BIOCHAR

A Regional Supply Chain Approach in View of Climate Change Mitigation

Climate change poses a fundamental threat to humanity, and thus solutions for both mitigation and adaptation strategies are becoming increasingly necessary. Biochar can offer a range of environmental services, such as reclamation of degraded land, improvement of soil fertility and carbon sequestration. However, it also raises questions, regarding sustainable feedstock provision, biomass pyrolysis and soil amendment. These questions, among various others, are addressed in this state-of-the-art compendium.

Covering a broad geographical range, with regional assessments from North America, Europe, the Near East and Southeast Asia, this interdisciplinary volume focuses on the entire biochar supply chain, from the availability and economics of biomass resources, to pyrolysis, and ultimately to the impacts on soil properties.

The combination of theory with practical examples makes this a valuable book for researchers, policymakers and graduate students alike, in fields such as soil science, sustainable development, climate change mitigation, biomass and bioenergy, forestry, and environmental engineering.

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CAMBRIDGE
UNIVERSITY PRESS

Shaftesbury Road, Cambridge CB2 8EA, United Kingdom

One Liberty Plaza, 20th Floor, New York, NY 10006, USA

477 Williamstown Road, Port Melbourne, VIC 3207, Australia

314–321, 3rd Floor, Plot 3, Splendor Forum, Jasola District Centre, New Delhi – 110025, India

103 Penang Road, #05–06/07, Visioncrest Commercial, Singapore 238467

Cambridge University Press is part of Cambridge University Press & Assessment,
a department of the University of Cambridge.

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education, learning and research at the highest international levels of excellence.

www.cambridge.org
Information on this title: www.cambridge.org/9781107117099

First published 2016

A catalogue record for this publication is available from the British Library

Library of Congress Cataloging-in-Publication data
Names: Bruckman, Viktor J., editor.
Title: Biochar: A Regional Supply Chain Approach in View of Climate Change
Mitigation / edited by Viktor J. Bruckman, Esin Apaydin Varol,
Başak B. Uzun and Jay Liu.
Description: New York: Cambridge University Press, 2016. |
Includes bibliographical references and index.
Identifiers: LCCN 2016026756 | ISBN 9781107117099 (hard back)
Subjects: LCSH: Biochar. | Greenhouse gas mitigation. |
Climate change mitigation.
Classification: LCC TP248.B55 B537 2016 | DDC 577.2/2–dc23
LC record available at https://lccn.loc.gov/2016026756

ISBN 978-1-107-11709-9 Hardback

Cambridge University Press & Assessment
978-1-107-11709-9 — Biochar
Edited by Viktor J. Bruckman , Esin Apaydın Varol , Başak B. Uzun , Jay Liu
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We would like to dedicate this book, as a token of our esteem, to our dear colleague and true friend Professor Dr Başak Burcu Uzun Akınlar, who tragically and unexpectedly passed away during the period of editing this book. Her contributions to this book as an editor, to science in general, her friendly and kind way of interacting with colleagues and students and her heartwarming smile will always be remembered.

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Preface

The world is currently facing major challenges such as climate change, a rising demand of biomass for food, feed, raw materials and energy, environmental degradation and pollution, as well as a considerable loss of biodiversity. Soils are at centre stage in all of these challenges and there are examples from the past where it was shown that the success of civilizations is tightly dependent on soil fertility and productivity. We begin to understand that the prosperity of the entire world population builds on soils, which are a non-renewable resource in human timescales and threatened on global scales by unsustainable management practices, climate change and other anthropogenic influences. Soils are not just fine grains of weathered rock, but can be described as living bioreactors that provide the basis for biomass production. They are regulators of the world's climate and represent the largest terrestrial carbon stock.

Scientists are now celebrating the discovery of something that was already there before humans actively managed and used land. Charred organic matter is an important component of soils in many ecosystems, especially those in Mediterranean regions, which are usually well-adapted to wildfires. The relative recalcitrance of charred organic matter makes the difference where things become interesting from an environmental engineering point of view. Why not bury charcoal in our soils where it decomposes slowly and hence sequesters carbon and ideally also improves soil properties such as nutrient and water retention? Indeed there is evidence that this is a promising strategy, as very fertile soils were discovered in tropical South America, where one would only expect heavy weathered clay minerals with poor fertility. It turned out that charred organic matter plays a role in improving and conserving fertility in at least some of these soils, which are called 'Terra Preta de Indio'. However, this might quickly lead to misunderstandings and misconceptions as it is by no means as simple as adding charcoal to poor soil to end up with 'Terra Preta'. There are many interactions and interdependencies between different types of carbon in the soil, microorganisms, moisture and the way land is being managed. We are currently only at the beginning of understanding the entire system and although we learn more with every single effort to study biochar and its application in the environment, there are still many questions, and some of them need time to find a satisfying answer.

