
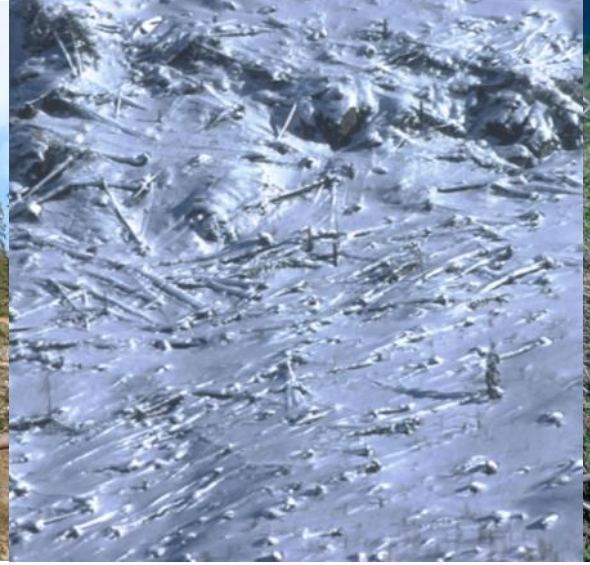


Protection against natural hazards on windthrow areas:

Experiences from Switzerland

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WSL Institute for Snow and Avalanche Research, SLF

Padova October 30th 2019

Windthrow history in Switzerland

Lothar 1999

Vivian 1990

Vaia

Burglind

Damage (million m³)

14
12
10
8
6
4
2
0

1865 1880 1895 1910 1925 1940 1955 1970 1985 2000 2015

Year

Source: Usbeck und Wohlgemuth / WSL

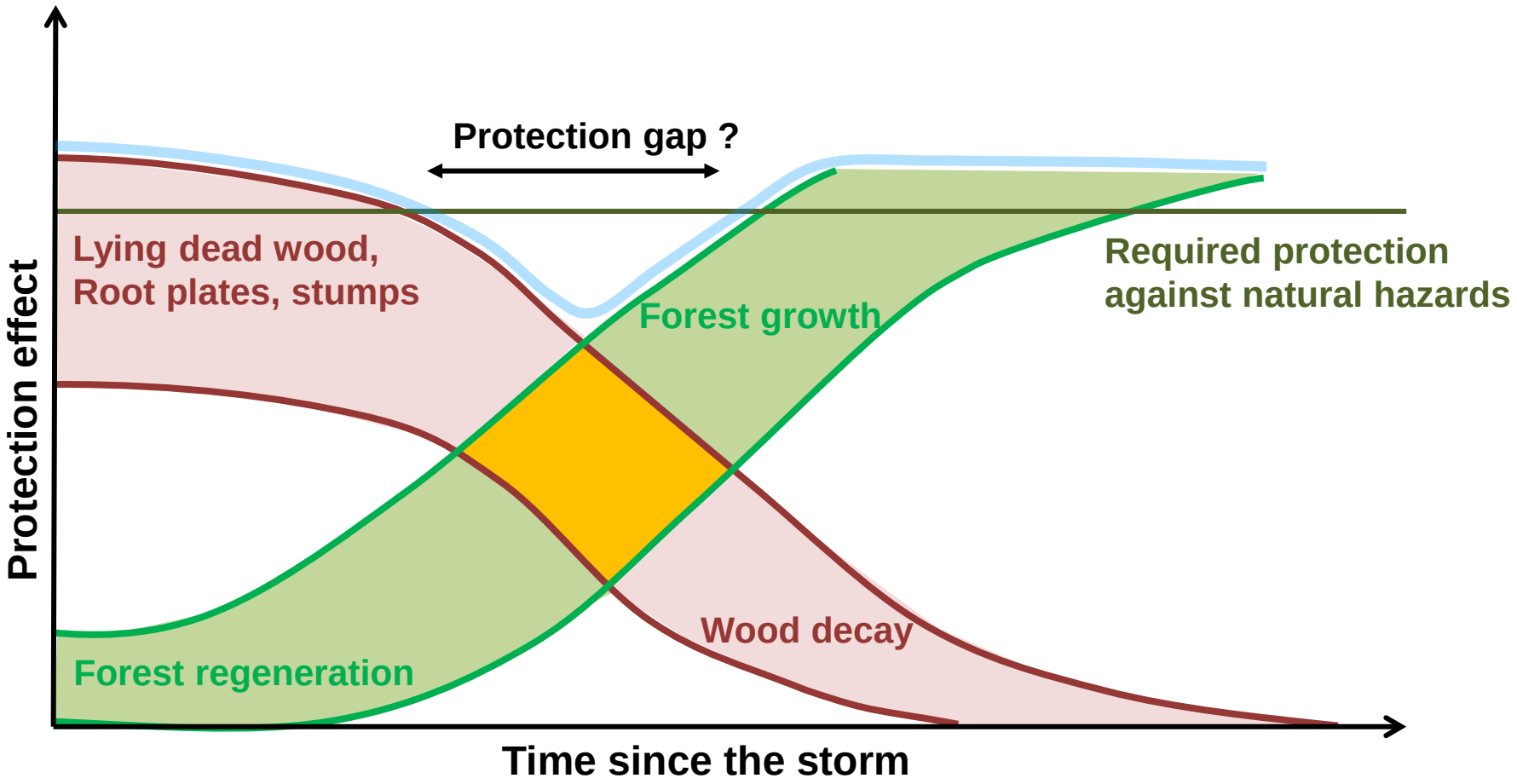
After Storm Vivian 1990

Damage of protection forests:

- **Acceptable risks?**
- **Remaining protection and changes with time under different treatments?**

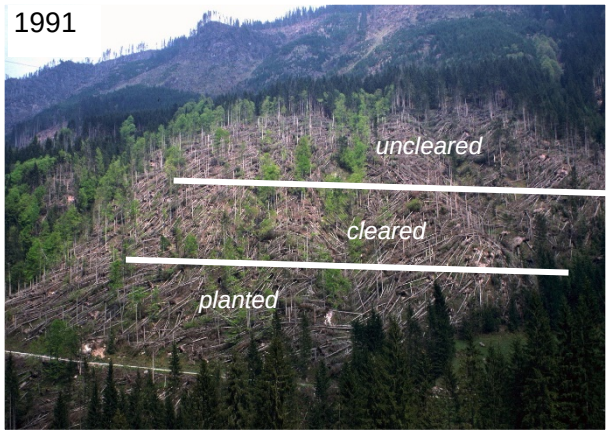
Curaglia, Foto:C. Flepp

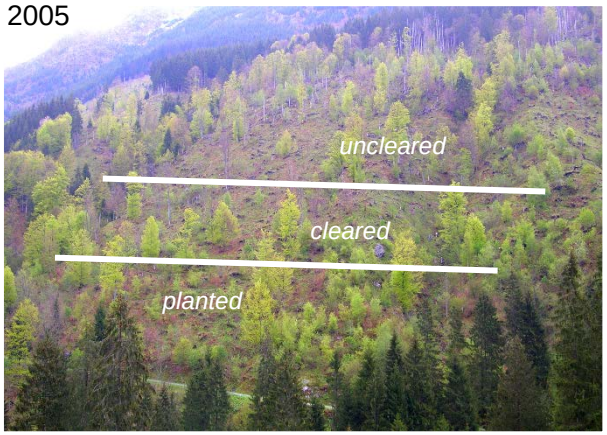
Protection against natural hazards after windthrow?
(Conceptual model)

