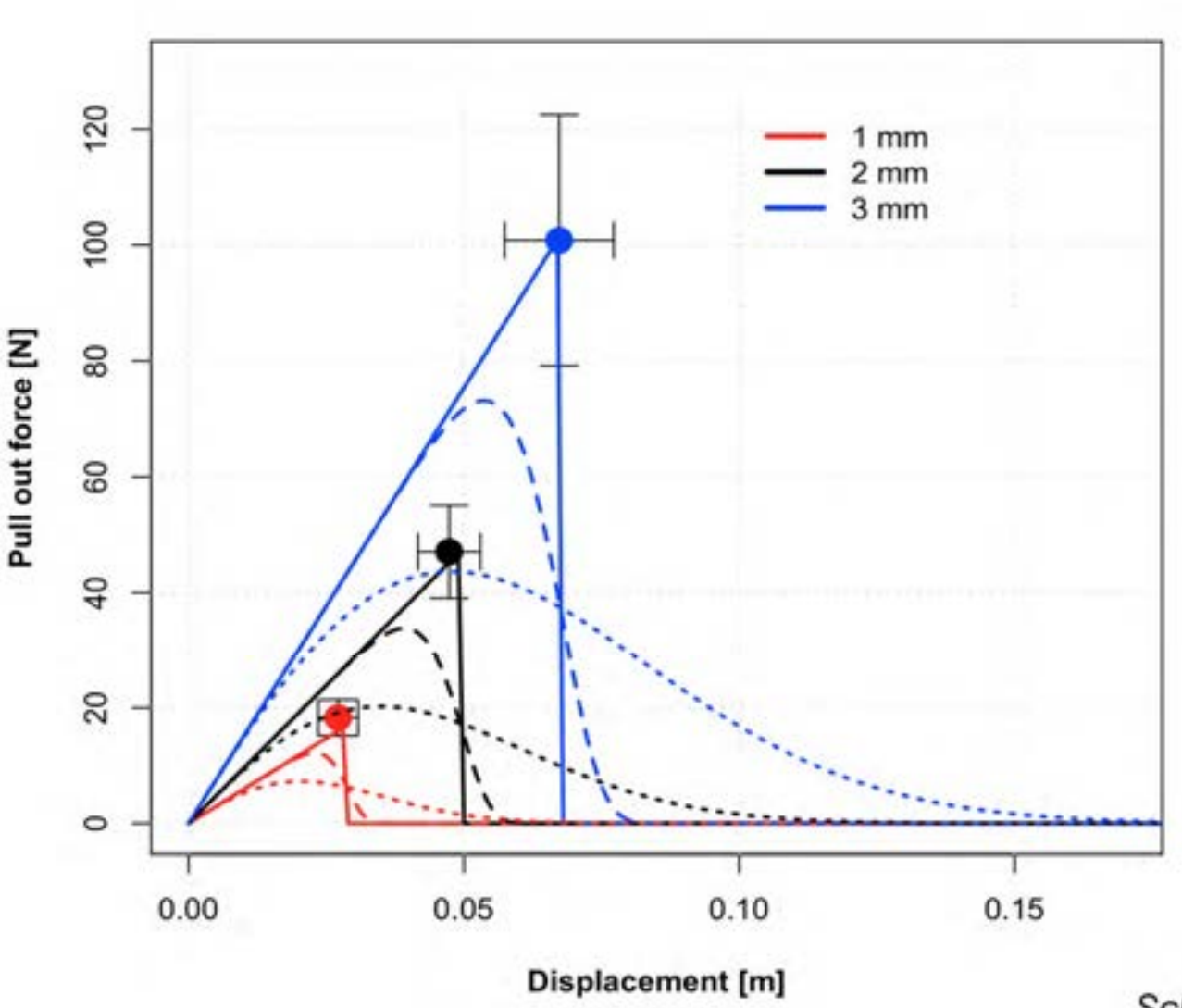
Calculation of root reinforcement





Root Bundle Model
(Schwarz et al., 2010, JGR)

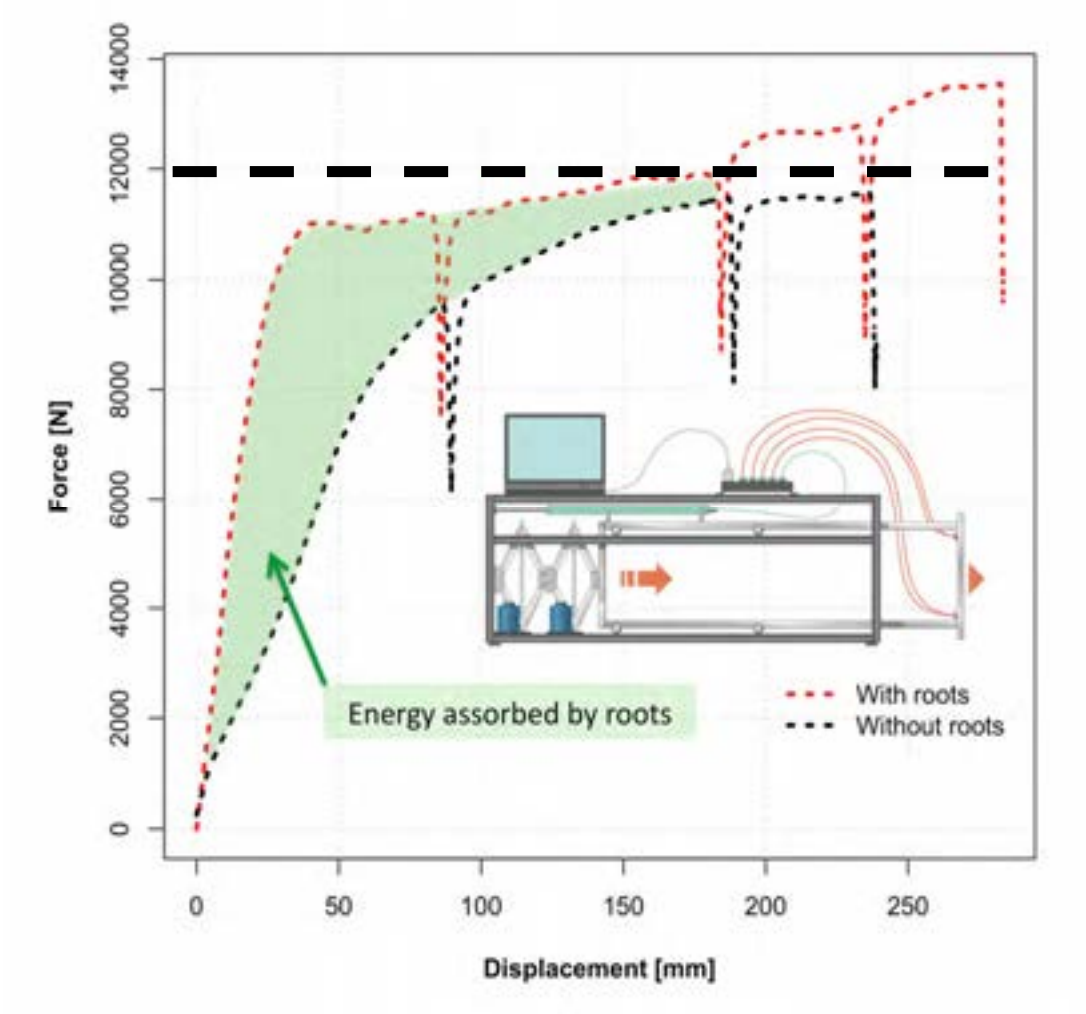
The “Root Bundle Model - RBMw”:
Calculation of root reinforcement



