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Carbon accumulation rate peaks at 1,000-m elevation in tropical planted and regrowth forests

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Tropical forests, accounting for approximately 40%–50% of global forest carbon sink, are under threat from ongoing deforestation. Thus, it is essential to regenerate tree cover pan-tropically, either in areas where forests have historically existed or where they have never existed before. Nevertheless, challenges persist in pinpointing which elevational ranges exhibit rapid growth rate. Using multiple data streams, as well as modeling and mapping approaches, our analysis reveals a robust and consistently increasing trend in the tree growth rate at elevations between 300 and 1,000 m but a subsequently declining trend at elevations >1,000 m. This optimal

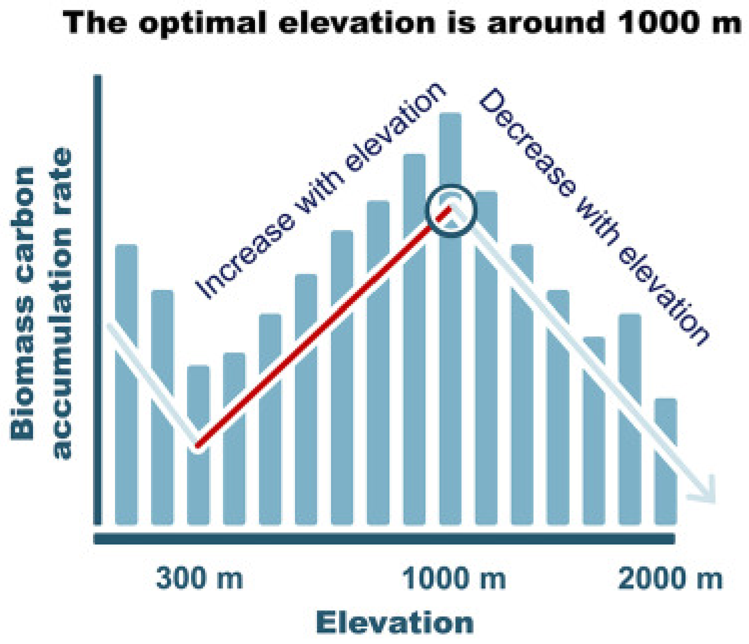
Highlights

- A new carbon-accumulation-threshold approach was used to detect optimal elevation
- The biomass carbon accumulation rate increases with elevation from 300 to 1,000 m
- The biomass carbon accumulation rate decreases when elevation >1,000 m
- 1,000 m is the optimal elevation for accumulating biomass carbon in the tropics

Summary

Tropical planted and regrowth forests (TPRFs) are one of the most low-cost components for recovering biomass-stored carbon in the tropics. Nevertheless, challenges persist in pinpointing which elevational ranges exhibit the largest carbon accumulation rate (γ_{rapid}) due to the highly inconsistent previous assessments. This prevents the selection of optimal locations for implementing large-scale reforestation in the tropics. Here, we proposed a refined approach that used a carbon accumulation threshold (<80% of the maximum value) to quantify γ_{rapid} in TPRFs at various elevations. We find that γ_{rapid} increases with elevations from 300 to 1,000 m and declines at elevations >1,000 m. TPRFs at elevations ~1,000 m exhibit three times more γ_{rapid} than lowland TPRFs. This optimal elevation, highly dependent on background temperatures, varies slightly but significantly across different mountains. These findings provide guidelines for policymakers to determine the optimal elevations from regional to continental scales when implementing reforestation initiatives in the tropics.

Graphical abstract



Keywords

tropical forests · biomass carbon accumulations rate · planted forests · natural growth forests · elevation pattern · rapid growth stage · relieve high-temperature stress

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