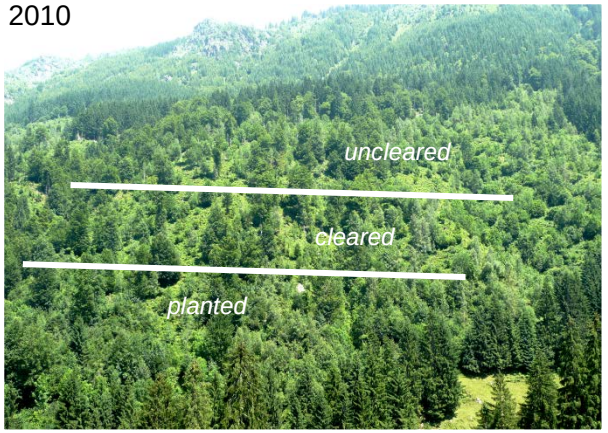


Testing of different treatments after Vivian (1990):

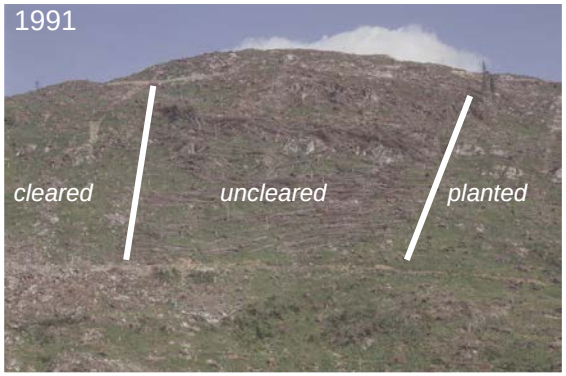
Schwanden, Kt. GL

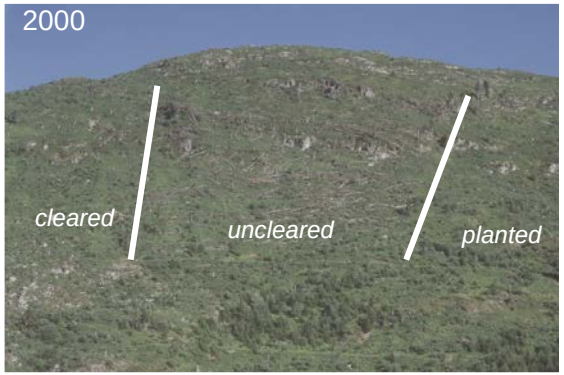


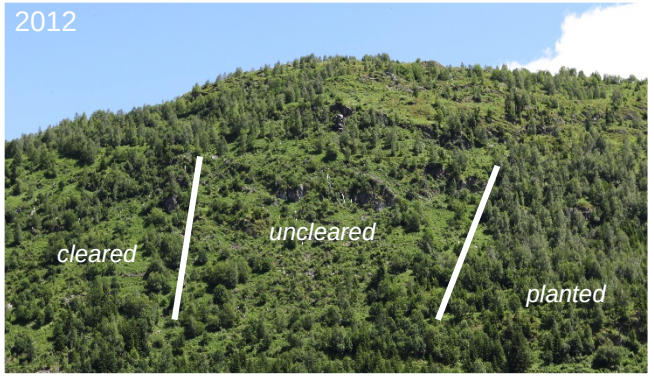




Disentis, Kt. GR

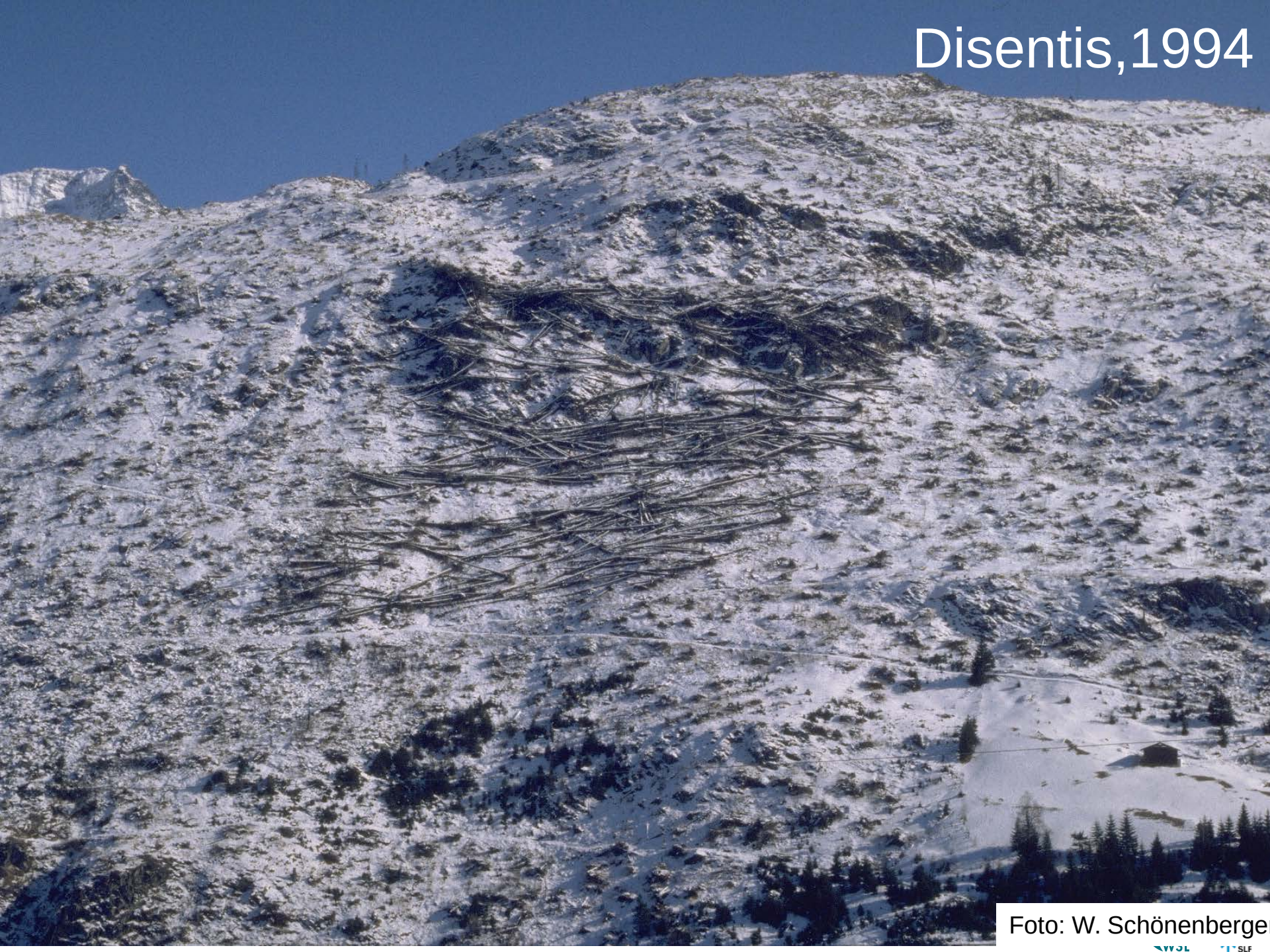






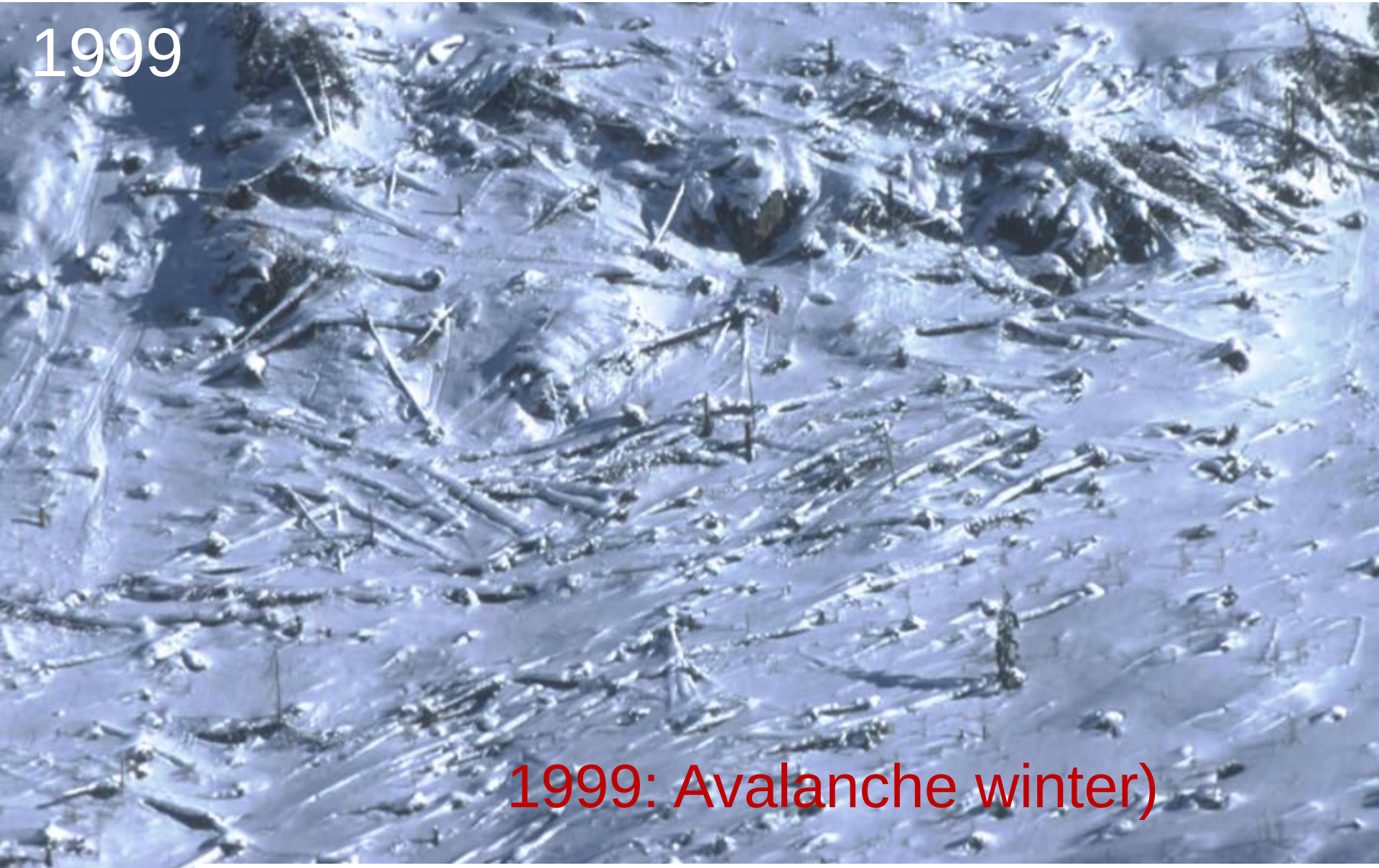
Images: U.Wasem, T. Wohlgemuth

- Long-term monitoring
- Changes of protection against natural hazards with time?