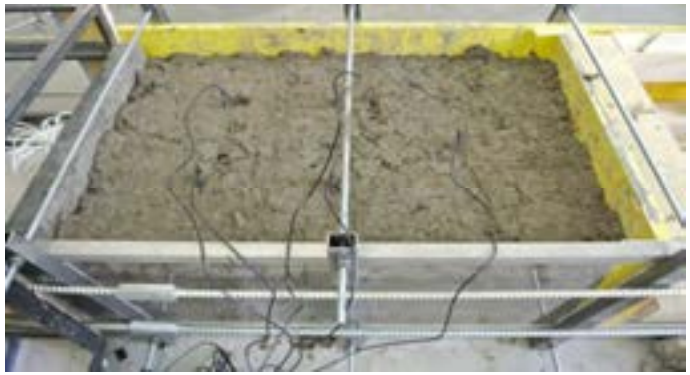
Schwarz et al., 2013, HESSD

The “Root Bundle Model - RBMw”:
Compression

Schwarz et al. (2015), JGR



Detail of compressed rooted soil



Box used for the lab. experiments

Betula pendula

Ailanthus altissima

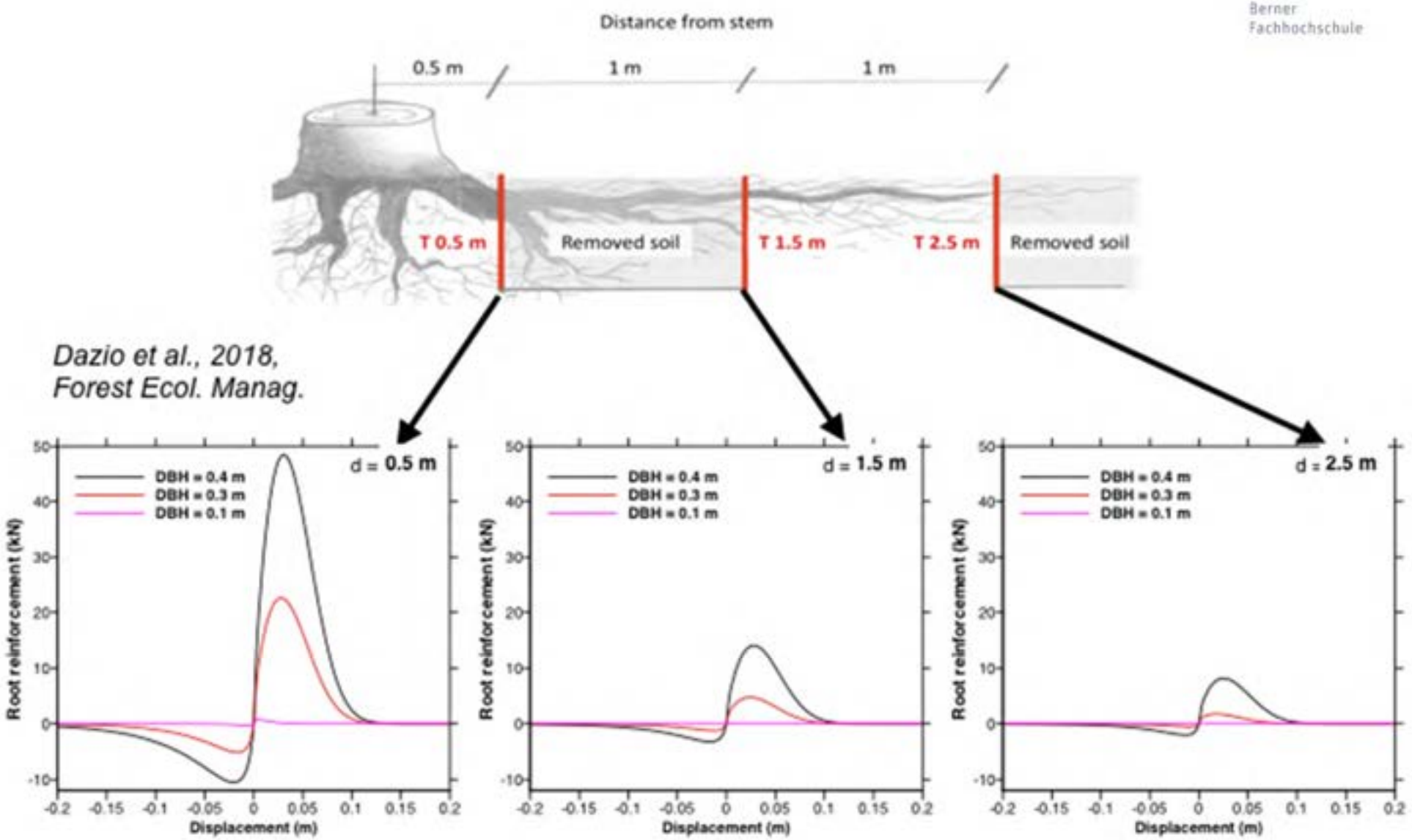
Castanea sativa


Quercus pubescens


Trachycarpus fortunei

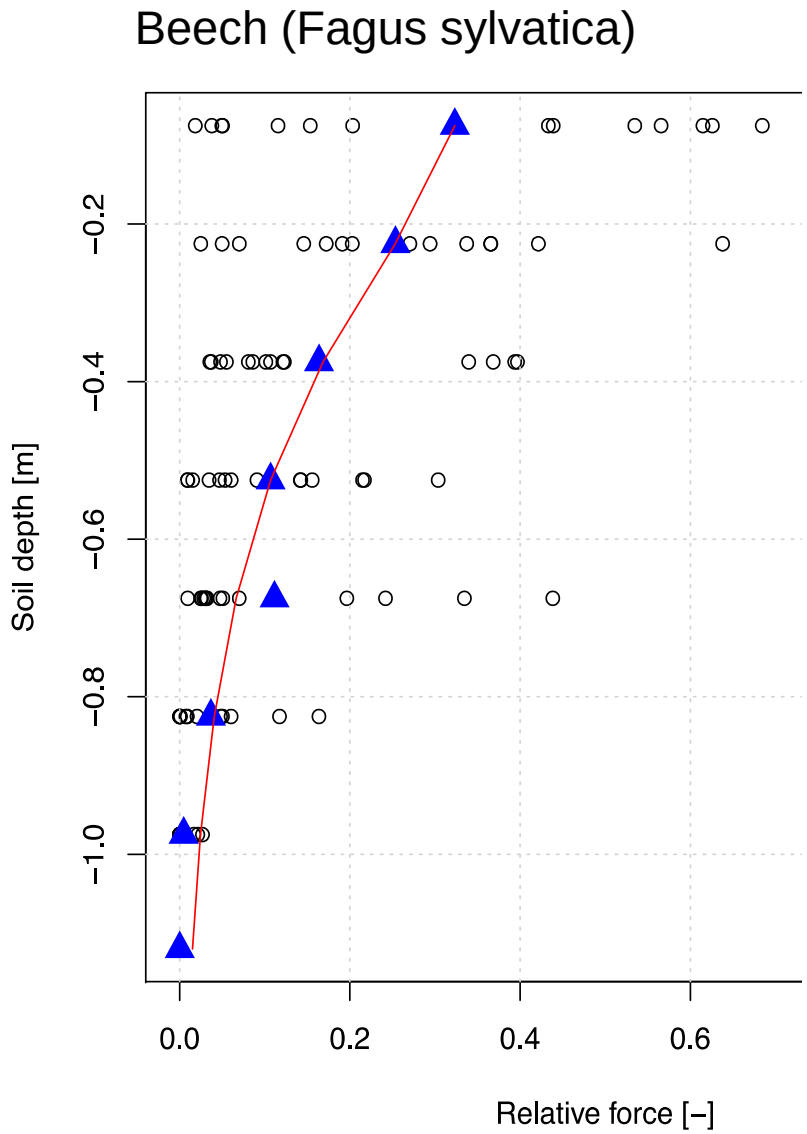
Distribution of root reinforcement:

