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Dealing with natural hazards in decision support

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FOREST-HUMAN-MACHINE INTERPLAY

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Development of carbon sinks in EU

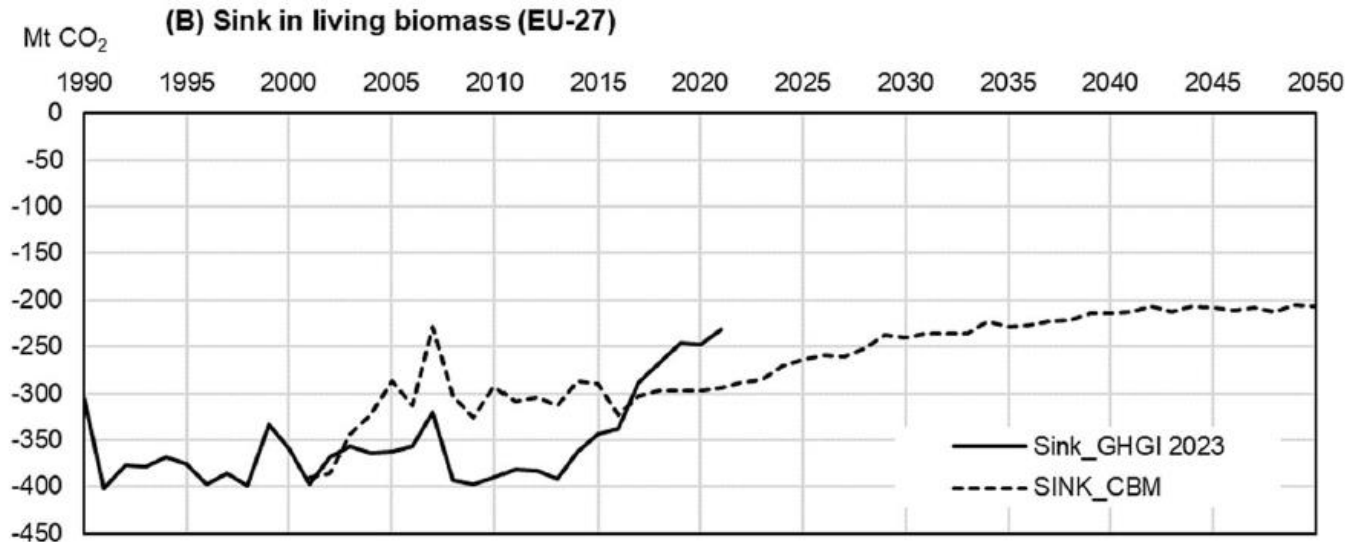


Fig. 6 Our model's results at the EU level, compared with reported statistics. **A** shows the net annual increment (NAI) and harvest (HARV) from the CBM modelling (see also [46]) and as reported by UNECE-FAO [34] and the National Forestry Accounting Plans (NFAP) by the EU member states [9]. **B** shows the results in terms of net carbon sink in living biomass compared with the reporting of GHGI 2023 [28]

Korosuo, A., Pilli, R., Abad Viñas, R. *et al.* The role of forests in the EU climate policy: are we on the right track? *Carbon Balance Manage* **18**, 15 (2023). <https://doi.org/10.1186/s13021-023-00234-0>

Trend in forest disturbance impacts in Europe



Patacca, M., Lindner, M., Lucas-Borja, M. E., Cordonnier, T. ... Schelhaas, M.-J. (2023). Significant increase in natural disturbance impacts on European forests since 1950. *Global Change Biology*, 29, 1359–1376. <https://doi.org/10.1111/gcb.16531>