Disentis,1994
Foto: W. Schönenberge

Effect of winthrow on natural hazards

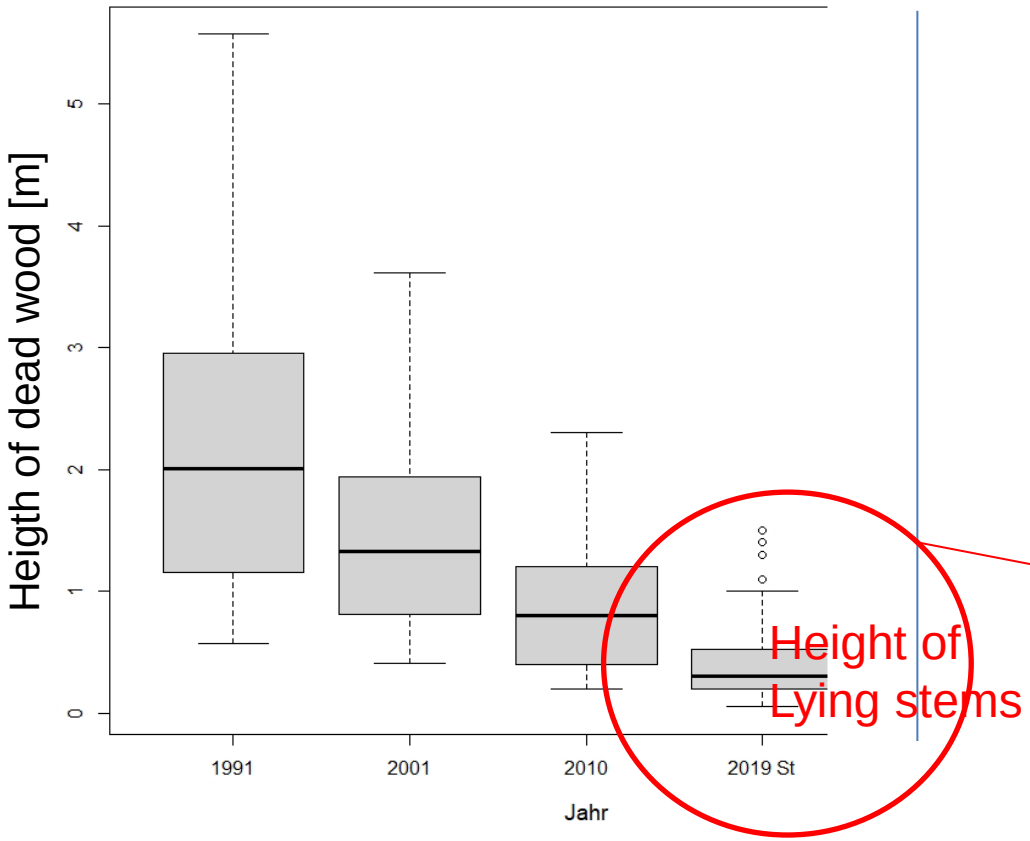
Case study Disentis / Cavorgia



Not cleared windthrow area, Disentis 25.2 1999, Foto: W. Frey, SLF/WSL

Effect of winthrow on natural hazards

Case study Disentis / Cavorgia



1991 2001 2010 2019

Anno

Stability of logs: Tensile tests

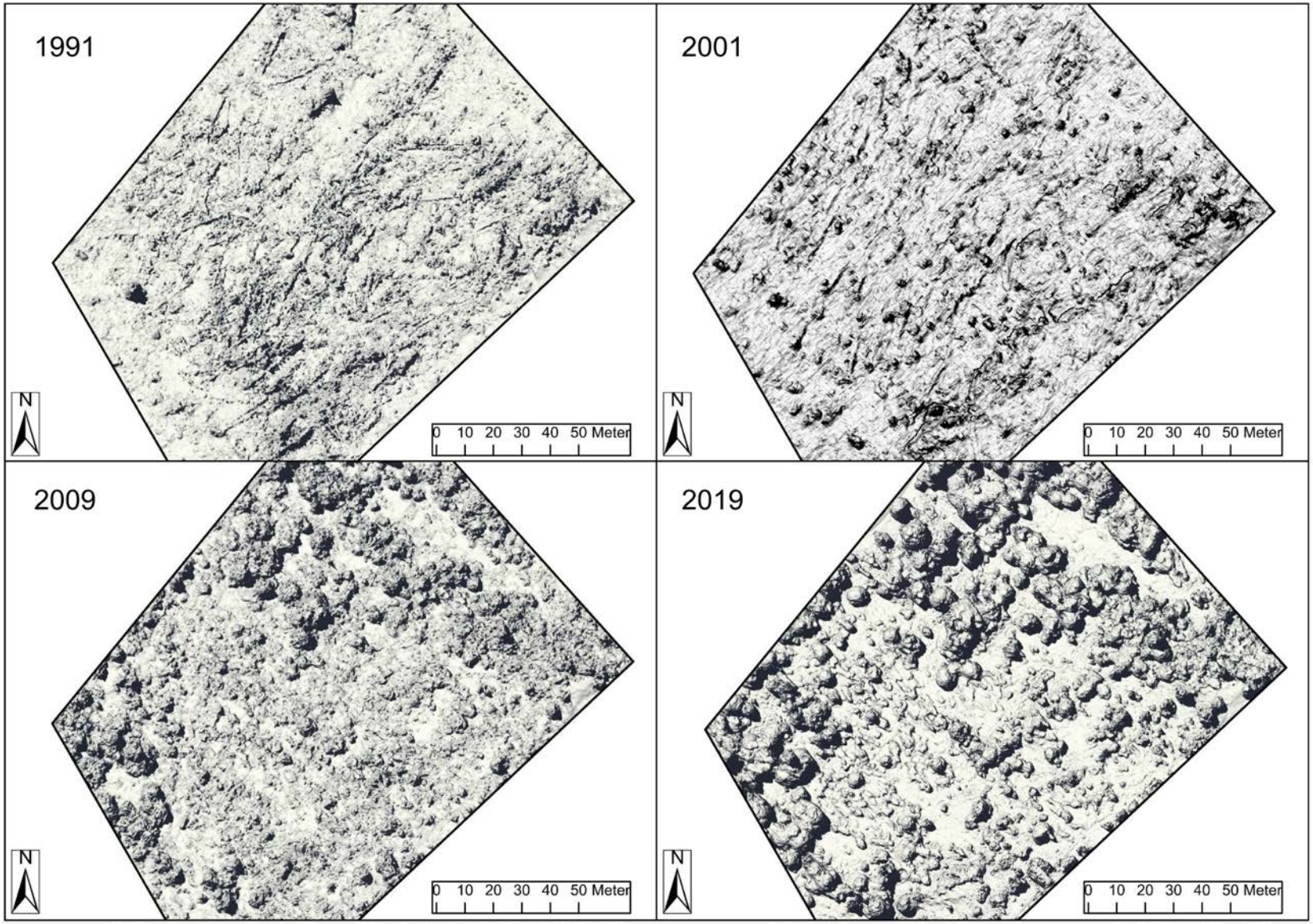
Tensile tests 2010

- The **resistence of logs** has **decreased** to 40% after 20 years
- Corresponds to a snow cover of ca. 1.8 m
- Only **few movements of lying stems**, in particular on steep slopes > ~45º

Source: Putallaz 2010