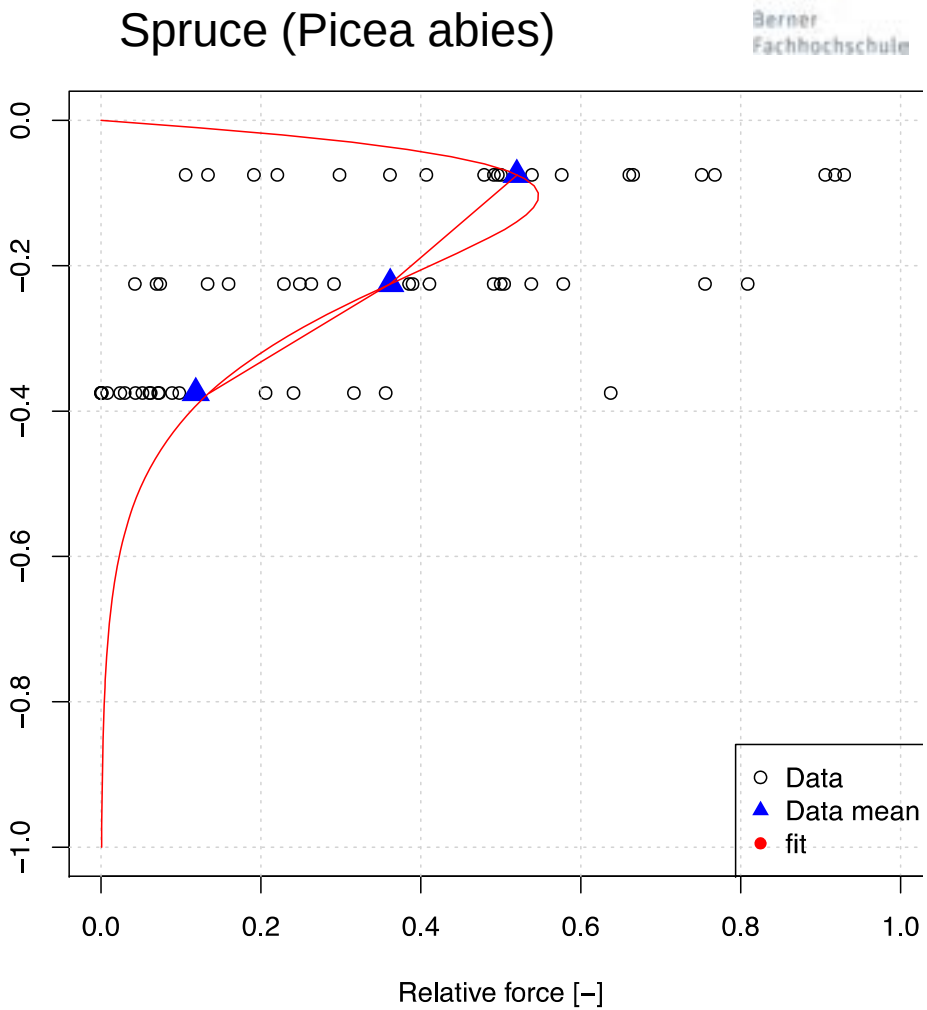
Horizontal distribution of root reinforcement



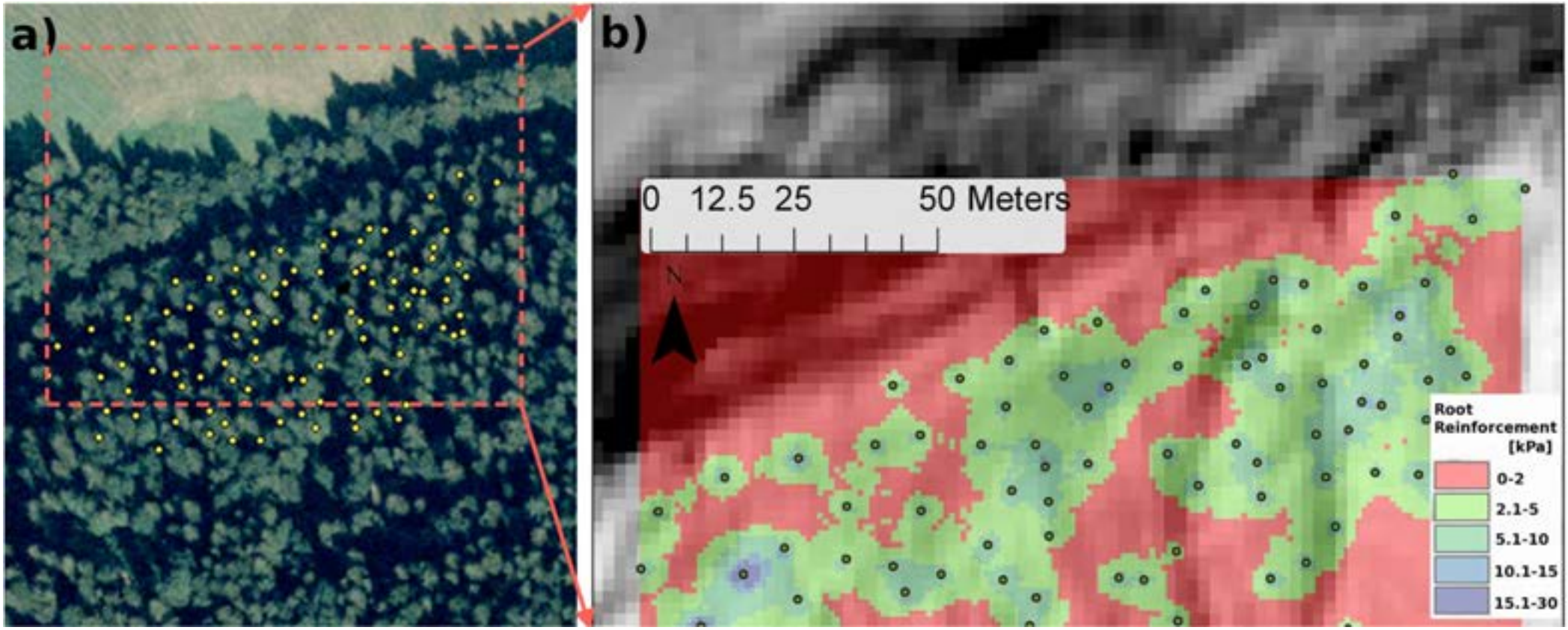
Distribution of root reinforcement:

vertical distribution of root reinforcement





Spatial distribution of root reinforcement:
as function of cover structure

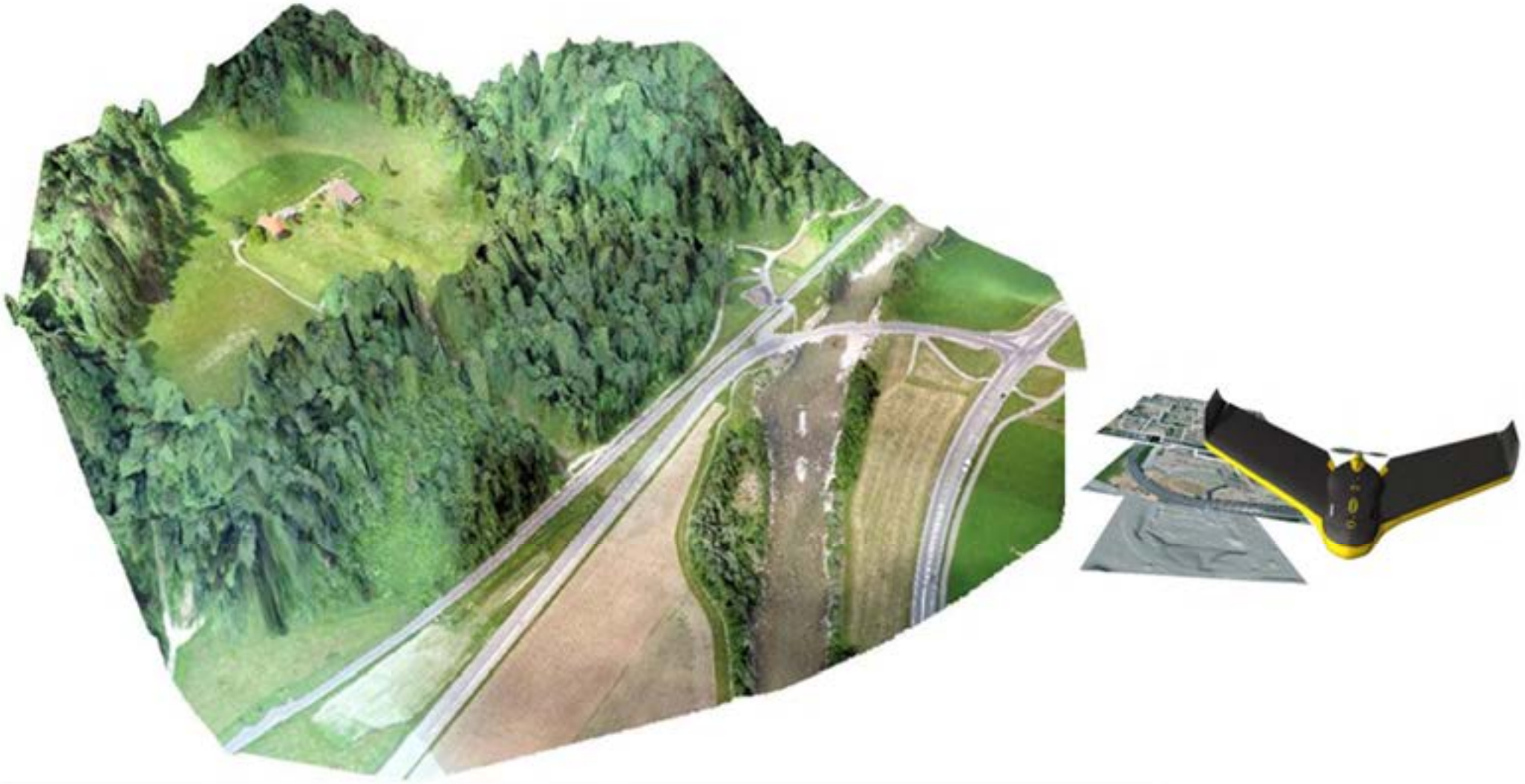


Steinmösli, Emmental, CH

Schwarz et al., 2012, Geosciences

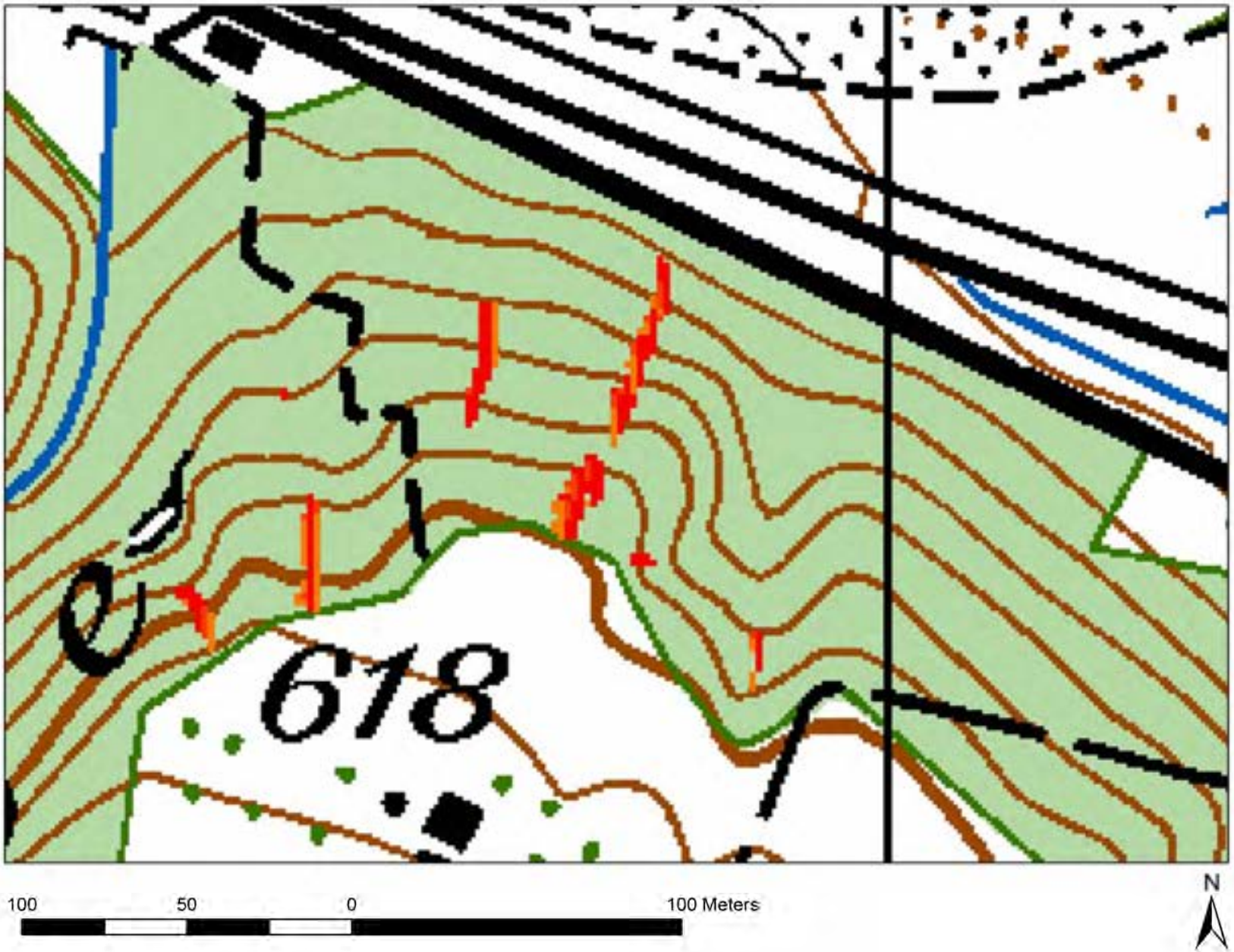