One of these recent approaches was made by an international collaboration project between Austria, South Korea and Turkey, with the aim of studying the potential for greenhouse gas (GHG) mitigation using biochar in the respective consortium member countries. This KORANET (Korean scientific cooperation network with the European Research Area) collaboration provided the basis to prepare this book, with contributions selected based on discussions with participants of the project workshops and in some cases also external expertise. The aim of this book is not to replicate existing knowledge and recently published books on this topic, but the discussions showed clearly that the biochar topic must be addressed in an interdisciplinary way by using a systems approach. Therefore, we purposely tried to include chapters on the entire supply chain, from biomass availability and provision to the actual conversion process, pyrolysis, to the final application.

The first part of the book (Chapters 2–5) provides a more integrative overview and describes the entire supply chain from different points of view. Part 2 (Chapters 6–9) is focused on the feedstock potentials and implications for biomass markets and regional trade scales. Chapters 10–13 comprise Part 3, which is devoted to the production of biochar from a technological point of view, but also considers byproducts and tradeoffs. Finally, in Part 4, (Chapters 14–18) we focus on biochar–soil interactions and the potential benefits (including co-benefits) of biochar amendment in soils.

We focus in this book on woody biomass and biomass resources from forests as well as forest plantations as these are currently not well covered in the existing literature. Likewise, we present potential uses of biochar in forest ecosystems as well. A key strategy of this book is to combine theoretical examples and considerations with practical examples, and therefore we include at least one practical chapter in each section with original data from field experiments or demonstration sites.

The inclusion of expertise from different climatic and geographic regions of the world highlights that if biochar is to be considered as a tool for environmental or geo-engineering, one may need to expect different (regional to site-specific) challenges but also opportunities. As the scenarios of biochar amendment are infinite in terms of expectations, biochar properties and environmental responses, it needs efforts to better understand and characterize the mechanisms behind it and to employ robust standards. This would also allow and facilitate a market for biochar and its safe use. Nevertheless, it will still be necessary to decide at project level if and under which circumstances the use of biochar delivers the expected benefits. Success finally also depends on economics, and this is currently one of the major drawbacks. But still, biochar may be helpful to restore soil functions and improve soil fertility, and the wide range of feedstock materials as well as pyrolysis conditions could allow the production of specific biochars with distinct properties, triggering specific environmental responses. A profound understanding of the entire supply chain and interdisciplinary approaches are needed to address this issue, and the aim of this book is to provide a good insight into different steps of the supply chain, under different circumstances. Ultimately it should help to understand the use of biochar as a tool to tackle the current challenges, without fuelling exaggerated expectations, in the most efficient way. Even though it may seem to be impossible to employ biochar for the sake of a single function,

it might be a viable solution when considering byproducts or co-benefits. The potential pathways of biochar utilization are endless, but science has to provide the basis for a sustainable and safe application and we hope that this book is of help for experts and students as well as engineers and land managers.

We would like to express our sincere gratitude to the institutions that funded the KORANET Project 'FOREBIOM', which allowed us to put this book together. These are the 7th Framework Programme for Research and Technological Development of the European Commission (FP7, Ref.: KORANET), The Austrian Federal Ministry of Science, Research and Economy (BMWFW, Ref.: BMWF-308.299/0023-II/6/2012), The National Research Foundation of South Korea (NRF) funded by the Ministry of Science, ICT and Future Planning (Ref.: 2012K1A3A7A03052140), and the Scientific and Technological Research Council of Turkey (TÜBİTAK, Ref.: 112M662). Mr Gerald Dunst, CEO of Sonnenerde, kindly provided the pyrolysis of woodchips for our field experiment.

We thank all the internal and officially appointed referees of the manuscripts in several development stages for their time and efforts to significantly improve the quality of the final chapters. We would also like to thank our colleagues for their advice in various discussions regarding the book project. Specifically, we would like to thank Hakkı Alma, Nele Ameloot, Nuray Çiçek Atikmen, Erland Bååth, Gero Becker, Torsten Berger, Paul Blanz, Anthony V. Bridgwater, Martin H. Gerzabek, Robert Jandl, Claudia Kammann, Rattan Lal, Sung-Rin Lim, Franz Oberwinkler, İbrahim Ortaş, Jun-Hyung Ryu, Inge Stupak, Mohd Nazip Suratman, Håkan Wallander, Michael Weiß, Karin Windsteig, Seung-Han Woo, Sophie Zechmeister-Boltenstern, Ronald Zirbs and a number of anonymous referees, including those reviewing the initial proposal for this book. We are thankful to members of the Task Force 'Sustainable Forest Biomass Network (SFBN)' and RG 7.01 (Impacts of air pollution and climate change on forest ecosystems) of the International Union of Forest Research Organizations (IUFRO) for continuous advice in several stages of this project. We would like to express our sincere gratitude to Emma Kiddle, Cassi Roberts and Zoe Pruce as well as their colleagues at Cambridge University Press (CUP) for guiding us through the entire publication process in an extraordinarily professional and dedicated way. Our friends, colleagues and most of all family members deserve our greatest gratitude for their support and patience during the compilation of this book.

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January, 2016