Effect of winthrow on natural hazards

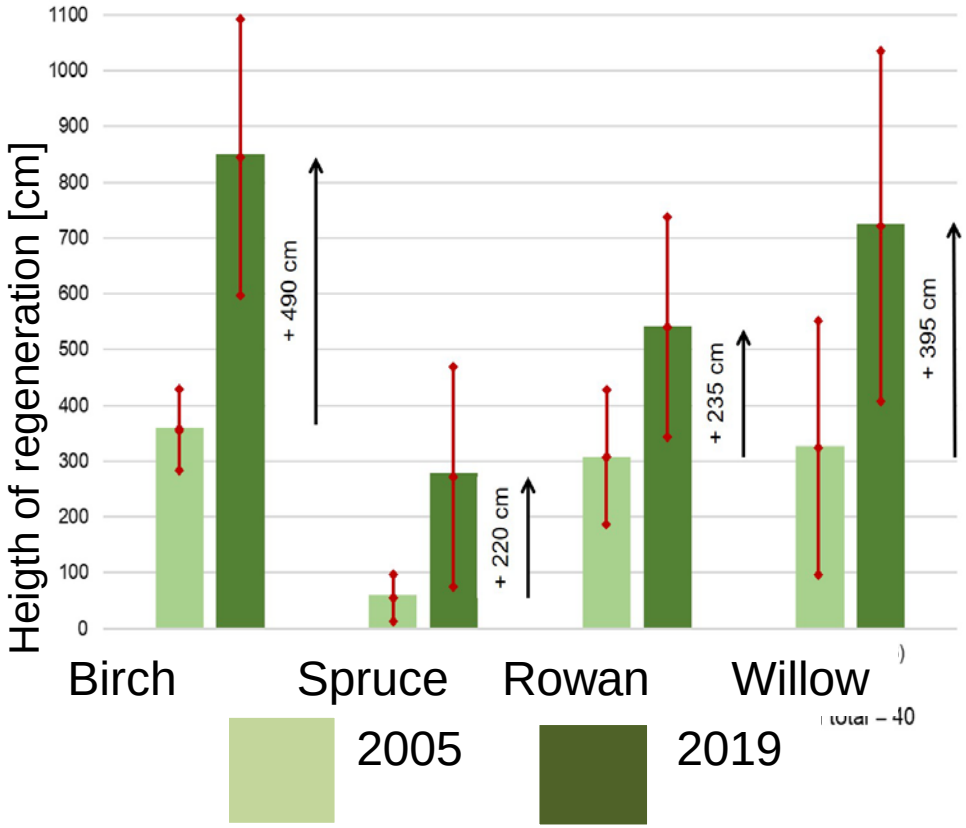
Case study Disentis / Cavorgia



DSM – Digital surface model

How fast is regeneration after windthrow?

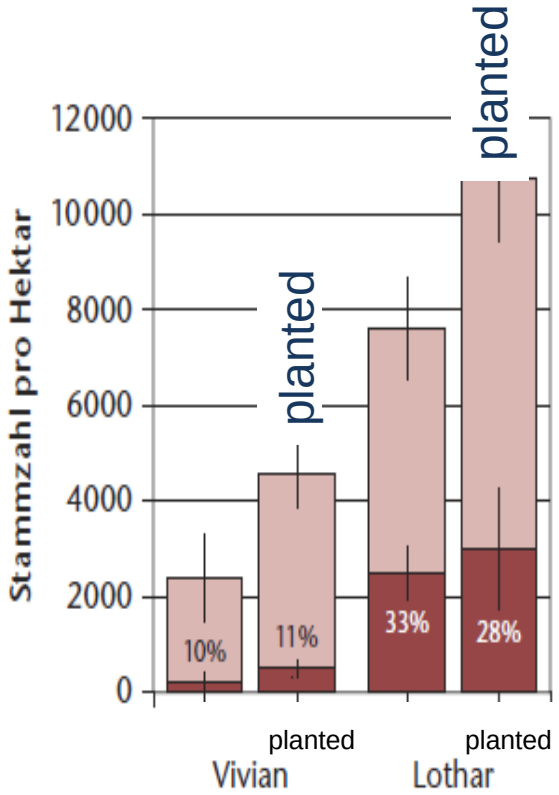
Case study Disentis / Cavorgia



Source: M. Marty, 2019

Regeneration on dead wood after 29 years

How fast is regeneration after windthrow?
(Synthesis of Lothar and Vivian sites)



- **Only ca. 10-30%** of regeneration was **advance regeneration**
- **Earlier protection** effect **with advance regeneration** and/or additional **planting**
- **High variablility** between sites and forest types