Example SOSlope: Protect-Bio

Example SOSlope: Protect-Bio

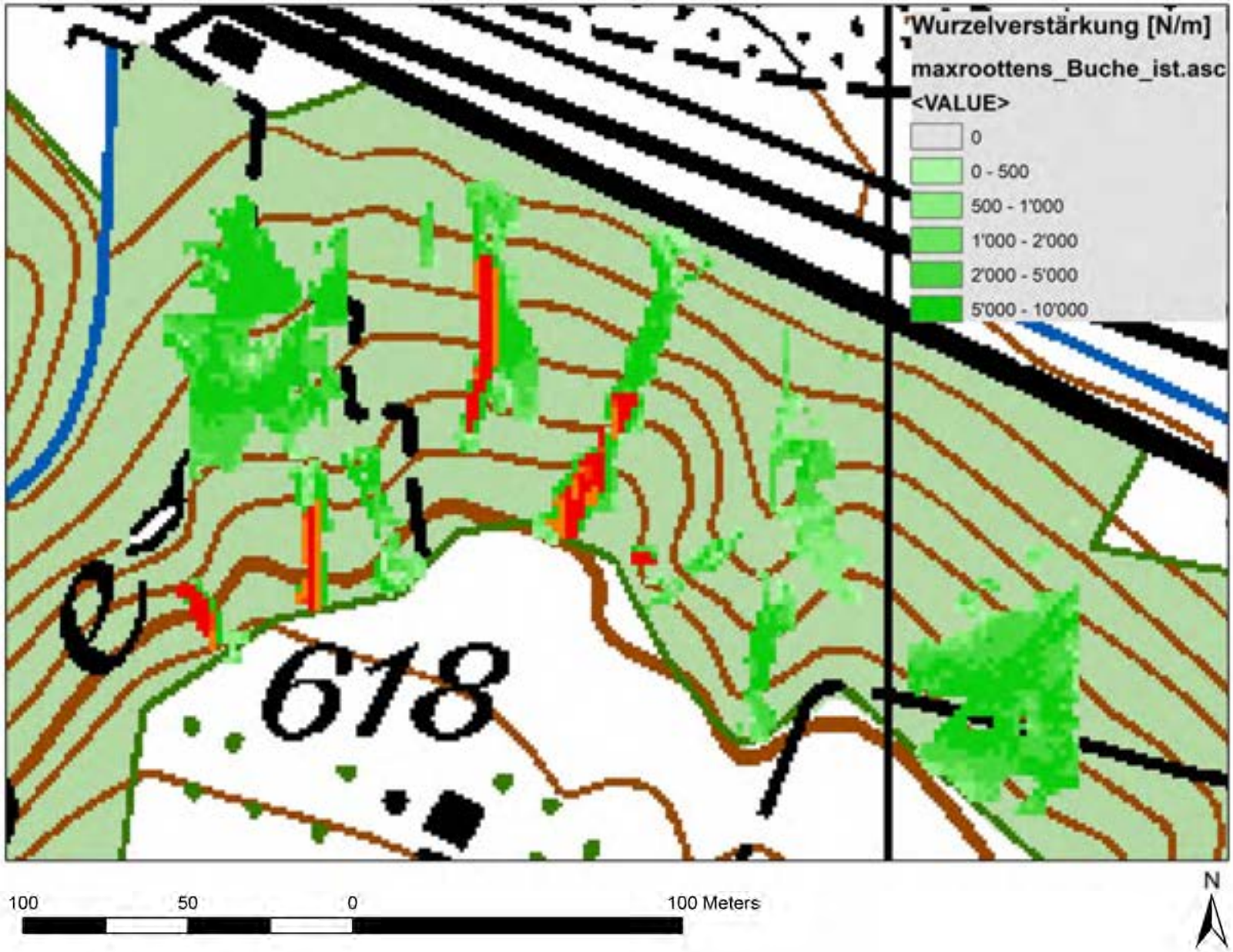


Example SOSlope: Protect-Bio

SOSlope, 100J, mit Wald, IST (Fichte)



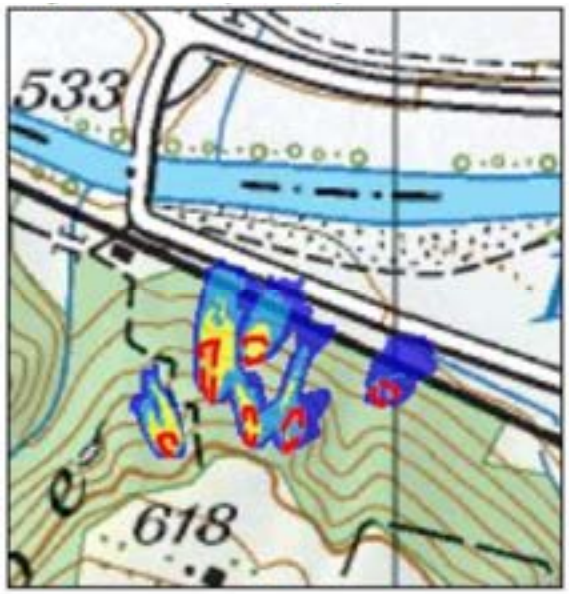
SOSlope, 100J, mit Wald, IST (Buche), aktivierte Wurzelverstärkung



