Searching for the Optimized Forest Management Maximizing Carbon Sequestration in Mountain Forests Impacted by Natural Disturbances: a Case Study in the Alps

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Supplementary Material

S1: Calculation of carbon sequestration

In the study, we focused on carbon sequestration in forest only, so it was calculated considering only the change in tree biomass and woody biomass of trees that have died naturally since they remain in forests (equation 1). We did not include harvested timber in the calculation because most of it is removed from the forest and does not represent direct sequestration. Nevertheless, it is important to note that in the long term harvested wood can positively affect the carbon stock on a broader level (i.e., state or EU level) (IPCC, 2003; Thrippleton et al., 2021). Equation 1 was used to calculate carbon sequestration in forests (adapted after Blattert et al., 2018):

$$\Delta C = C_{\text{live trees, t+n}} - C_{\text{live trees, t}} + \Sigma\, C_{\text{remaining deadwood, a}} \qquad \text{(S1)},$$

where ΔC is the change in carbon pool between time t and t+n (t C ha^{-1}), $C_{live\ trees}$ is the carbon in the above- and below-ground living tree biomass (t C ha^{-1}) and is calculated according to equation S2 (Thrippleton et al., 2021), $C_{remaining\ deadwood}$ is carbon in the deadwood from natural mortality, stumps and harvest residues (t C ha^{-1}) calculated according to equation S3, t is the start time of the simulation (years), n is the duration of the simulation (years) and a is the simulation interval (years).

$$C_{live\ trees} = CF * V_{live\ trees} * WD * BEF * R \qquad \text{(S2)},$$

where $V_{live\ trees}$ is aboveground volume of alive trees (m^3 ha^{-1}), CF is species-specific carbon factor, WD is species-specific wood density (Table S1), BEF is species-specific biomass expansion factor and R is species-specific root-shoot expansion factor.

$$C_{remaining\ deadwood,a} = CF * WD * ((R * BEF * V_{natural\ deadwood,a}) + V_{stumps,a} + V_{harvest\ residues,a})) * e^{-k*(t+n-a)} \qquad \text{(S3)},$$

$$V_{stumps,a} = 0{,}03 * V_{timber,a} \qquad \textit{(S4)},$$

$$V_{harvest\ residues,a} = 0{,}10 * V_{timber,a} \qquad \textit{(S5)},$$

where $V_{natural\ deadwood}$ in deadwood volume from natural mortality (m^3 ha-1), V_{stumps} is volume of tree stumps (m^3 ha^{-1}), $V_{harvest\ residues}$ is volume of harvest residues (m^3 ha^{-1}) and k is the indicator of decomposition rate, calculated according to equation 4 (Mackensen et al., 2003)

$$k = dec1 * dec2*MAT \quad \text{(S6)},$$

where *dec1* is decomposition factor 1, being 0,0166, *dec2* decomposition factor 2 being 0,093, and *MAT* mean annual temperature (°C).

S2: Parameters for calculating the aboveground biomass of live trees

Table S1. Parameters used for calculation of the aboveground biomass of live trees (IPCC, 2003)

	Beech	Spruce	Fir	O. conif.	O. broad.
CF	0,48	0,51	0,51	0,51	0,48
BEF	1,4	1,3	1,3	1,3	1,4
WD	0,58	0,4	0,4	0,4	0,52
R	0,26	0,3	0,3	0,3	0,26

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