Post-windthrow regeneration

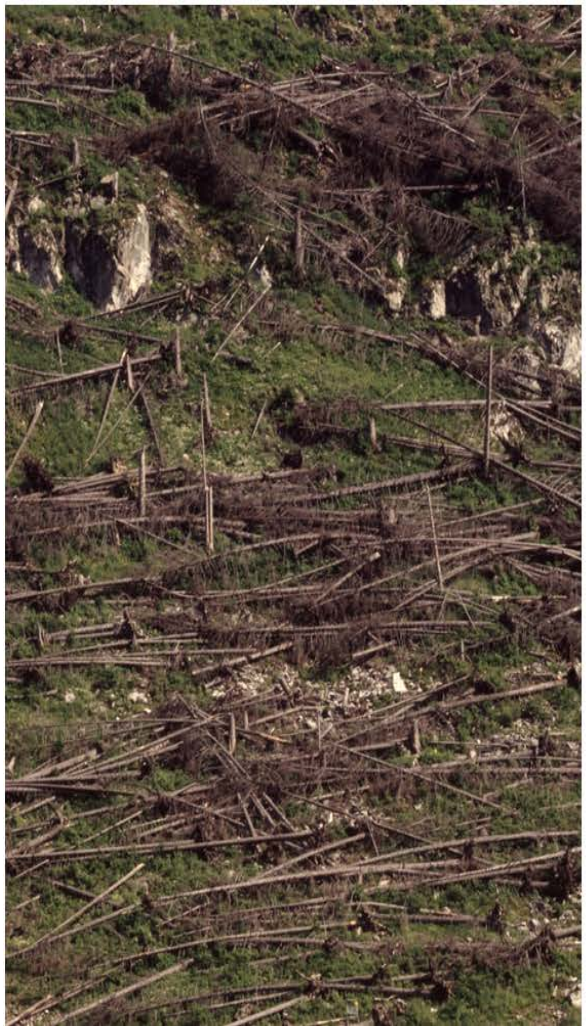
Advance regeneration

Sources : Wohlgemuth und Kramer / WSL

Effect of winthrow on natural hazards

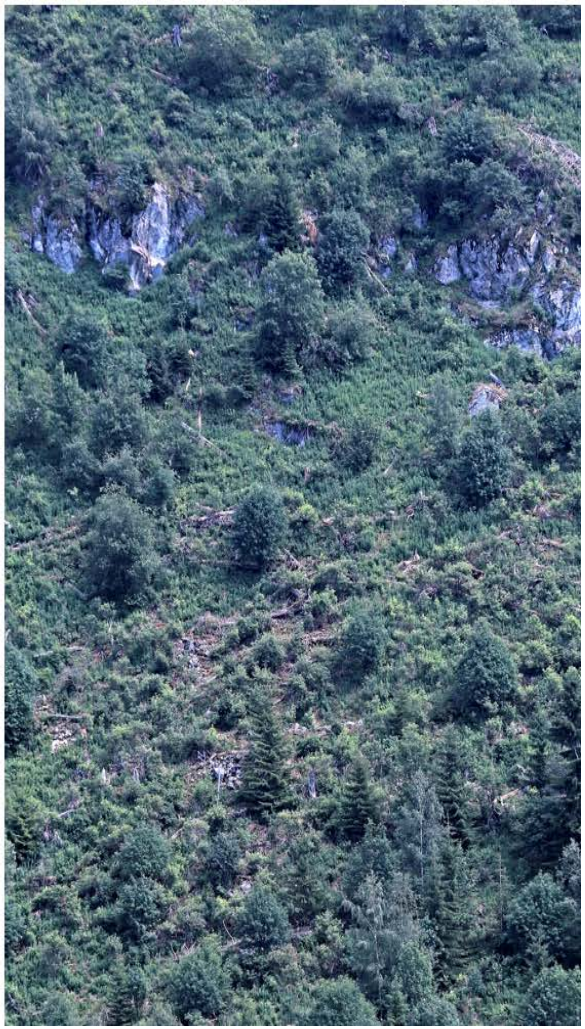
Case study Disentis / Cavorgia

1992



1997

2019



Fotos: U Wasem, WSL

Avalanche events after windthrow?

Snow movements in cleared
Windthrow area Disentis, 1999
(Foto W. Frey)

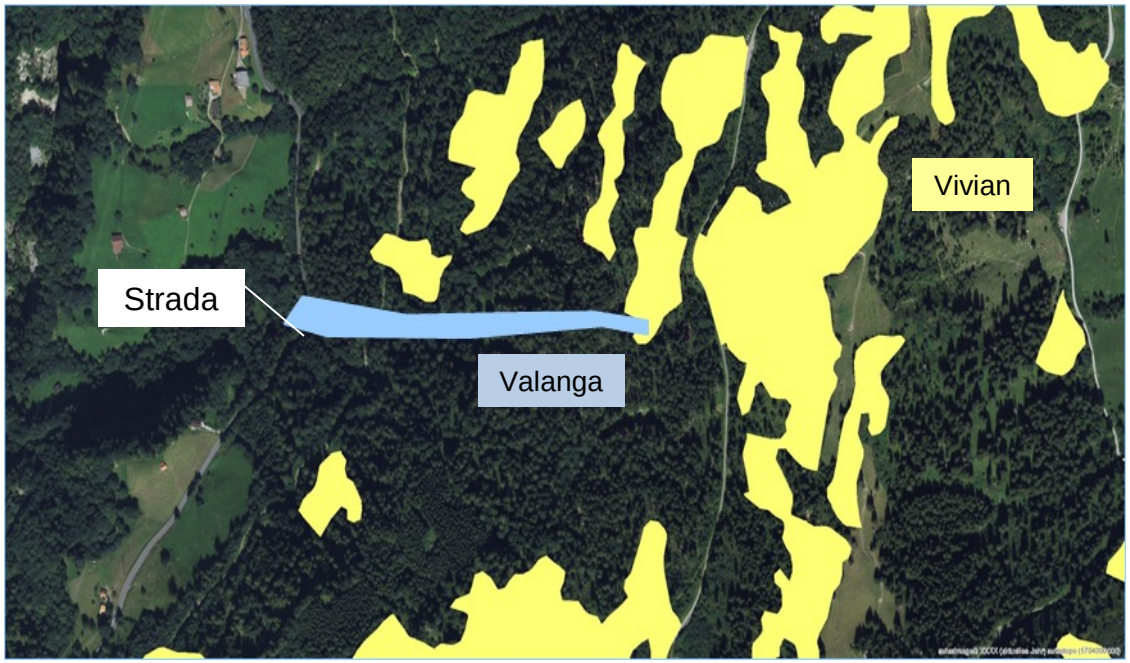
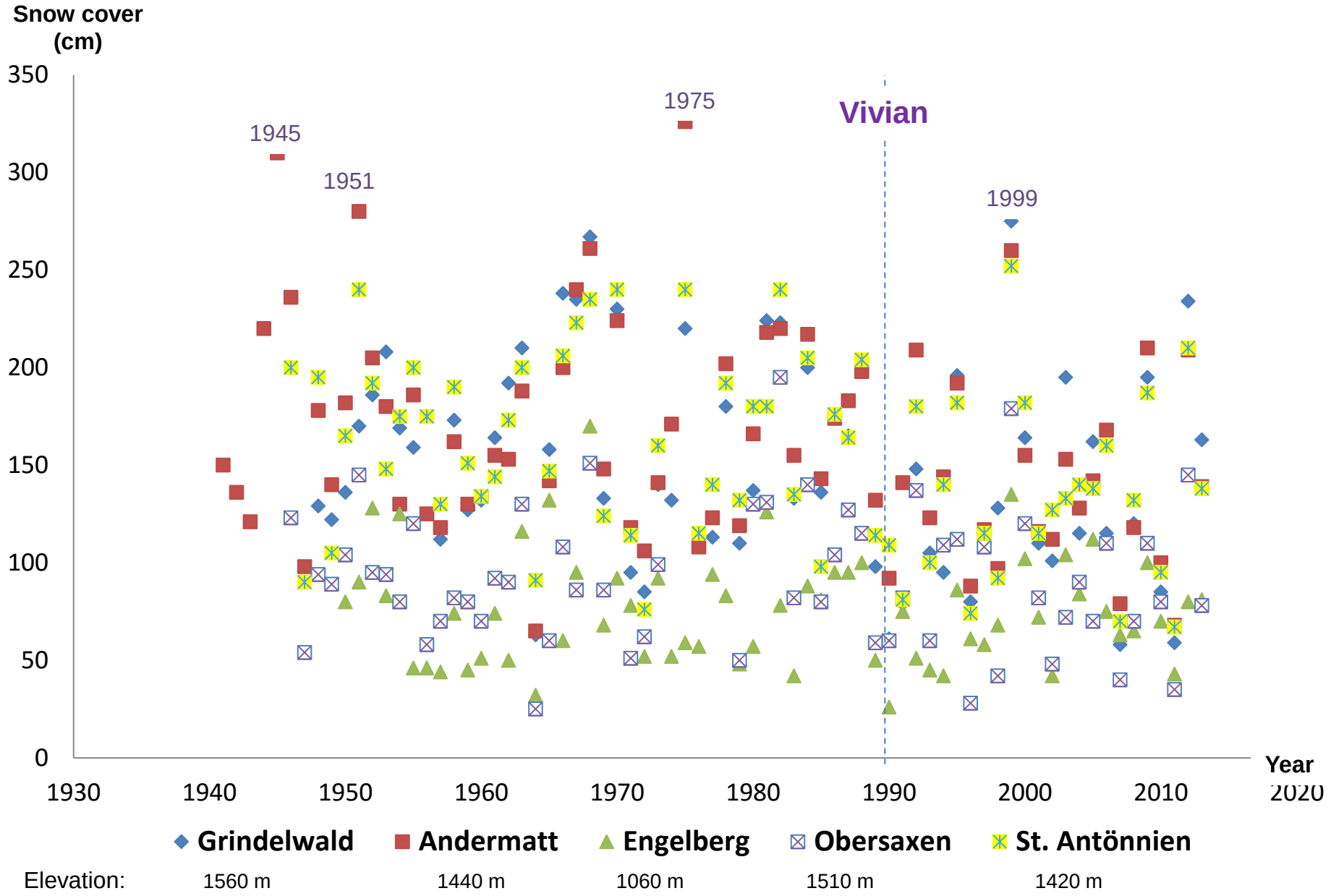


