Abstract

[Project Information]

Project Title :	Reduction of CO_2 Emission and Boost of Ecosystem Services by Applying Biochar to Forest Ecosystems
Project Number :	JPMEERF20221C07
Project Period (FY) :	2022-2024
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[Abstract]

Biochar, which is obtained by pyrolysis under oxygen-limiting conditions and applied to soil, is one of the low-cost options for carbon sequestration for climate change mitigation. We hypothesize that by converting unused organic matter accumulated in forests (coarse woody debris (CWD) such as dead and fallen trees and prunings) into biochar and returning it to forest floors, long-term and stable carbon sequestration by biochar could be achieved while promoting forest management and solving the problem of underuse. The objective of this study was to obtain the scientific knowledge necessary to verify the effectiveness and feasibility of such a project; that is, quantitative data on CO_2 emission reductions when biochar is used and on changes in forest ecosystem services after biochar application.

The effects of biochar on ecosystem components and ecosystem services, such as carbon sequestration (Net Ecosystem Production; NEP) and soil resilience (physical and chemical buffering capacity), were investigated in a secondary deciduous broad-leaved forest where biochar was applied at 10 ton ha^{-1} in 2015. Biochar application increased CO_2 emissions from decomposition in the short term (~3 years) but increased plant primary production over 8 years, resulting in an increase in NEP. Biochar spread on the soil surface migrated downward and remain in the mineral soil layer after 7–10 years. Furthermore, from a long-term perspective, biochar had no negative effects on the physical, biological, or chemical properties of the soil, and maintained a high moisture content in the shallow soil layer.

Quantitative data were obtained on the amount of coarse woody debris (CWD) on the forest floor, the carbonization rate of converting it to biochar, and the decomposition rate of biochar on the forest floor. A preliminary life cycle assessment of the entire project, encompassing the entire process from collection of CWD, transportation, carbonization, biochar application, and changes in

NEP, showed that this project is carbon negative as a whole.

A pot-culture experiment simulating several forest types to determine the short-term effects of biochar application indicated that biochar application tended to promote the growth of saplings of all tree species without adversely affecting the components of the ecosystem.

These results indicate that projects that convert unused forest organic matter into biochar and return it to the forest floor are carbon negative as a whole, and that biochar application to forests has little negative impact on ecosystem components in the long term, enhancing carbon sequestration and soil resilience.

[References]

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