

The effects of forest cover and disturbance on torrential hazards: Large-scale evidence from the Eastern Alps

Julius Sebald¹, Cornelius Senf¹, Micha Heiser², Christian Scheidl², Dirk Pflugmacher³ & Rupert Seidl¹

¹Institute for Silviculture | Department of Forest and Soil Sciences | University of Natural Resources and Life Sciences Vienna (BOKU) | Austria

²Institute of Mountain Risk Engineering | Department of Civil Engineering and Natural Hazards | University of Natural Resources and Life Sciences Vienna (BOKU) | Austria

³Geography Department | Humboldt-Universität zu Berlin | Germany



Problem

Human settlements and infrastructure in mountain regions are exposed to **destructive natural events**.

Large-scale evidence for effects of forest cover and disturbance on torrential hazards is **lacking**.

Europe's forest are changing, with intensifying forest disturbances and increasing harvest levels.

Research questions

Does **forest cover** reduce the probability of torrential hazard events?

Do **forest disturbances** influence the probability of torrential hazard events and how do effects change with different types of disturbance regimes?

Results

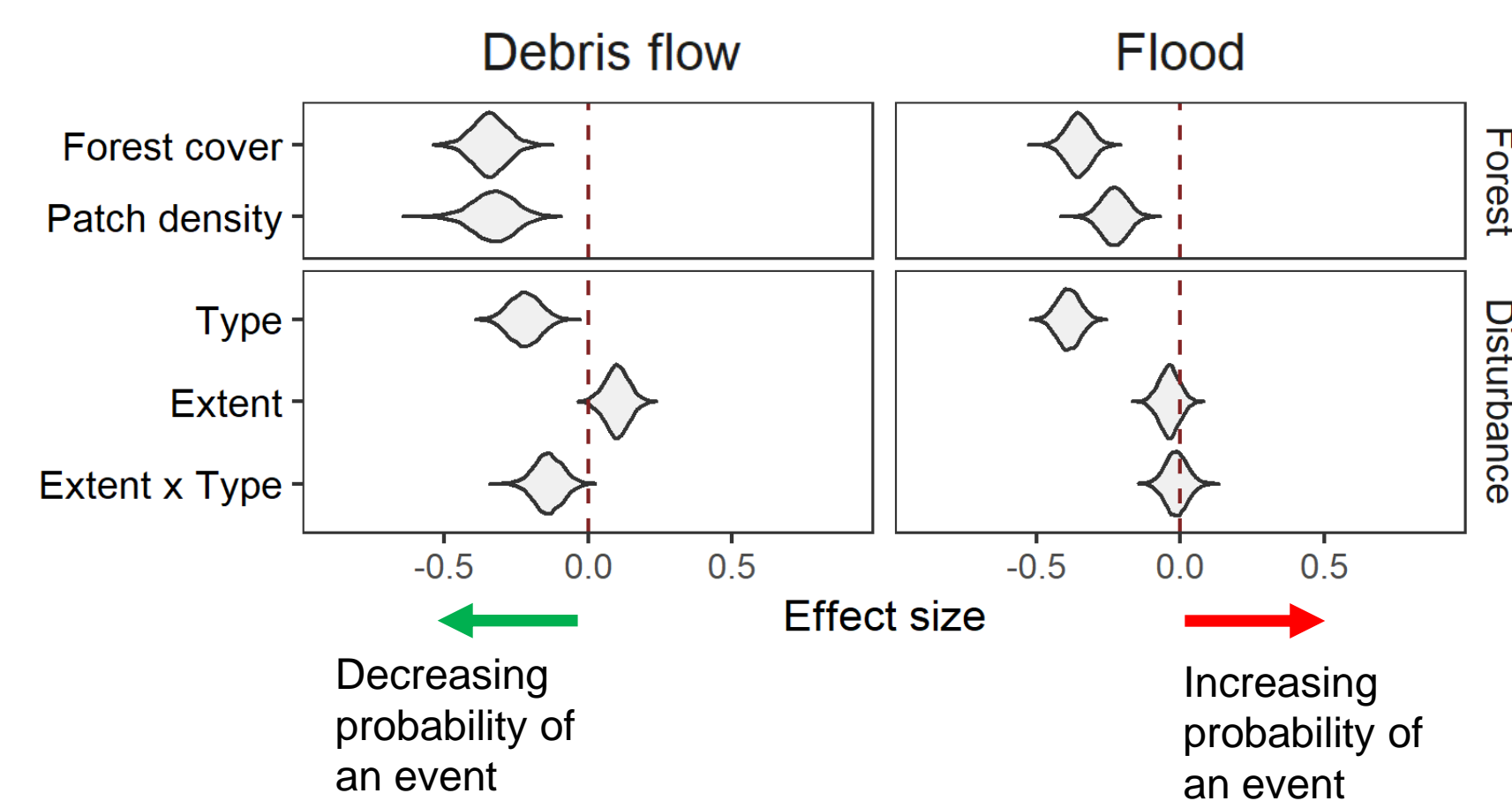
Does forest cover reduce the probability of torrential hazard events?