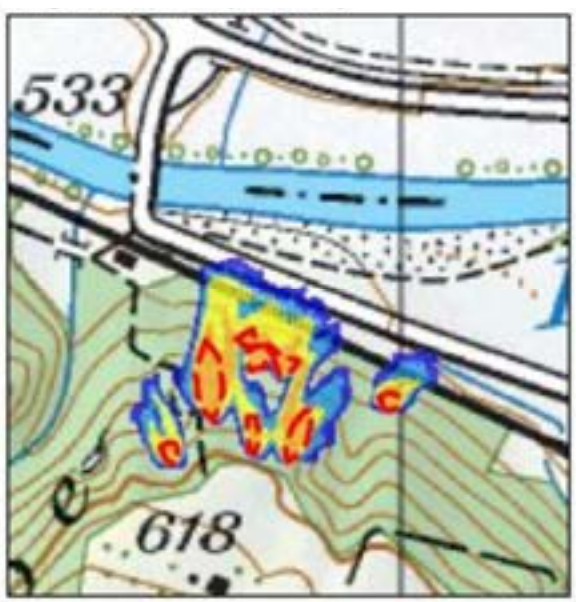
Example SOSlope: Protect-Bio

Berner Fachhochschule

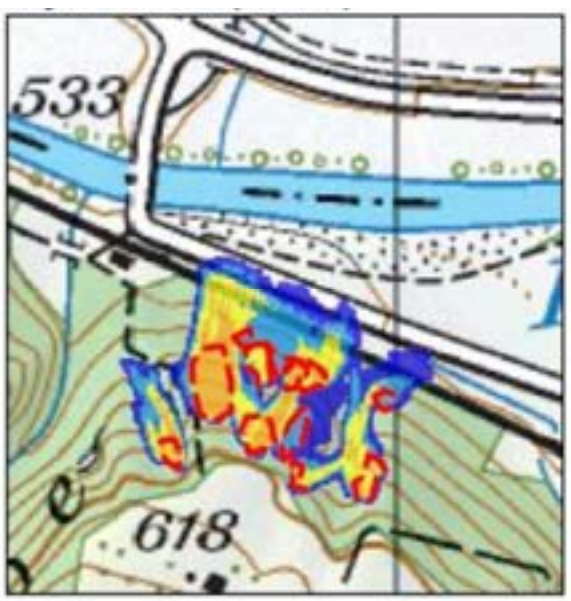
Szenario 10 Y, without forest



Szenario 30 Y, without forest



Szenario 100 Y, without forest



Example SOSlope: Protect-Bio

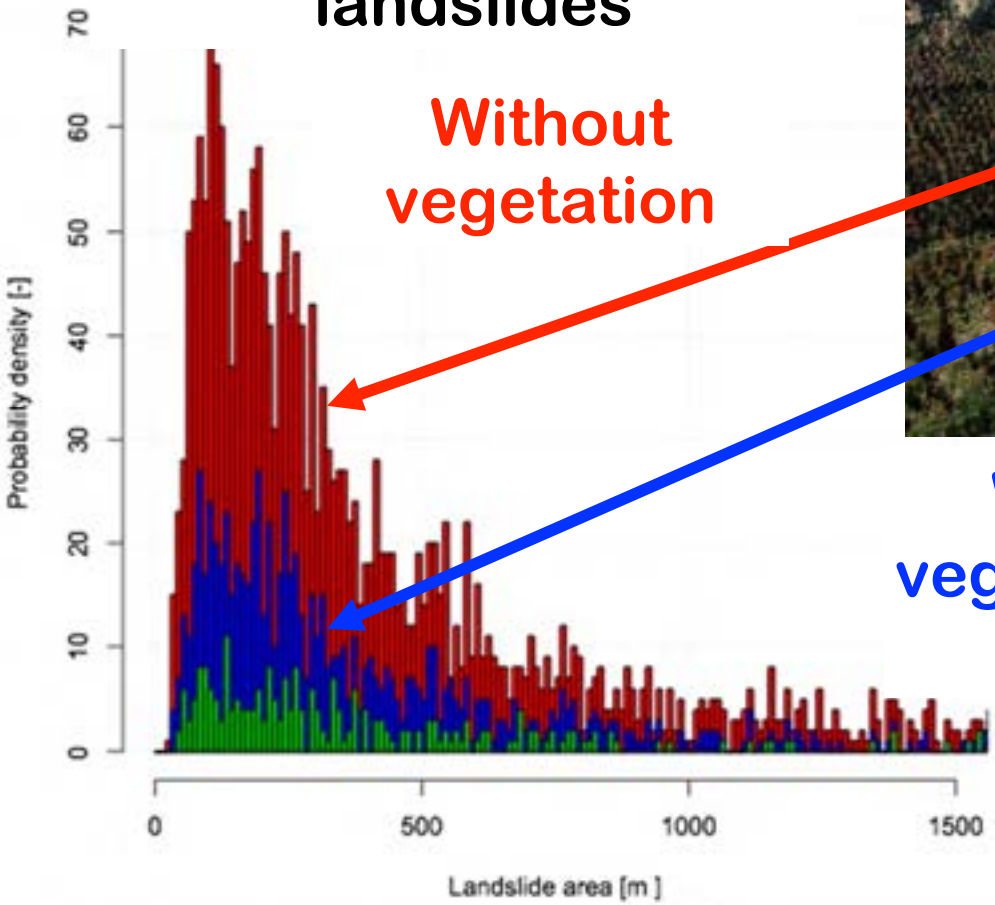
Schwarz et al., 2019, BAFU-SBB

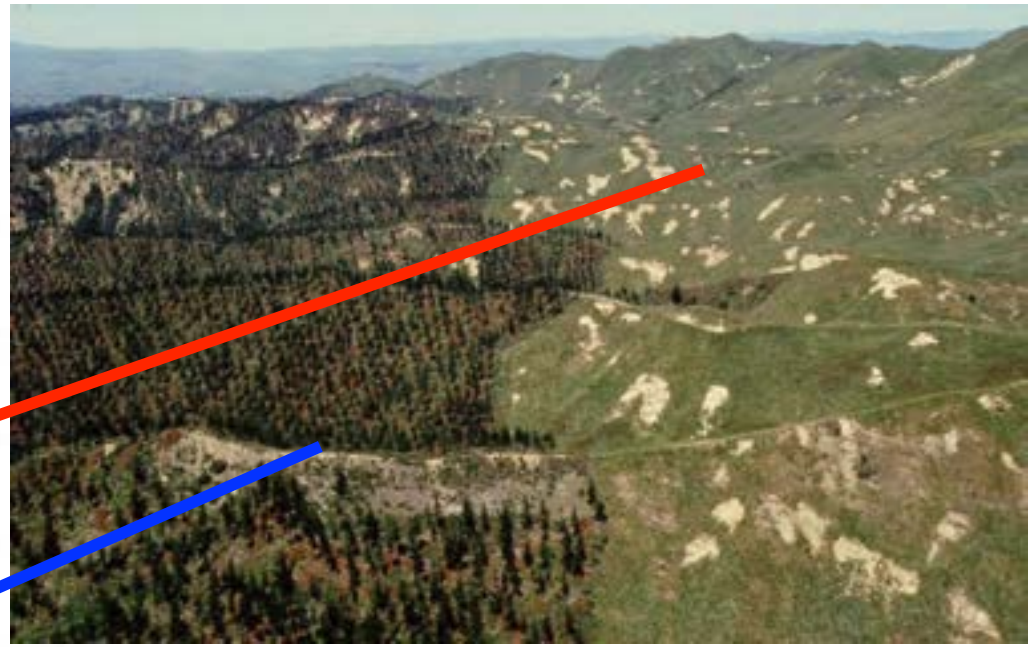
Langnauerwald	Without measures	With biological mesures (fortest scenarios)	
	Without forest	Beech forest - minimal (NaiS)	Actual conditions
Risk	73‘911 CHF/y	73‘911 CHF/y	25‘869 CHF/y
Risik reduction	-	0 CHF/y	48‘042 CHF/y
Cost/Benefit	-	0	20.3

Example SlideforMAP: Smart targeting of soil erosion control (NZ MBIE Project)