Foto above: avalanche in Pfäfers, February 1999
(Source – SLF-database and R. Schwitter)

- Almost no observed avalanche releases from windthrow areas.
- Only in winter 1999 (very snow rich) and in cleared windthrow areas

Maximum snow cover in the Swiss Alps since 1930



Avalanches after disturbances in areas with **extreme snow conditions** (examples Utah/USA)

Avalanche (1986) in not cleared area after fire in 1971

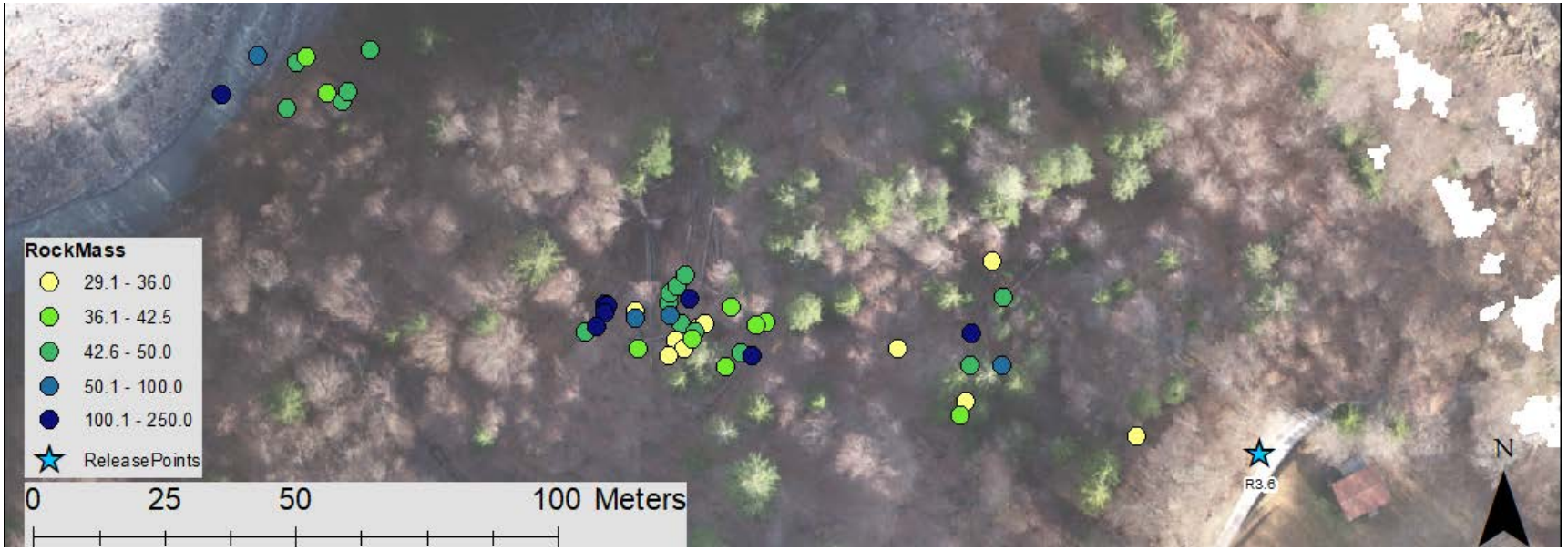
Avalanche release in clearcut area

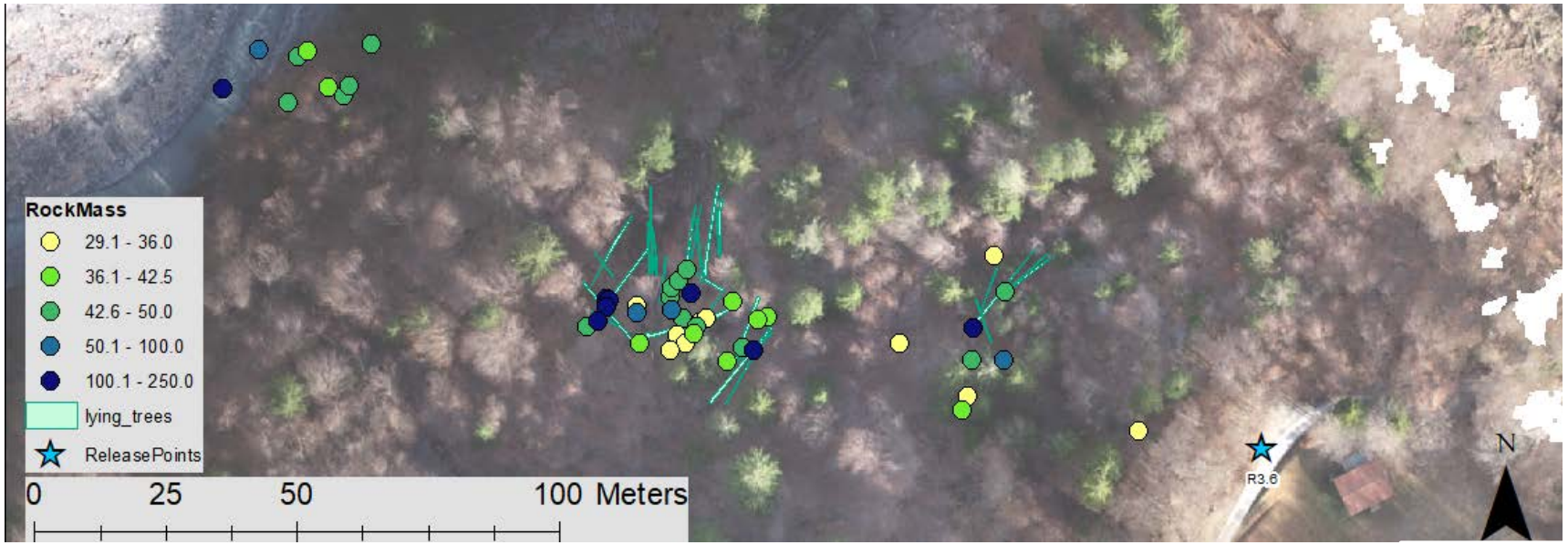
Foto: M. Jenkins, Utah State University

Effects of windthrow on Rockfall
(Results of rockfall experiments)

