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

Supplementary information

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SI 1: Nine main ecological regions of Austria according to Kilian et al. (1994) with effect on probability of occurrence/frequency of torrential hazards. Note that the ecological region 1 is used as baseline and all effects are estimated relative to this ecological region. Watersheds in ecoregions with effect sizes on the right (left) side of the dashed line have a higher (lower) probability of torrential hazards than ecoregion 1.
SI 2: We tested the sensitivity of our results to land-use change within the study period by removing all watersheds that had a forest cover change of >5 % between 1990 and 2018 (n= 2,241) according to Corine land cover maps (Copernicus, 2019). Effect sizes and directions remain similar to the analysis conducted with the full data set (see Figure 2), indicating that our findings are robust to land-use changes within our study period.
SI 3: Characterization of disturbance regimes in the Eastern Alps based on disturbance type and disturbance extent. Please note that the examples for the four quadrants are only highlighted for illustrative purposes (e.g. bark beetle outbreaks can also occur with a large spatial extent and wind-throw disturbances can also result in small patchy canopy disturbances) and that continuous variables are used in the analysis for both dimensions of the canopy disturbance regime.
SI 4: Information on the value and range of predictors in our study region. See Table 1 for variable description.

| Domain          | Predictor       | Unit  | Mean  | Standard deviation | Minimum | Maximum |
|-----------------|-----------------|-------|-------|--------------------|---------|---------|
| Geography       | Area            | km²   | 4.37  | 11.90              | 0.05    | 198.43  |
|                 | Elevation       | m a.s.l. | 995   | 484               | 178     | 3059    |
|                 | Infrastructure  | %     | 0.2   | 1.0               | 0.0     | 36.4    |
| Geomorphology   | Melton          | -     | 0.59  | 0.42              | 0.03    | 2.77    |
|                 | Elevation ratio | -     | 0.50  | 0.10              | 0.08    | 0.83    |
|                 | Elongation      | -     | 0.56  | 0.15              | 0.04    | 1.92    |
|                 | Circularty      | -     | 0.47  | 0.13              | 0.06    | 0.90    |
| Forest          | Forest cover    | %     | 63    | 25                | 0       | 100     |
|                 | Patch density   | n/km² | 6.45  | 6.00              | 0.06    | 64.57   |
| Disturbance     | Extent          | %     | 11    | 11                | 0       | 100     |
|                 | Type            | -     | 0.73  | 0.33              | 0       | 1       |
SI 5: Posterior predictive checks for the occurrence models. The black line shows the observed mean probability of an event in a given watershed during the study period, whereas the grey bars indicate random draws from the model. The model is well specified as there is no substantial deviation between model draws and observed data.
SI 6: Posterior predictive checks for the frequency models. The blue bars show the observed number of events per watershed during the study period whereas the blue dots indicate random draws from the model. The model is well specified as there is no substantial deviation between model draws and observed data.