Logging disturbance shifts net primary productivity and its allocation in Bornean tropical forests

ABSTRACT

Tropical forests play a major role in the carbon cycle of the terrestrial biosphere. Recent field studies have provided detailed descriptions of the carbon cycle of mature tropical forests, but logged or secondary forests have received much less attention. Here we report the first measures of total net primary productivity (NPP) and its allocation along a disturbance gradient from old-growth forests to moderately and heavily logged forests in Malaysian Borneo. We measured the main NPP components (woody, fine root and canopy NPP) in old-growth (n=6) and logged (n=5) 1 ha forest plots. Overall, the total NPP did not differ between old-growth and logged forest (13.5 ± 0.5 and 15.7 ± 1.5 Mg C ha-1 year-1, respectively). However, logged forests allocated significantly higher fraction into woody NPP at the expense of the canopy NPP (42% and 48% into woody and canopy NPP, respectively, in old-growth forest vs. 66% and 23% in logged forest). When controlling for local stand structure, NPP in logged forest stands was 41% higher, and woody NPP was 150% higher than in old-growth stands with similar basal area, but this was offset by structure effects (higher gap frequency and absence of large trees in logged forest). This pattern was not driven by species turnover: the average woody NPP of all species groups within logged forest (pioneers, non-pioneers, species unique to logged plots and species shared with old-growth plots) was similar. Hence, below a threshold of very heavy disturbance, logged forests can exhibit higher NPP and higher allocation to wood; such shifts in carbon cycling persist for decades after the logging event. Given that the majority of tropical forest biome has experienced some degree of logging, our results demonstrate that logging can cause substantial shifts in carbon production and allocation in tropical forests.