Source: Adrian Ringenbach SLF/WSL

Deposition Points of rockfall experiment





Source: Adrian Ringenbach SLF/WSL

Rockfall from windthrow areas

(Analysis of STORME data of cantons Berne and Graubünden)

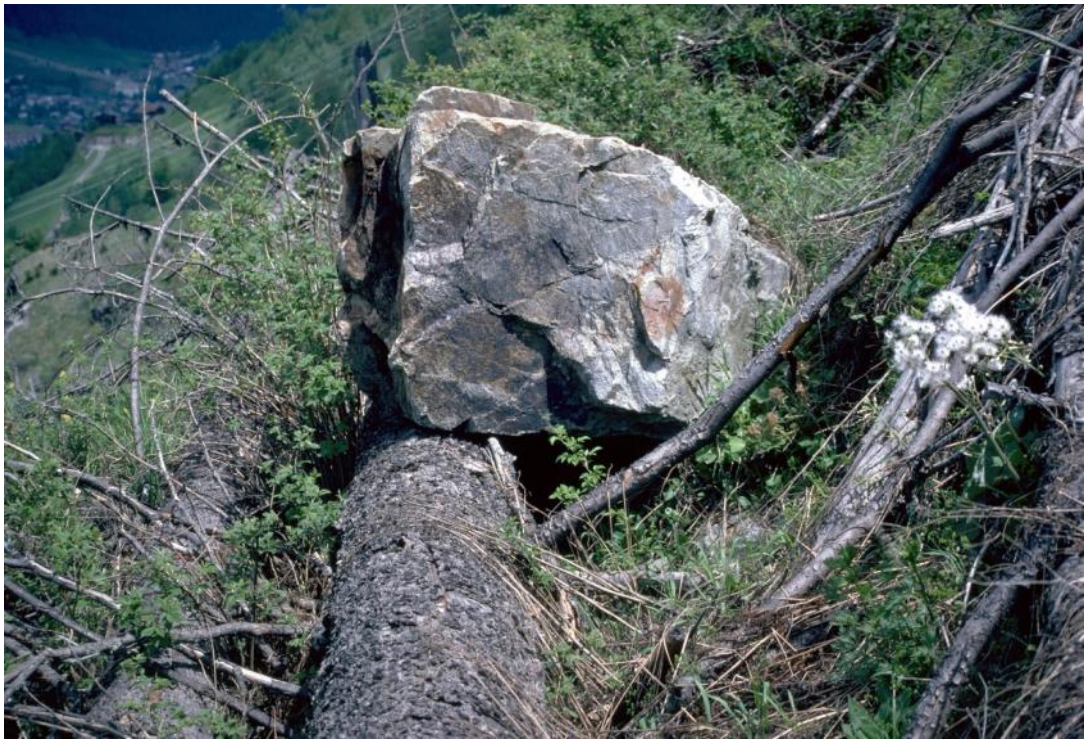
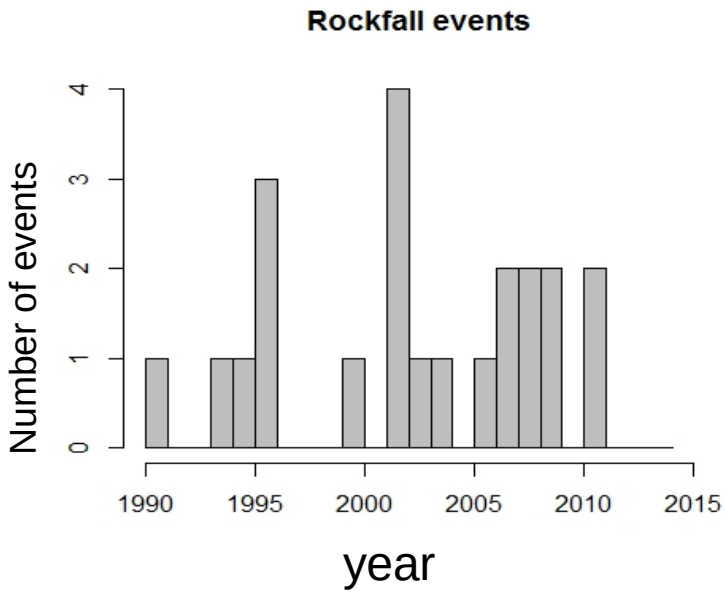


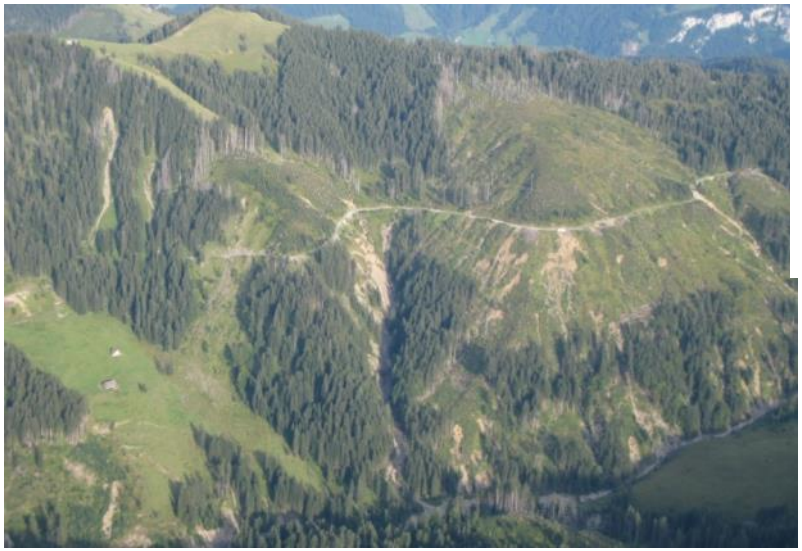
Foto left: Not cleared are in Disentis
(U. Wasem WSL)



- No increase of rockfall events from windthrow areas compared to other forested areas
- But: Important to **check** for big and **instable rocks behind decaying wood!**

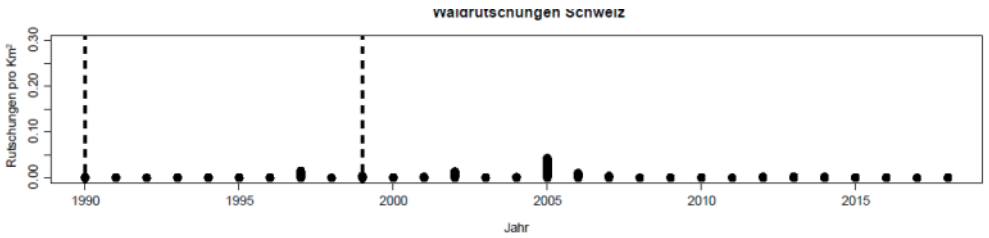
Shallow landslides and debris flows

Analysis of national landslide data (StorMe)