Increasing forest cover decreases torrential hazard probability

One standard deviation increase in forest cover decreases torrential hazard probability by **-9 %**.

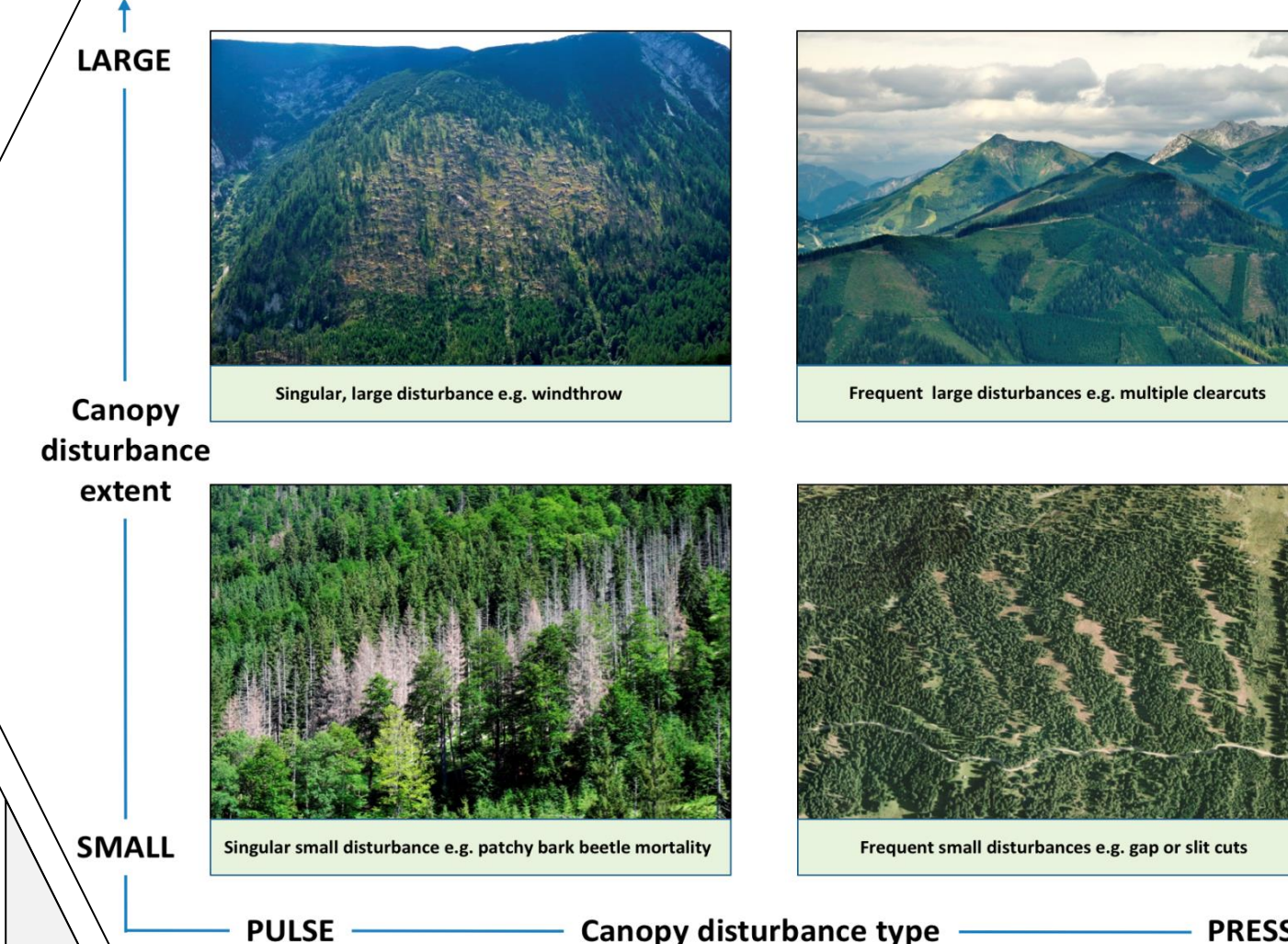
Distributed forest cover decreases torrential hazard probability

One standard deviation increase in patch density (distinct forest patches per km²) decreases debris flow (flood) probability by **-8 % (-6 %)**.

