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Carbon and nitrogen cycle dynamics during forest regrowth in the dry tropical Miombo Woodlands of western Tanzania

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Extensive regions of dry tropical forests, such as the Miombo woodlands of sub-Saharan Africa, are experiencing high rates of both deforestation and forest regrowth on abandoned agricultural lands. Changes in the cycles of key elements such as carbon (C) and nitrogen (N) in the regrowing woodlands are not well understood. This study examines the plant and soil C and N dynamics along a chronosequence of regrowing Miombo woodland sites in western Tanzania following abandonment from cultivation. Our primary goals were to address two questions: (1) what are the timescales over which aboveground tree C stocks recover and soil mineral N stocks change during regrowth; (2) when, and/or to what degree, do tree C stocks and soil mineral N reach conditions of mature forests at decadal timescales? We established a chronosequence of 18 sites ranging in age from 3 to >40 years since abandonment. At each site, we conducted tree surveys and made measurements to quantify the aboveground tree C stocks using multiple sets of Miombo-specific allometric equations. In addition, we sampled soils at each site to a depth of 100 cm, and determined total and mineral N standing stocks. We also conducted short-term soil incubations to determine nitrogen mineralization potentials for the surface soils at each site. Aboveground tree C stocks ranged from 0.4 $\pm$ 0.1 Mg C ha-1 for 3-4 year sites (n = 3) to 27.2 $\pm$ 5.2 Mg C ha-1 (n = 3) for 30-40 year sites, and were 44.5 $\pm$ 7.4 Mg C ha-1 for mature forest sites (n = 6) . Annualized rates of aboveground tree C stock changes (0.68 – 0.89 Mg C ha-1 yr-1) were comparable to the few published for Miombo forests. However, tree C stocks of regrowth sites between 10 - 24 years (5.2 $\pm$ 1.1 Mg C ha -1 (n=3)) were much lower than those reported at similarly aged sites in other comparable studies. Across this study's chronosequence, only the regrowth sites older than three decades (30-40 year sites) had C stocks approaching those of mature forests. Further analyses will compare patterns of N dynamics across the chronosequence and relate them to the trends we have quantified in aboveground tree C stocks. In the future, we will use data from this study to provide foundational information to test remote-sensing characterization of land cover conditions corresponding with forest regrowth stages. Such scaling relationships will allow us to improve upon global data products that poorly characterize land cover in Miombo systems, and to develop improved estimations of how ongoing land cover changes are affecting C stock and N cycling at landscape scales in Miombo ecosystems.