Defending Climate Targets Under Threat of Forest Carbon Impermanence

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1 Background

A quarter of our carbon emissions are absorbed by forests[1]. Additionally, the cheapest available option for large-scale carbon removal is reforestation[2-4]. As a result, the perpetual growth of the forest carbon sink has become critical to our plans to stay within the Paris Agreement climate targets[5-7]. However, an increasing number of studies cast doubt on the continued resilience, health, and productivity of forests under threat of climate change and direct human interference[8-19]. We use the integrated assessment model REMIND-MAgPIE to explore 1.5°C and 2°C mitigation scenarios assuming a range of forest disturbance levels and policy responses. We demonstrate the cost and effort incurred by policy that meets climate targets despite increasing forest carbon loss.

2a Policy Scenarios

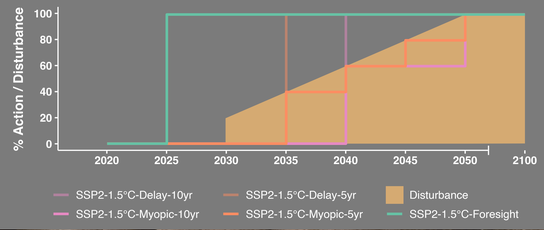

Fig 1. Shows the disturbance growth in fraction (%) of the total rate reached in 2050 (filled area). Rates explored range from 2 to 16 per thousand trees disturbed yearly (see Figure 5).
Colored lines schematically depict the five policy responses to the disturbance. The action (%) refers to the fraction of the disturbance rate the policy addresses at that time. Scenarios explored are: (turquoise) Foresighted, (light orange/pink) respond five/ten years after the initial disturbance, (dark orange/pink) respond myopically five/ten years after the initial disturbance.

3 Results

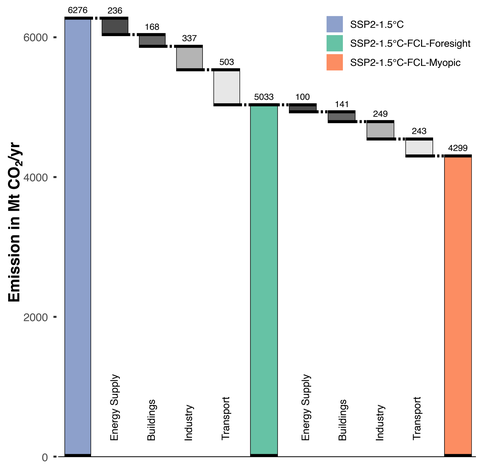

Fig 2. 2050 emissions colored by scenario and reductions by sector (greyscale) Scenarios depicted are the SSP2-1.5°C scenario without taking forest disturbances into account (blue), the scenario mounting a foresighted preemptive response to forest carbon loss (FCL) of 0.4%/yr (green), and the scenario in which action against the same FCL is taken myopically five years after the initial disturbance (orange).

- 1.2GtCO$_2$/yr reduction in allowed emission in foresighted response to 0.4%/yr disturbance rate.
- 2.0GtCO$_2$/yr reduction (+59%) in the 5yr myopic response.

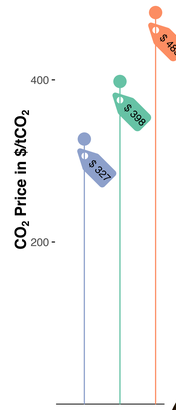

Fig 4. CO_2 price driving regulations in 2050 colored by scenario (see Fig 2.).

- 71$/tCO$_2$ higher CO_2 price in foresighted response to 0.4%/yr disturbance rate.
- 156$/tCO$_2$ higher CO_2 price (+120%) in the 5yr myopic response.

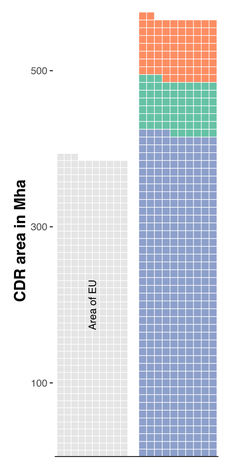

Fig 3. Area occupied by bioenergy and A/R in 2050 colored by scenario (see Fig 2.). Each square represents 1 Mha. For a sense of scale, the total land area of the European Union is added.

- 69Mha more land dedicated to mitigation in foresighted response to 0.4%/yr disturbance rate.
- 149Mha more (+116%) in the 5yr myopic response.

2b Disturbance Scenarios

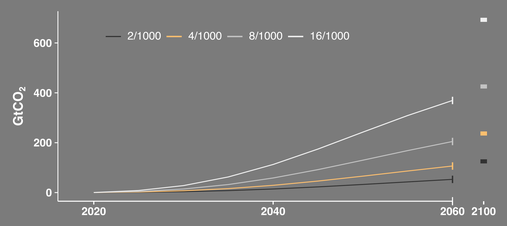

Fig 5. Shows the cumulative net CO_2 emission (GtCO$_2$) caused by four different rates of forest disturbance (2/1000, 4/1000, 8/1000, and 16/1000 trees per year), represented by gray shading. Disturbed trees are moved to the youngest age class. The difference in carbon storage between the age classes is emitted. However, the trees are allowed to regrow immediately. Thus, the net emissions are the difference between the disturbance and subsequent regrowth. The resulting net emissions from forests take up part of the overall carbon budget. The results depicted in section 3 are specifically for the 4/1000 disturbance rate (colored).

5 Conclusion

- **Failing to prepare in advance and delaying action can result in double the cost and effort needed to respond to the same amount of carbon loss of forests.**
- **Even modest increases in forest carbon loss require more rigorous mitigation measures to meet climate goals.**
- **Preserving and monitoring forests is essential for the economic viability of mitigation pathways.**

References

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