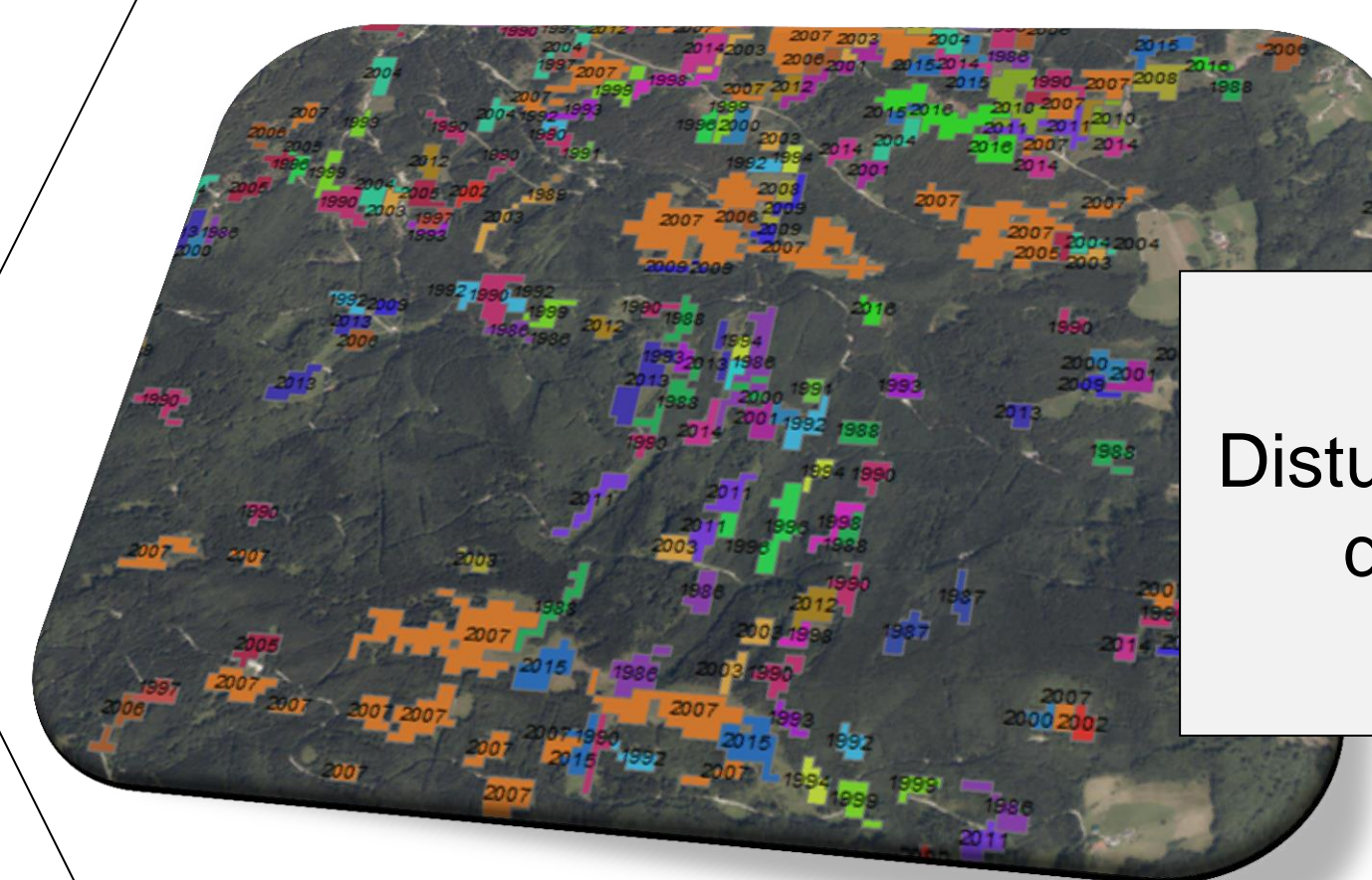


Posterior probability distribution of effect sizes of each predictor. Effect sizes are given as standardized z-scores.

