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Prospects for enhancing carbon sequestration and reclamation of degraded lands with fossil-fuel combustion by-products☆

A.V. Palumbo[a,*], J.F. McCarthy[b], J.E. Amonette[c], L.S. Fisher[a], S.D. Wullschleger[a], W. Lee Daniels[d]

[a]*Environmental Sciences Division, Oak Ridge National Laboratory, Oak Ridge, TN 37831-6038, USA*
[b]*Center for Environmental Biotechnology, Department of Ecology and Evolutionary Biology, The University of Tennessee, Knoxville, TN 37996, USA*
[c]*Environmental Molecular Sciences Laboratory, Pacific Northwest National Laboratory, Richland, WA 99352, USA*
[d]*Department of Crop and Soil Environmental Sciences, Virginia Tech, Blacksburg, VA 24061-0404, USA*

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Abstract

Concern for the potential global change consequences of increasing atmospheric CO_2 has prompted interest in the development of mechanisms to reduce or stabilize atmospheric CO_2. During the next several decades, a program focused on terrestrial sequestration processes could make a significant contribution to abating CO_2 increases. The reclamation of degraded lands, such as mine-spoil sites, highway rights-of-way, and poorly managed lands, represents an opportunity to couple C sequestration with the use of fossil-fuel and energy by-products and other waste material, such as biosolids and organic wastes from human and animal sewage treatment facilities, to improve soil quality. Degraded lands are often characterized by acidic pH, low levels of key nutrients, poor soil structure, and limited moisture-retention capacity. Much is known about the methods to improve these soils, but the cost of implementation is often a limiting factor. However, the additional financial and environmental benefits of C sequestration may change the economics of land reclamation activities. The addition of energy-related by-products can address the adverse conditions of these degraded lands through a variety of mechanisms, such as enhancing plant growth and capturing of organic C in long-lived soil C pools. This review examines the use of fossil-fuel combustion by-products and organic amendments to enhance C sequestration and identifies the key gaps in information that still must be addressed before these methods can be implemented on an environmentally meaningful scale.

Keywords: Carbon sequestration; Degraded lands; Fossil-fuel by-products; Soil organic matter; Land restoration

1. Introduction

Atmospheric CO_2 concentrations and other so-called greenhouse gases have, due in large part to fossil-fuel combustion, increased considerably since the early to mid 1800s and are projected to accelerate during the coming century (e.g. IPCC, 1995; Houghton et al., 2001). It is estimated that in the United States alone, CO_2 emissions increased more than eightfold between 1990 and 1998 (Fig. 1; Marland et al., 2001). Such increases are believed to have the potential to cause unprecedented regional and global climatic and related environmental changes, including increased global temperatures, altered patterns of regional precipitation and cloud cover, rises in sea level, and increased frequency and severity of extreme weather events (e.g. Easterling

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*Corresponding author. Fax: +1-865-241-0595.
E-mail address: palumboav@ornl.gov (A.V. Palumbo).

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