



Research paper

Carbon stocks in necromass and soil pools of a Mozambican tropical dry forest under different disturbance regimes



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ABSTRACT

Tropical dry forests comprise almost half of the world's tropical and subtropical forests, support the livelihoods of large numbers of the world's poorest people, yet they are the most threatened of the major tropical forest types and least studied of the world's forested ecosystems. Due to their fragility and the high demand for forest goods and services, tropical dry forests are also subject to one of the highest rates of deforestation and degradation. These disturbances affect the amount, input and the availability of woody debris, depending on the disturbance regime. This study aimed to quantify the C stocks in necromass and soil pools of Mecrusse woodlands under different disturbance regimes. C stock values for the different necromass components were consistently larger for the most disturbed Mecrusse woodlands. Consequently, soil organic matter and soil organic C (SOC) mass fractions and SOC stock were also larger for the most disturbed Mecrusse woodlands. Most C stock was from intact coarse woody debris (CWD). Overall, C stored in necromass was 37.7 Mg ha⁻¹, of which 58.2% was from aboveground CWD, 30.3% from belowground necromass, and 11.4% from litter and fine woody debris. The majority of aboveground necromass was fallen CWD (54.6%), standing CWD ranked next (30%). The densities of intact, partially decayed, and rotten CWD were 98.7%, 83.2%, and 56.9% that of living trees, respectively. SOC stock was 39.7 Mg ha⁻¹ for the whole population. Human pressure has led to more necromass and SOC stock.

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1. Introduction

Tropical dry forests are defined as those experiencing a tropical climate, with summer rains, a dry period of 5–8 months and annual rainfall ranging from 500 to 1500 mm [1]. Tropical dry forests comprise almost half of the world's tropical and subtropical forests [2], support the livelihoods of large numbers of the world's poorest people [3], yet they are the most threatened of the major tropical forest types [4] and least studied of the world's forested ecosystems [1].

Tropical dry forests are subject to one of the highest rates of deforestation and degradation [4] due to their fragility and the high demand for forest goods and services [3]. The disturbances that dry forests are subject to affect the amount, input and the availability of woody debris, depending on the disturbance regime (intensity, frequency and scale).

Woody debris is an important, but often neglected component of many terrestrial and aquatic ecosystems [5]. It is an important

component of forest ecosystems of interest to wildlife biologists, ecologists, mycologists, foresters, fire experts [6] and soil specialists; as it provides information on quality and status of wildlife habitats, structural diversity within the forest, fuel loading and fire behaviour, carbon sequestration, storage and cycling of nutrients and water, seedling establishment [5,6]. Woody debris is also important for erosion reduction, soil development, is a source of energy and nutrients, serve as seedbeds, and provide habitat for decomposers and heterotrophs [7].

As a carbon (C) pool, woody debris has also been neglected [7–9]; much attention has been given to living plants [8] and soil organic C (SOC). Therefore, studying a least studied C pool and ecosystem component (woody debris) for the most threatened and least studied tropical forest ecosystem (tropical dry forests) is timely and of a great importance.

The intensive biomass harvesting which these forests are subject to [3] may lead to SOC losses in all layers of forest soils [10]. Therefore, different forest disturbance regimes may have distinguishable impacts on SOC stocks of forest soils.

The aim of this study was to quantify C stocks in necromass and soil pools of Mecrusse woodlands under different disturbance

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regimes; i.e. this study addressed the following research question: do C stocks in necromass and soil pools vary with disturbance regime? It was hypothesized that, in short-term, the C stocks of woody debris and soil are higher for the most disturbed Mecrusse patches.

Further, the basic densities and the C stocks of the different CWD decay classes were estimated.

2. Material and methods

2.1. Study area

Mozambique (18° 15'S, 35° 00'E, Fig. 1A) is dominated by tropical dry forests and woodlands [1,3,11,12], comprising mainly Miombo, Mopane [11] and Mecrusse woodlands [13].

The study was conducted in all Mecrusse woodlands of Mozambique, which cover 12 districts (Fig. 1B) with a total area of 112,080 km² (14% of the Country's area), of which Mecrusse woodlands cover 5519 km² (5% of the study area).

Mecrusse is a forest type in which the dominant canopy species is *Androstachys johnsonii* Prain, the relative cover of which varies from 80% to 100% [14]. It is typical found in dry tropical climates with Ferralic Arenosols (covering 74% of Mecrusse woodlands) and Stagnic soils (covering 20% of Mecrusse woodlands) [15,16], and from sites with intense and long-lasting meteorological and hydrological droughts [15,17–26]. For a detailed description of Mecrusse and the study area, refer to Magalhães [13,16].

2.2. Data acquisition and analysis

Necromass and soil parameters were measured using a fixed area plot sampling method [6,27,28] and a stratified random sampling design.