Natural and human disturbance regimes



Remote sensing



Annual Landsat-based disturbance maps for Austria from 1986 to 2016

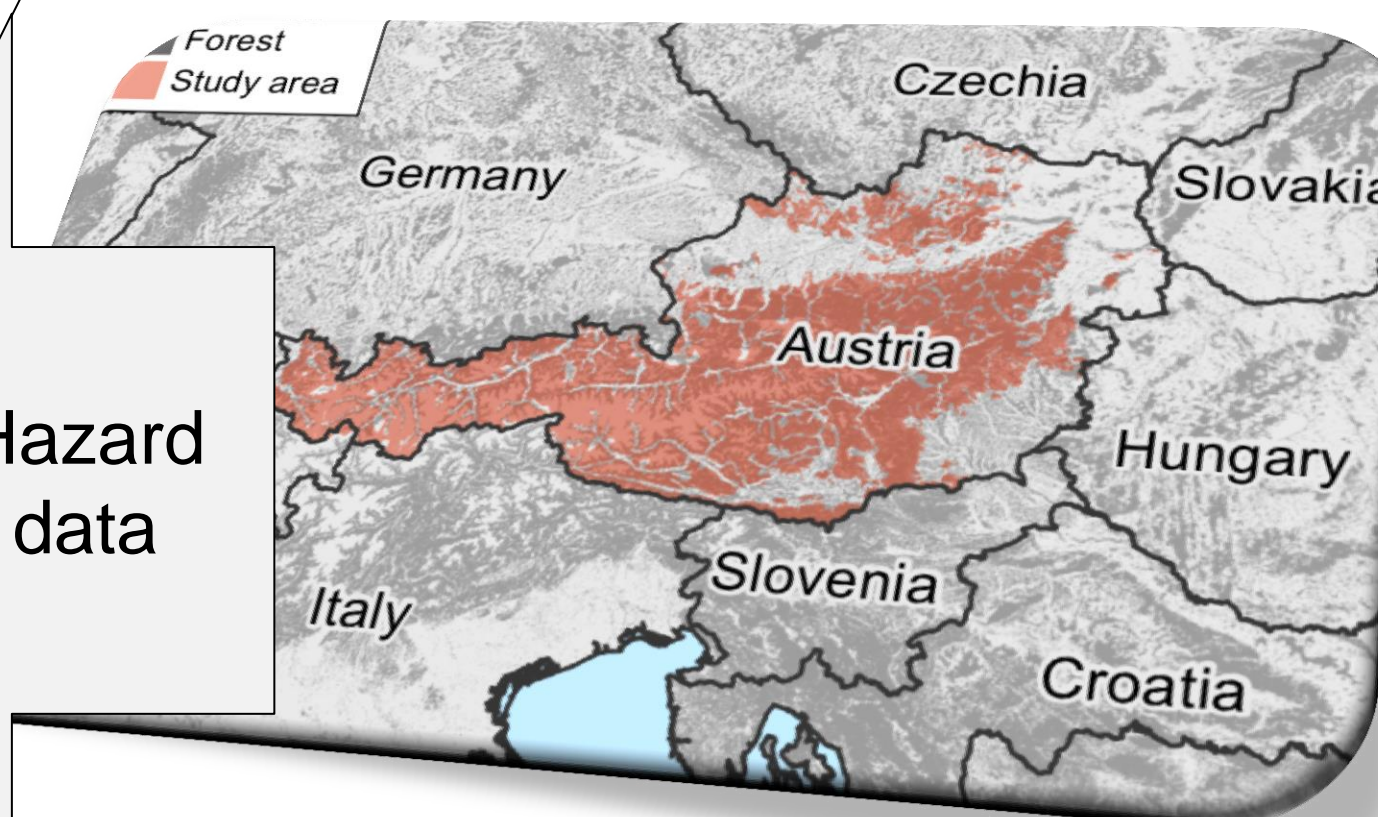
Torrential hazards risk of watershed



Debris flow Flood

Two processes, causing 877 Million € damage and death to 49 people in Austria (1972-2004)

National torrential hazard catalogue



Hazard data

A total of 10,885 watersheds in Austria, from 1980 to 2018, 3,768 torrential events recorded

Do forest disturbances influence the probability of torrential hazard events and how do effects change with different types of disturbance regimes?