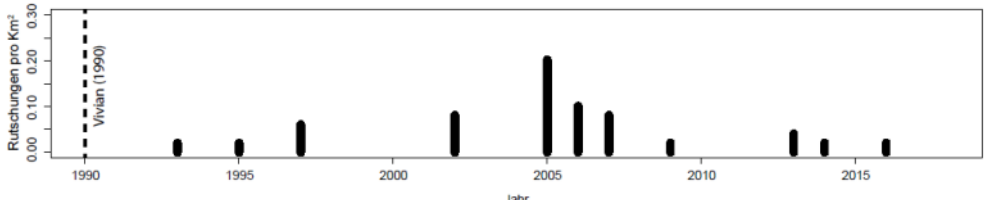
(Foto: C. Rickli, WSL)

- More shallow landslides after 3-17 years after windthrow
- Mainly in very steep slopes (> 35º)



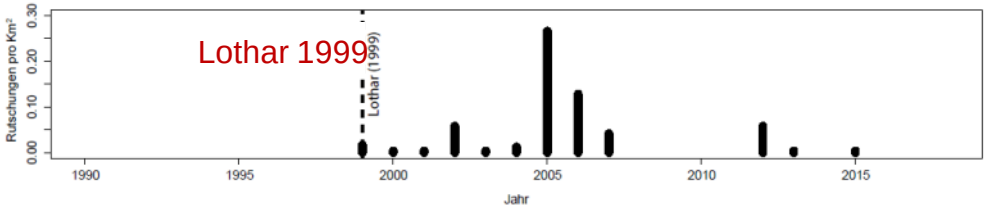
Vivian 1990

Shallow landslides after Vivian



Shallow landslidesafter Lothar

Lothar 1999



Curaglia, Octobre 2019

Bark-beetle after windthrow

Development in Switzerland 1990-2018

Ips typographus

Bark beetle damages [m³]

2'250'000
2'000'000
1'750'000
1'500'000
1'250'000
1'000'000
750'000
500'000
250'000
0

1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014 2015 2016 2017 2018 2019

?

"Vivian"

"Lothar"

Drought

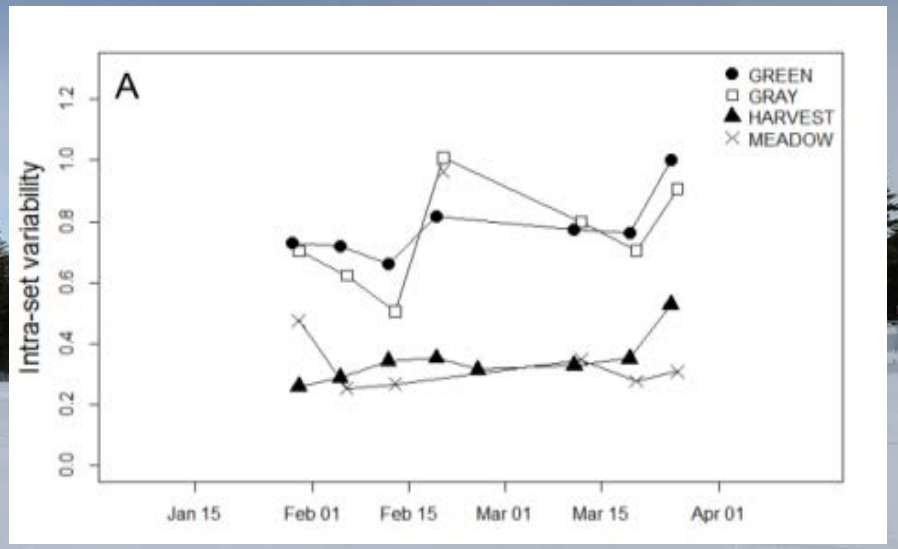
Drought
+
"Vaia"

Natural hazards after bark beetle outbreaks?

- Similar processes like on windthrow areas, but generally slower decay
- Often longer protection effect against natural hazards

Bark beetle outbreak 1994: Gandberg/GL
(Foto: U. Wasem)

During first years after bark beetle outbreak: Snow cover in invested “gray” stands similar compared to “green” stands.



Source Teich et al. (2019)

Priority of sanitation felling and salvage logging:

- pure spruce stands,
- where protection function of adjacent stands is very important
- small windthrow areas

Development of protection after windthrow and bark beetle

Windthrow area and follow-up bark beetle disturbance 1996

Situation in Februar 2011 (Fotos: Raphael Schwitter) after local planting of additional trees.

- Several successful management options after windthrow and bark beetle outbreaks.
- Regional coordination of bark beetle intervention is very important!

Risks related to natural hazards vs. other risks

	Damaged wood	Fatalities during work on windthrow areas	
	mil. m^3	Public forest	private forest
Vivian (1990)	4.9	10	14
Lothar (1999)	8.1	2	13

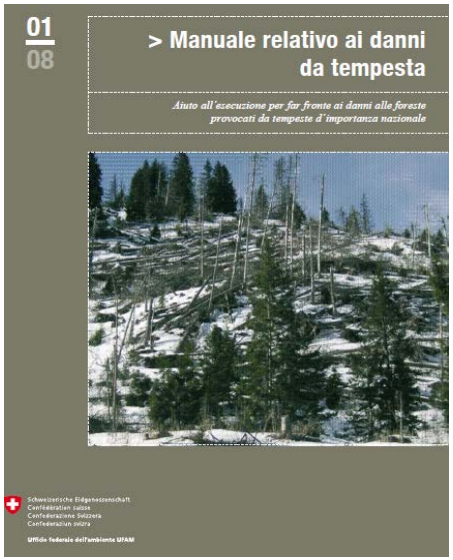
Source: Lothar Der Orkan (1999), p. 61

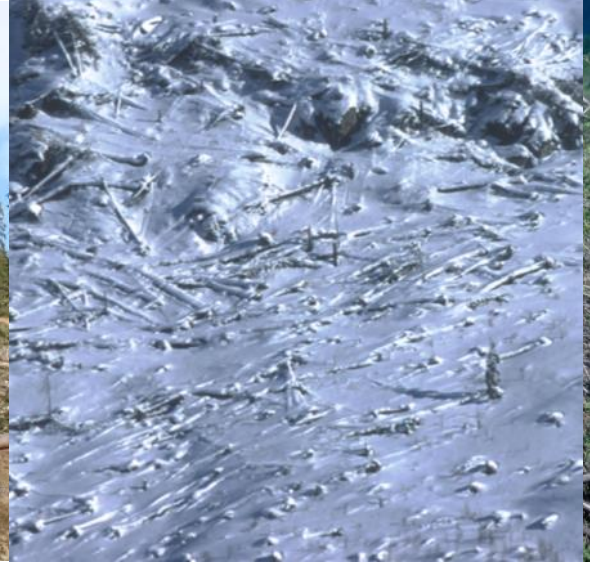
Experiences from Vivian (1990) helped to reduce fatalities after Lothar (1999)

- Vivian: 5 fatalities / mio. m^3
- Lothar: 2 fatalities / mio. m^3

Some general conclusions:

- Forest and **protection function** generally **comes back** after windthrow.
- **Several management options** (including mixed options) can be applied depending on situation (cf. windthrow manual)
- Effect of **terrain roughness** (logs, root plates) i**mpacts** the **protection** against avalanches and rockfall **positively.**
  -> Often an argument against clean salvage logging.
- **Investments in resilience *I*** advance regeneration of protection forests **should not been neglected**
- Important to **share experiences between Switzerland and Italy** and to do **joint research projects** and coordinated monitoring on post-windthrow dynamics and protection effects.




Thank you for your attention!

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Padova October 30th 2019