Berner Fachhochschule

Frequency-Magnitude distribution of shallow landslides





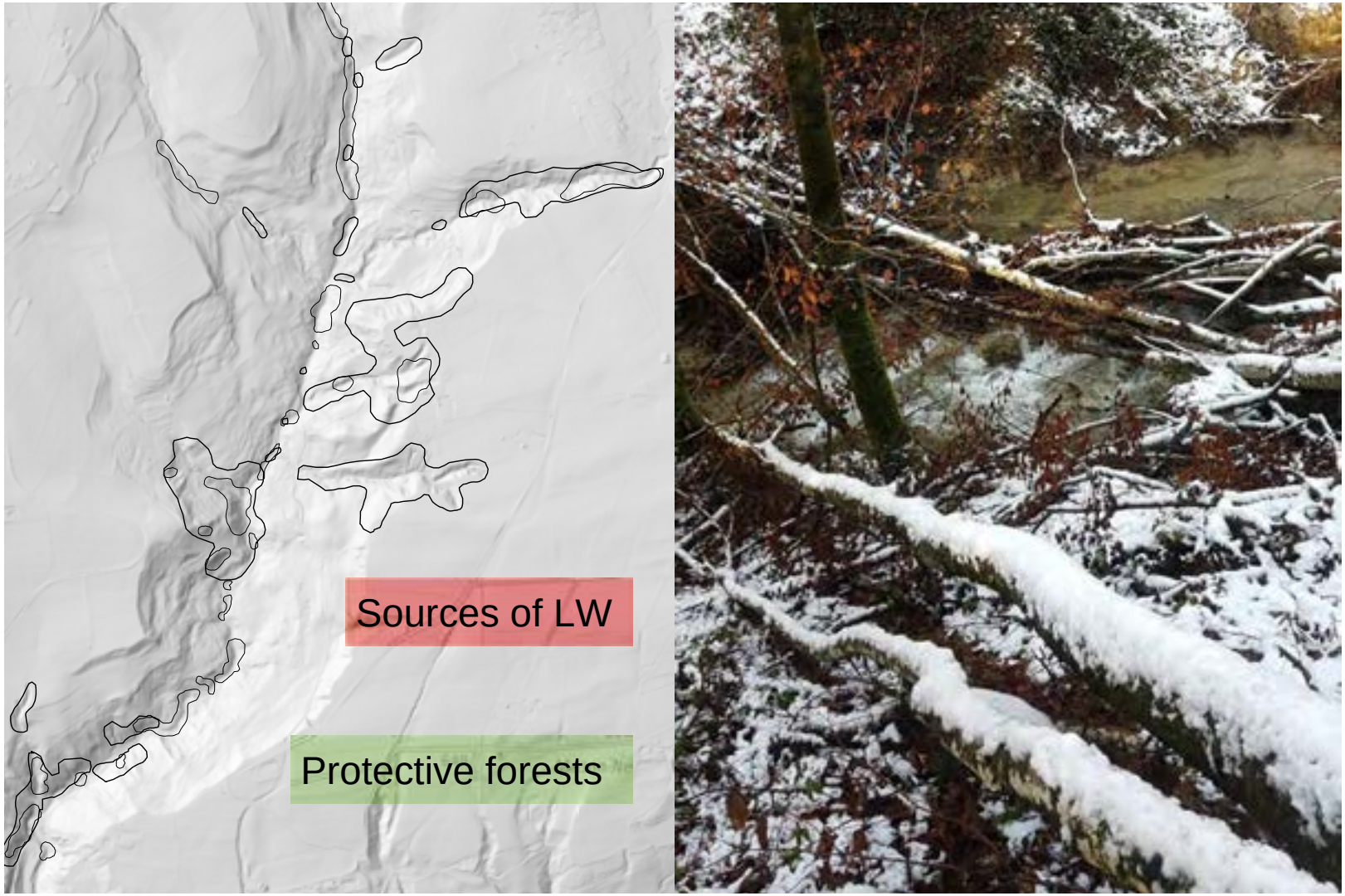
Without vegetation

With vegetation (6y)

With vegetation (16y)