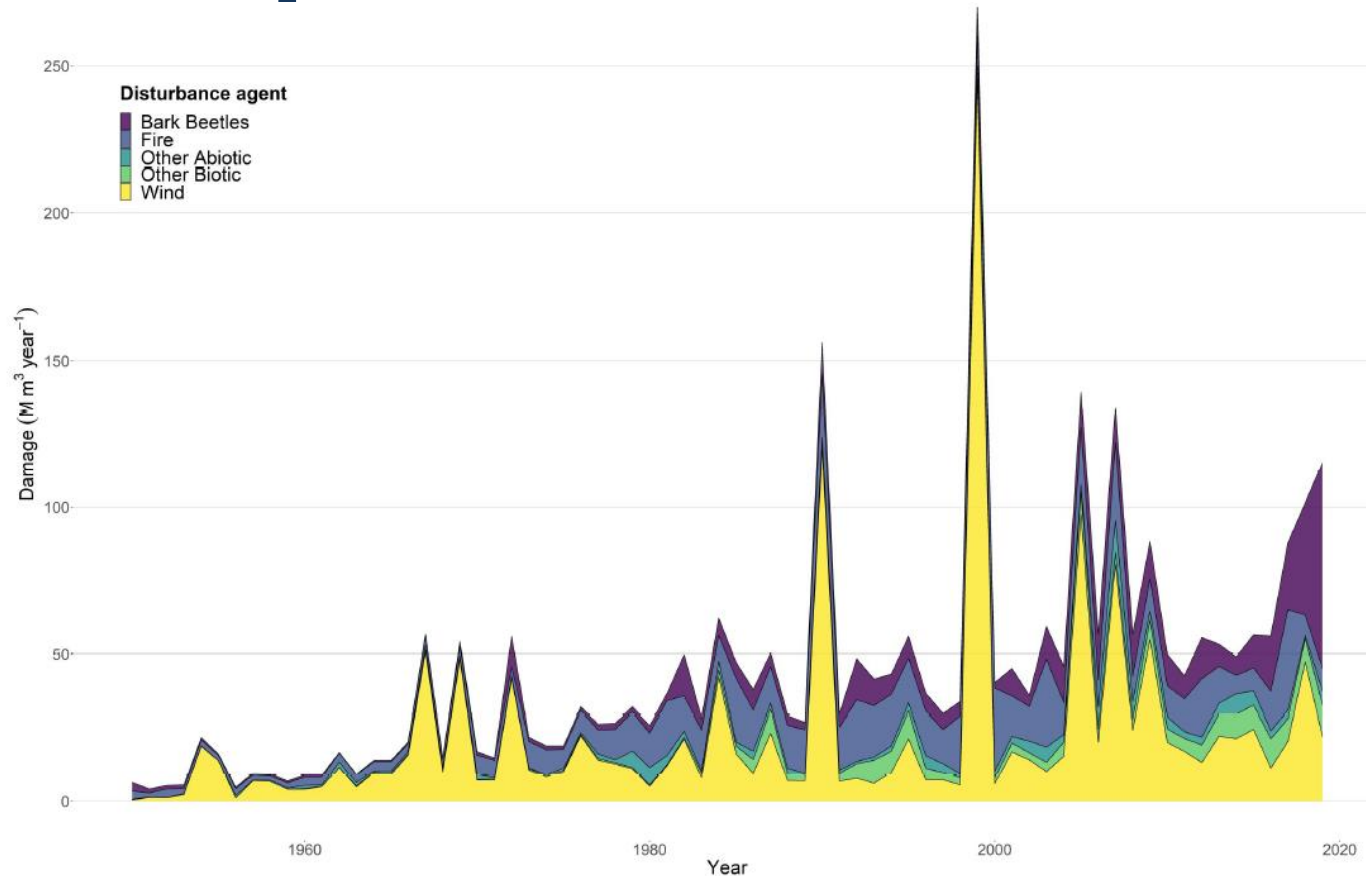
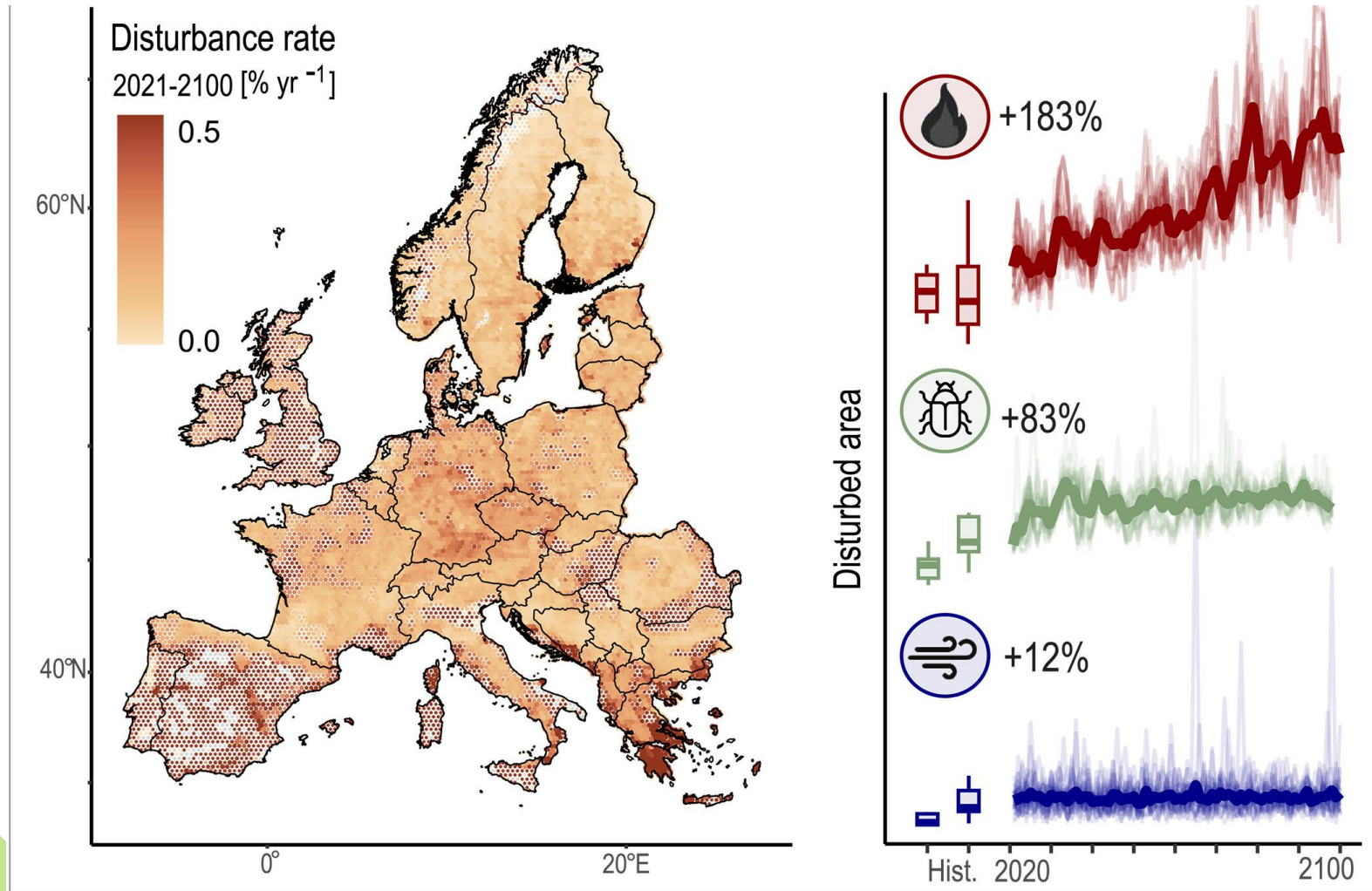


