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**Changes in microbial biomass and activity in relation to shifting cultivation and horticultural practices in subtropical evergreen forest ecosystem of north-east India**

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**Abstract**

The present study conducted in the Nokrek [biosphere reserve](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/biosphere-reserve) (BR) of Meghalaya in north-east India aimed at analyzing the impact of human activities such as shifting [agriculture](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/agricultural-science) (‘Jhum’) and horticultural practices on temporal and spatial changes in [microbial biomass](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/microbial-biomass) and [dehydrogenase](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/dehydrogenase" \o "Learn more about dehydrogenase from ScienceDirect's AI-generated Topic Pages) and [urease](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/urease" \o "Learn more about urease from ScienceDirect's AI-generated Topic Pages) activities in soil. Microbial biomass-C (MBC) and -N(MBN) as well as dehydrogenase and urease activities were significantly (*P* < 0.01) greater in the soils of the undisturbed forest ecosystem in core zone of the BR than the soils under various land use practices in the buffer zone of the BR. The microbial biomass-N in the [surface soil layer](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/soil-surface-layers) (0–10 cm) was maximum (285.4 μg g–1) in the undisturbed core zone and minimum (75.1 μg g−1) in the 1-year-old jhum fallow, which was subjected to intense human activities. Similarly, dehydrogenase (TPF released = 0.70 μg g−1 24 h−1) and urease activities (NH4 released = 31.56 μg 100 g−1 6 h−1) were maximum in the undisturbed core zone and minimum (TPF released = 0.37 μg g−1 24 h−1 and NH4 released = 10.78 μg 100 g−1 6 h−1, respectively) in the 1-year-old jhum fallow. Thus, human activities in the buffer zone of the BR were responsible for significant reduction in both microbial biomass-N and [enzyme activities](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/enzyme-activity). Both these properties showed recovery during [regrowth](https://www.sciencedirect.com/topics/earth-and-planetary-sciences/regrowth" \o "Learn more about regrowth from ScienceDirect's AI-generated Topic Pages) of vegetation on jhum fallows. Microbial biomass-N and [enzyme activities](https://www.sciencedirect.com/topics/agricultural-and-biological-sciences/enzyme-activity) declined significantly (*P* < 0.01) with increasing soil depth at all the sites. Seasonal variations in both microbial biomass-N and enzyme activities at all sites were also significant (*P* < 0.01) with peak in autumn and trough in winter.

**Introduction**

The soil microbial biomass constitutes a transformation matrix for all natural organic materials in the soil and acts as a labile reservoir of plant available nutrients (Jenkinson and Ladd, 1981). Since it constitutes a significant part of the potentially mineralizable N and serves both as the transformation agent and source-sink of N (Bonde et al., 1998), it plays an important role in N cycling due to rapid turnover rate. Garcìa-Gil et al. (2000) concluded that microbial biomass is a much more sensitive indicator of changing soil conditions than the total organic matter content. In recent years, studies on microbial biomass and their activity have engaged the attention of many researchers. However, most of these studies are confined to agricultural soils (e.g. Grayston et al., 2001) and in forest ecosystem such studies are rather limited. Microbiological indicators have been used by research groups in numerous studies of soil restoration in forest ecosystem (e.g. Caravaca et al., 2002, Caravaca et al., 2003).

Soil enzymes are essential for catalyzing reactions necessary for organic matter decomposition (Ajwa et al., 1999) and their activities are strongly influenced by organic matter content of the soil (Klose and Tabatabai, 2000). The enzyme activities have often been used as indices of microbial activity and soil fertility (Kennedy and Papendick, 1995). Human activities that minimize the organic matter content of the soil may reduce enzyme activities and could alter the availability of nutrients for plant uptake (Dick et al., 1998). Therefore, the study of soil microbial biomass and their potential activity is important for understanding early changes in biological quality of soil following changes in the land management (Palma et al., 2000). The objective of the present study was to analyze the effect of various human activities on soil biological properties of forest ecosystem in Nokrek biosphere reserve (BR), north-east India. The study sites that were exposed to different degrees of human activities, such as ‘Jhum’ (shifting cultivation or slash and burn agriculture) fallows of different ages undergoing natural recovery, tea gardens and orange orchards recently raised in the buffer zone as well as the undisturbed primary forest in the core zone. In order to achieve the aforesaid objective, the soil microbial biomass-N and biomass-C, and soil enzyme (urease and dehydrogenase) activities were measured in the undisturbed forest and above-mentioned communities that varied in the degree of disturbance and intensity of human intervention.

**Section snippets**

**Study site**

The study was carried out in the Nokrek BR (latitude 25°20′N–25°29′N; longitude 90°13′E–90°35′E) situated in the western part of the state of Meghalaya, north-east India. The altitude of the BR ranged between 200 and 1412 m (a.s.l.). The BR has an area of 820 km2, of which 47.48 km2 is covered by undisturbed primary subtropical evergreen forest. This portion is designated as the Nokrek National Park and constitutes the core zone of the BR spreading in east–west direction. The northern aspect of

**Soil physico-chemical properties**

The bulk density of soil ranged from 0.9 g cm–3 in the surface soil layer (0–10 cm depth) of the tea garden to 1.5 g cm–3 in the sub-surface soil layer (10–20 cm depth) of the primary forest. However, it did not vary significantly (*P* < 0.05) between the stands and depths. The soil was sandy loam in the undisturbed primary forest and jhum fallows, sand–clay–loam in the tea garden and loamy-sand in the orchard (Table 3). The soil was acidic in all stands with pH ranging between 5.3 and 6.0; the tea

**Seasonal and spatial changes**

Ecosystems with high organic matter input and easily available organic matter compounds tend to have higher microbial biomass contents and activities because organic substances are the preferred energy source for the microorganisms (Hassink, 1994). The high concentration of detrital material in the surface soil layer (0–10 cm) in the subtropical forest increases the availability of soil organic matter in the surface layer due to fast turnover rates of litter and fine roots (Arunachalam et al.,

**Conclusion**

Human activities such as shifting agriculture and horticultural practices in the hilly buffer zone of the Nokrek BR coupled with high rainfall cause depletion of the MBC and MBN, and reduction in their activities in soil except in the tea garden where fertilizer and manure were applied. Several physico-chemical properties of soil (WHC, pH, CEC, SOC, TKN) and ambient temperature also affected MBC, MBN and enzyme activities. As the vegetation regrows after abandonment of cultivation on jhum land,

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