Example SlideforMAP: Large Wood recruitment

Example SlideforMAP: Large Wood recruitment



Vuaridel et al., 2022


2011

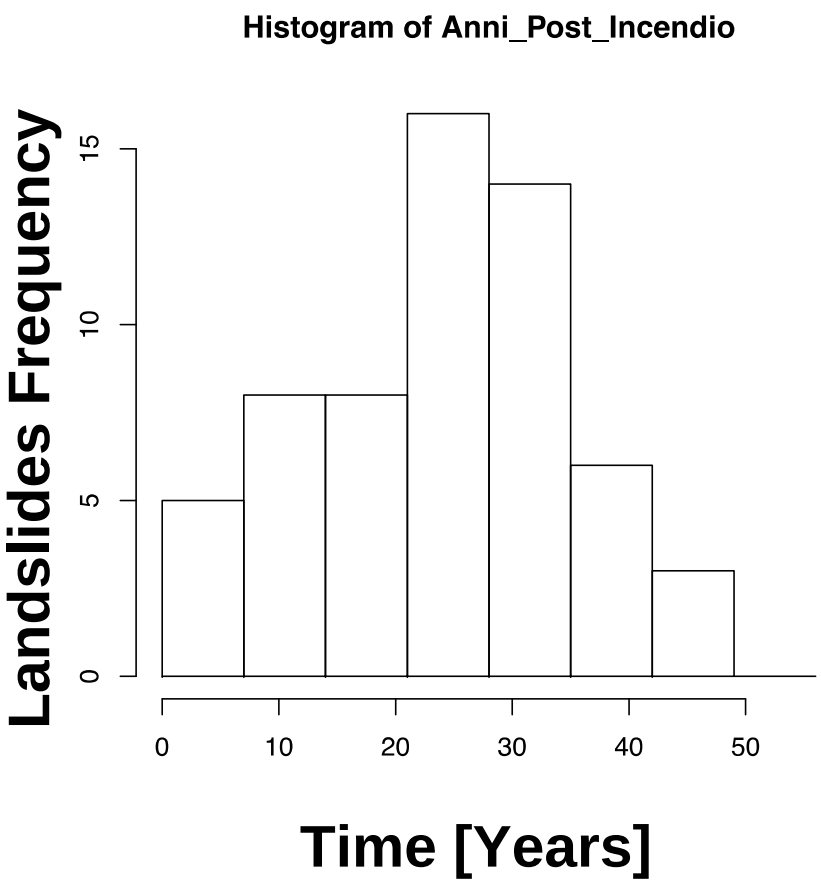

2015

Introduction

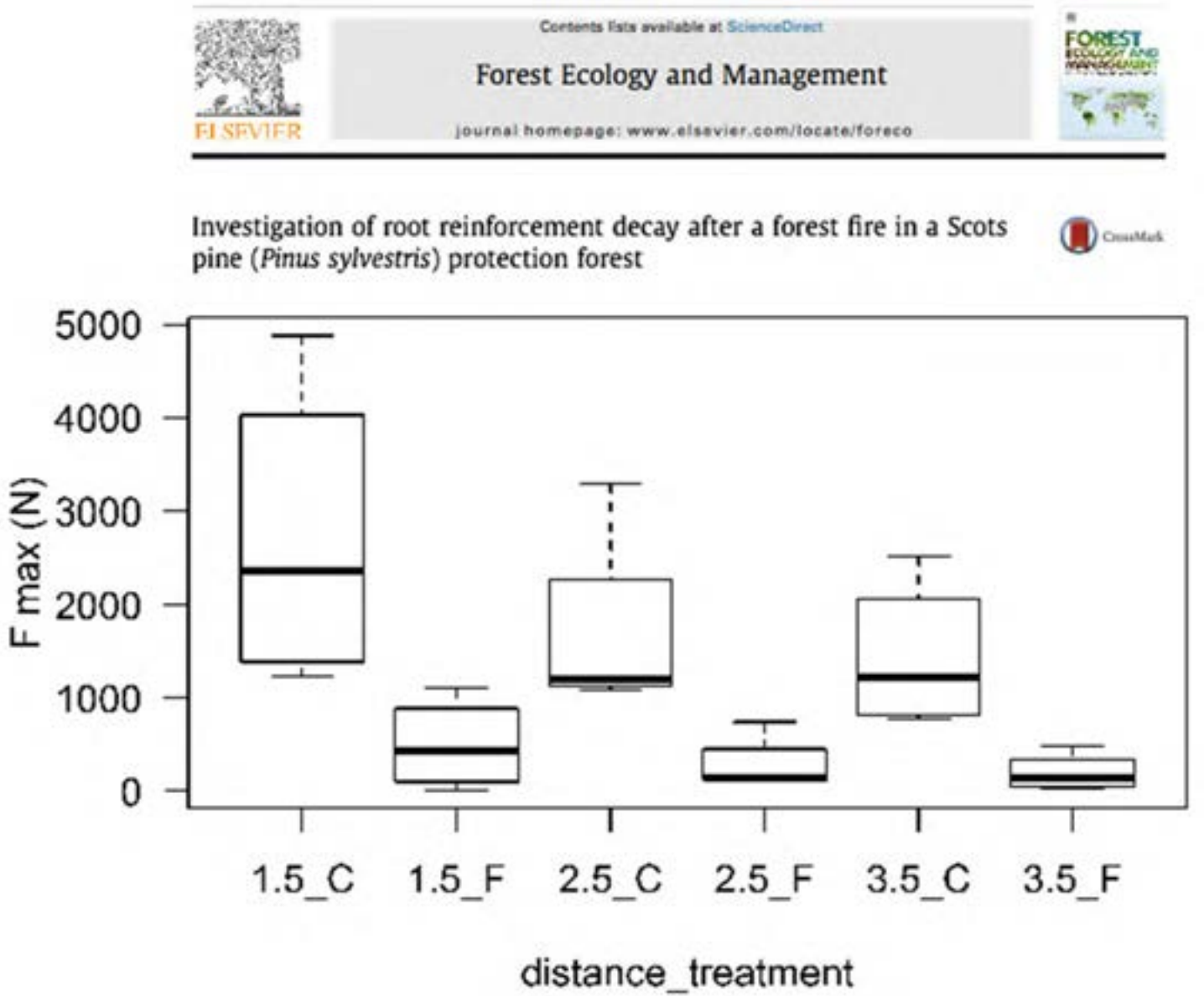
2018

Temporal dynamic of root reinforcement

Of the 372 shallow landslide registered in the StorMe databank, 89 of those failed on burnt areas registered in the SwissFire databank. Only 60 of those landslides happened after the forest fires.



Temporal dynamic of root reinforcement



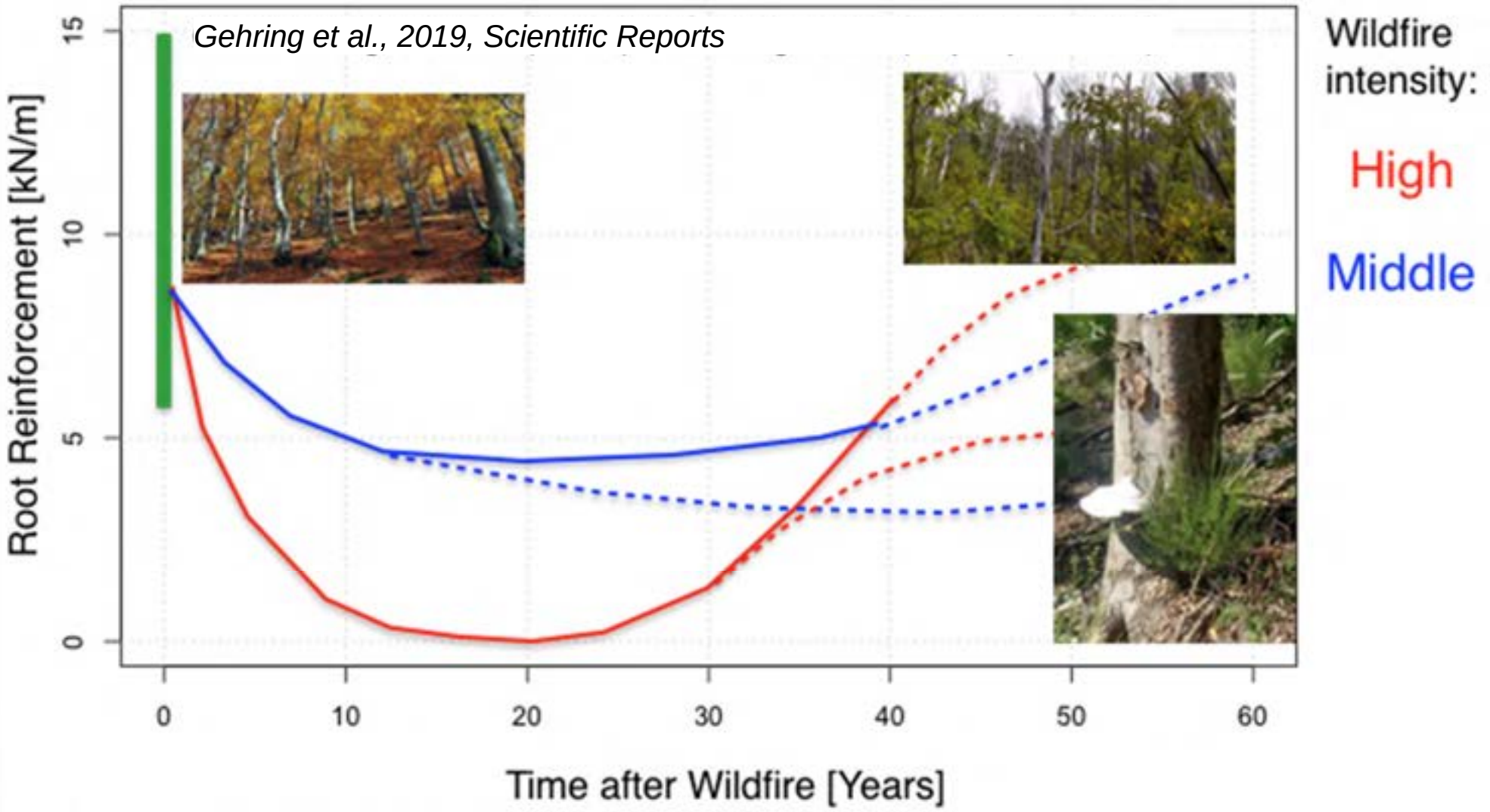
Vergani et al., 2017, Forst. Ecol. Man.

- **C = Control**
- **F = Fire**

Distance in m

Temporal dynamic of root reinforcement

- **Case study for beech (*Fagus silvatica*)**



Temporal dynamic of root reinforcement

- **Case study for spruce (*Picea abies*)**