FIGURE 3 Total reported damage caused by natural disturbance in Europe between 1950 and 2019.



Prediction of future development



Marc Grünig *et al.*
Climate change will increase forest disturbances in Europe throughout the 21st century. *Science* **391**, eadx6329(2026). DOI: [10.1126/science.adx6329](https://doi.org/10.1126/science.adx6329)

Decision support systems in risk management



- Most forest decision support systems only cover small-scale mortality due to the tree age and competition between trees
- Disastrous large-area events cannot be predicted or mitigated by any planning tools
 - Wind damage (e.g. 2006 75 million m³ due to Gudrun storm in southern Sweden)
 - Fire damage (e.g. 2018 25 000 hectares in Sweden)
 - Bark beetle damage (e.g. 2019 23 million m³ in Czechia)



Missing natural hazards result in overly optimistic forest scenarios

- Effect depends on salvage cuttings
 - How large a part of timber is non-usable (10-80%)
 - How large part of timber has downgraded quality
- Salvage percentage depends on time between the hazard and the salvage operation
- Hazards also effects on future growth
 - Planned harvests are postponed and hazards select harvested trees

What can be done to improve large-area scenarios?



- Probabilistic predictions give expected development
 - Make several scenarios with randomly allocated disasters
 - Make several scenarios with random salvage percentage
 - Calculate the expected scenario as an average
- This would result in a more realistic view of development of carbon sinks on large areas

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Damages can be mitigated at stand level using forest DSS



- Mitigation is dependent on the choices made at the time of the harvest / tending
 - Changes in tree species distribution
 - Mosaic of single-species stands or mixed stands
 - Difficult in continuous cover forestry
 - Timing of the harvests
 - shortening the rotation times to reduce impact of hazards



Conclusions

- Large-area scenarios require different approach to address hazards than normal forest planning
 - Large-area scenarios should predict expected sinks under risk
 - or predict proportion of downgraded quality and non-usable wood
- Forest planning should enable owners to mitigate risk at stand level
- Clearcutting vulnerable stands and changing tree species might be the best method for mitigation

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