A comparison of soil CO2 efflux rate in young rubber plantation, oil palm plantation, recovering and primary forest ecosystems of Malaysia

ABSTRACT

Tropical deforestation and land conversion has been an environmental challenge over time and this is likely to have wide-reaching consequences for soil CO2 efflux. Such soil-carbon dynamic disturbances are critical in light of climate change, as tropical forests store almost 30% of global forest carbon. Soil CO2 efflux and environmental factors were determined in four different forest ecosystems of primary Dipterocarp forest, a 50-year-old recovering Dipterocarp forest, and a 5-year-old rubber and oil palm plantation using an automated soil CO2 chamber technique (Li-Cor 8100) with an in-built infrared gas analyzer. The forest sections are located within 1,800 m of each other while the plantation is 1,500 m away in the tropical lowland forest of Pasoh, Peninsular Malaysia. The aim was to determine the influence of environmental factors influencing soil CO2 efflux in relation to different forest ages and stand densities as a result of forest disturbance. Multiple regression analysis has been conducted on the relationship between soil CO2 and environmental factors. Soil CO2 efflux rate was found to range from 1.47-13.22 μmolCO2 m-2·s-1 (5.37 μmolCO2 m-2·s-1), 1.18-10 μmolCO2 m-2·s-1 (5.107 μmolCO2 m-2·s-1), 0.88-12.07 μmolCO2 m-2·s-1 (3.260 μmolCO2 m-2·s-1), and 2.33-7.89 μmolCO2 m-2·s-1 (4.678 μmolCO2 m-2·s-1) in the 50-year-old recovering forest, primary forest, oil palm plantation, and rubber plantation, respectively. Likewise, the highest forest biomass occurred in the primary forest and was followed by the 50-year-old recovering forest, rubber and oil palm plantation. Although the mean soil CO2 efflux rate did not differ significantly, differences were evident in the environmental factors such as soil temperature and moisture occurring at a range of 23 to 32°C and 15 to 35.56%, respectively, to influence soil CO2 efflux. The highest CO2 efflux rate was recorded in the 50-year-old recovering forest and followed by the primary forest, and rubber and oil palm plantation. The finding revealed a significant and strong correlation between soil CO2 efflux and soil temperature, moisture, and forest carbon input. Furthermore, the spatial variation in soil CO2 efflux was attributed to total above-ground biomass, below ground biomass, and forest carbon stock. We can conclude that the spatial variation in Soil CO2 efflux across the four different forest ecosystems is as a result of forest disturbance and land conversion triggering changes in environmental factors as well as forest carbon, thereby increasing microbial activity to emit soil CO2.

Keyword: Forest ecosystem; Recovering forest; Plantation; Primary forest; Soil CO2 efflux; Soil temperature