The disturbance regimes of Mecrusse woodlands are strongly associated with proximity to the villages. Mecrusse woodlands were, thus, stratified according to the distance from the nearest village in (1) Mecrusse woodlands close to the village ([0, 5] km), Mecrusse woodlands at an intermediate distance from the village ([5, 10] km), and (3) Mecrusse woodlands far from the village (≥ 10 km). Mecrusse woodlands close, at an intermediate distance, and far from the villages are often open, moderately dense, and dense woodlands [29]. However, it should be pointed out that Mecrusse patches far from the villages (dense Mecrusse patches) are not intact; are just those where the anthropogenic disturbances have not decreased significantly the forest canopy cover.

The straight-line distance from Mecrusse patches to the boundary of the closest village was derived with ArcGIS 10.2.2 [30].

Seventy (70) 12.5 m radius random sampling plots were proportionally distributed in the 3 strata (Table 1). Coarse woody debris (CWD), defined here as the woody material ≥ 2.5 cm in diameter at wider end, regardless of the length, were measured for volume inside the plots. Subplots of 1 m radius were established in the centre of the 12.5 m radius plots for measurement of litter and fine woody debris (FWD, woody materials < 2.5 cm in diameter at wider end) and for collection of soil samples.

CWD were divided into standing and fallen. Standing CWD

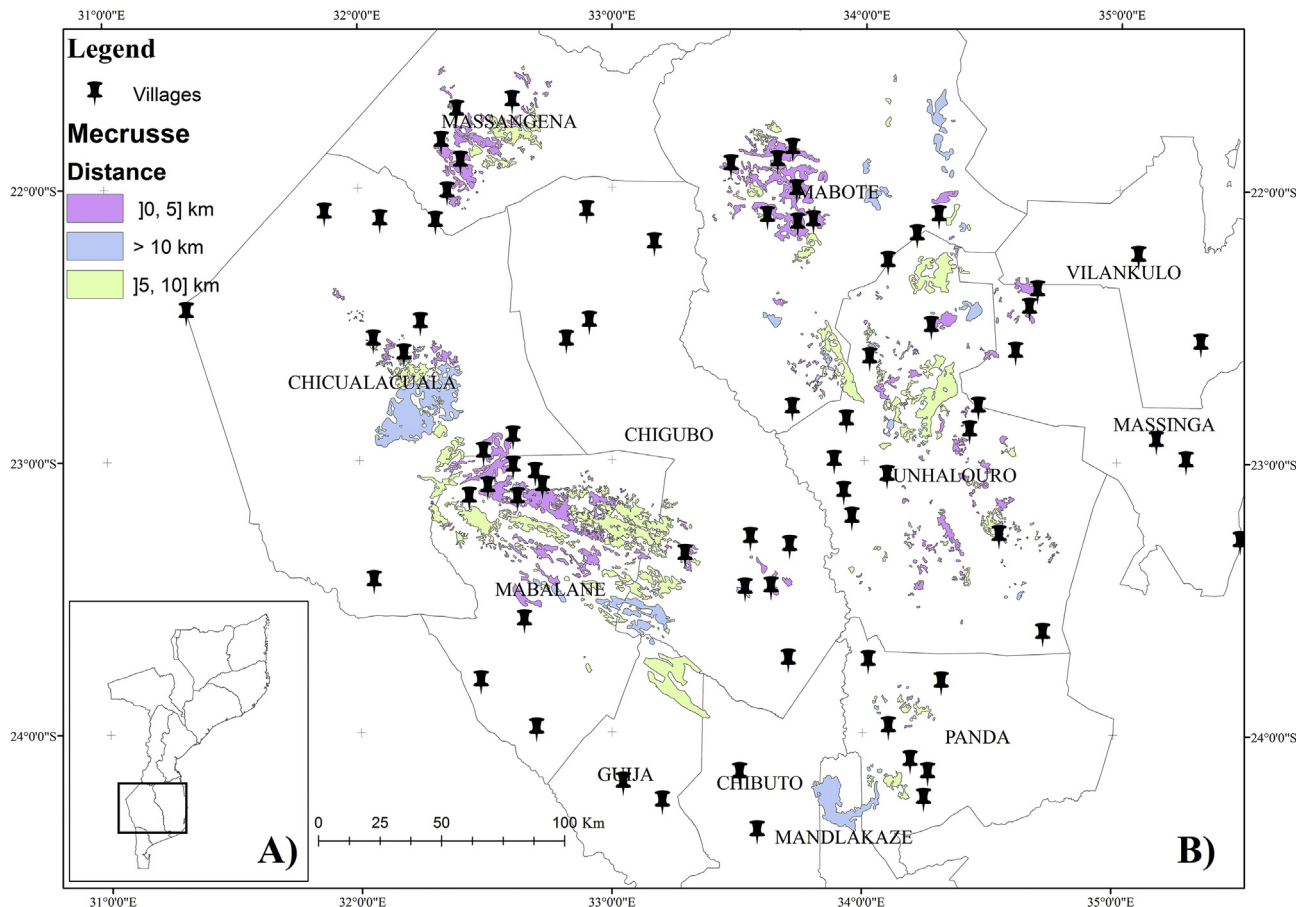


Fig. 1. Study area.

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