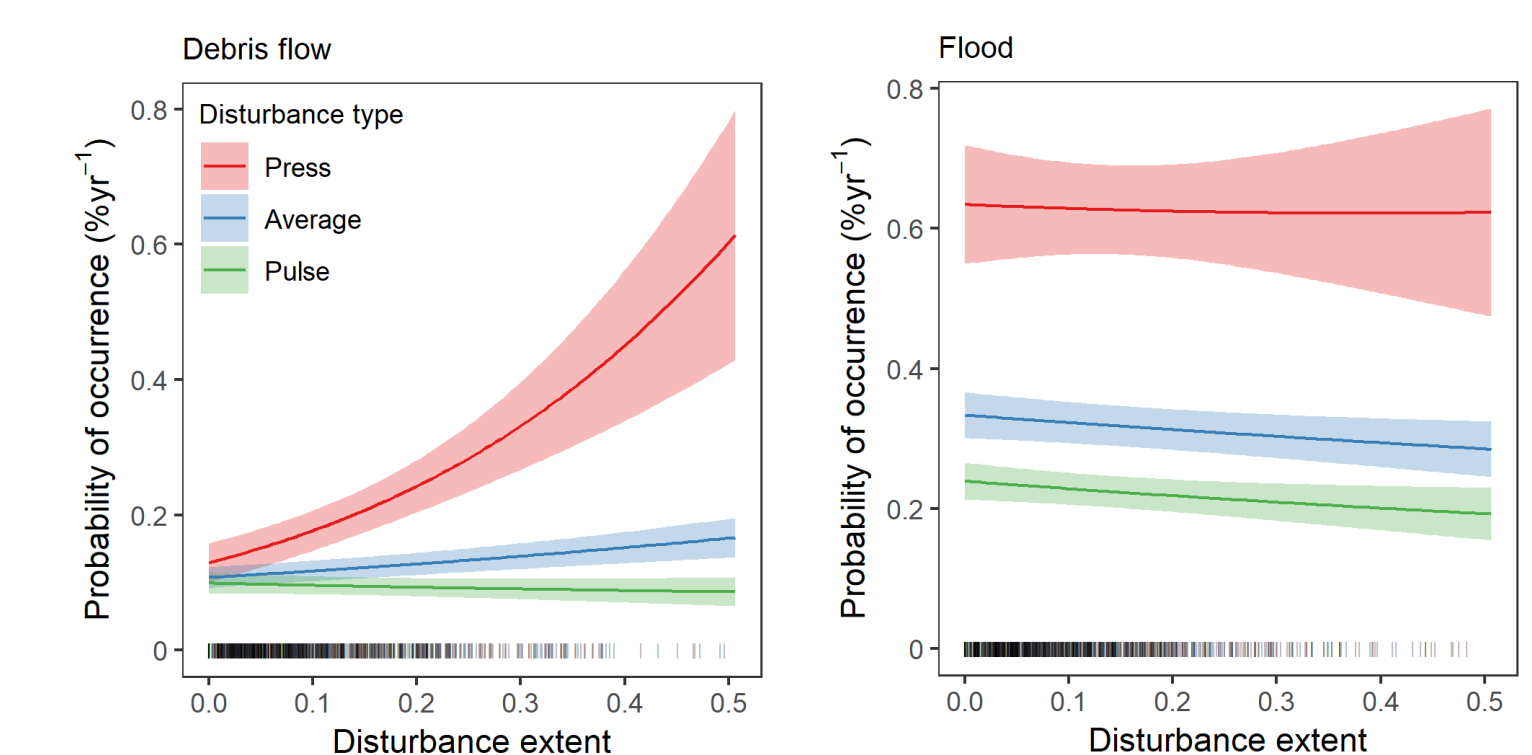
Large disturbances or high disturbance frequencies increase probability of debris flows

Given a press disturbance regime (high frequency), probability of a debris flow increases by 248 % when moving from 10 to 50 % of the watershed disturbed.

Flood is only influenced by disturbance regularity

Probability of a flood increases by 183 % when moving from a pulse (low frequency) to a press (high frequency) disturbance regime.

Predicted annual probability of debris flow and flood events based on the interaction between disturbance extent and disturbance type. Disturbance extent describes the relative forest cover disturbed between 1986 and 2016. Press, average and pulse disturbance types here correspond to Gini coefficients of 0, 0.7, and 1. The data density is indicated by tick marks at the bottom of the panel.



Acknowledgements

This research was supported by Austrian Science Fund (FWF) through the project "Forest disturbances in a changing world" (grant Y895-B25).



Julius Sebald

Institute of Silviculture | BOKU Vienna

Mail julius.sebald@boku.ac.at Twitter twitter.com/juliussebald GitHub github.com/juliussebald/dis-haz