EDITED BY PAVAN KUMAR ▪ RAM KUMAR SINGH
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CLIMATE IMPACTS ON SUSTAINABLE NATURAL RESOURCE MANAGEMENT

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Climate Impacts on Sustainable Natural Resource Management

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Foreword

Climate change refers to any distinct behavior in measures of climate such as temperature, rainfall, snow, or wind patterns lasting for decades. Over the past several years, the international and national research communities have developed a progressively clearer picture of how and why Earth's climate is changing and of the impacts of climate change on a wide range of human and environmental systems. Natural resources and their management form a critical interface between climate change and development. The impacts of climate change can affect the quality and reliability of many of the services that natural resources provide. On the other hand, natural resources play an important role in greenhouse gas mitigation and also serve as a first line of defense against climate change.

This book covers a wide range of strategies that can be applied to various sectors, from forest productivity to climate change threat on natural resources. Its aim, as with resource management itself, is to combine economics, policy, and science to help rehabilitate and preserve our natural resources. This book provides a comprehensive compilation of sustainable natural resource management, determinants of forest productivity, agriculture and climate change impact, water management and control of salinity, climate change threat on natural resources, and vulnerability due to climate change. I believe that this book serves as an opportunity for scientists who are internationally renowned in their fields, addressing issues and interests of academics and other stakeholders engaged in applied science.

I congratulate the editors, the contributors across the country, and the publisher for bringing out timely publication depicting climate impact on natural resource management and hope that this important book shall serve as a reference for different institutions working in this area.

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Preface

Climate change is one of the major global concerns in today's world. Assessment of the relationship between natural resources and climatic drivers along with the assessment of probable impacts of climate change on natural resources is essentially required to develop mitigation and adaptation strategies. Statistics show that the average surface temperature of planet Earth has increased by about 1.18 °C since the late nineteenth century. Apart from this, the sea level has also increased by about 8 inches since the last century. Any further increase in the global temperature and sea-level rise would have a significant negative impact on the majority of natural resources and human well-being. Global climate change that is mostly driven by human-induced activities needs to be understood clearly so that strategies can be planned for an early action before it is too late. Thus it is quite evident that we need to be serious when dealing with the consequences of climate change. Updated and timely information on the changing flux of solar radiation, atmospheric warming, patterns and variations in precipitation, trends of increasing CO_2 concentration, etc. are essential to keep track of changing climate. The pathways that are linked to climate change such as different socio-economic activities, burning of fossil fuels, land-use change, forest cover change dynamics, health estimates of agriculture and forested lands, the productivity of agriculture and forestry systems, etc. provide essential insight to develop a sustainable plan for the management of natural resources.

The IPCC announced that the increase in the recorded Earth's temperature during the last 50 years is the result of various human activities. Climate change has become an important driving force in regulating mechanisms of the physical and biological world. It is now well established that climate change influences a vast number of sectors and resources, either directly or indirectly. The governments of the world have responded to the threats associated with climate change to formulate actions for mitigation. For a better understanding, long-term observation is desirable to continuously monitor precipitation, temperature, daily radiation, etc. along with the monitoring of the spatial extent and health of natural resources to conclusively establish site-specific impact assessment. Throughout the world, several attempts have been made to minimize the impact of climate change or to initiate necessary steps to retard the speed of climate change. Natural resources not only contribute to the overall growth of the economy of a nation but also reduces poverty when adequate management and sustainability are ensured. Natural resource management has emerged as one of the most inclusive growth sectors for supporting the economy of Asian countries. Besides, the forward and backward linkages of natural resources to climate

change require a comprehensive understanding of a sustainable world. Global weather and climate studies are increasingly being considered as a vital source of information to understand the Earth's environment, especially human-induced climate studies and factors affecting natural resources.

This book covers significant and updated contributions in the field of sustainable natural resources management linked to climate change. The updated knowledge from countries like India, Indonesia, Japan, Malaysia, Sri Lanka, and the USA is presented in this book through selected case studies for major thematic areas that have basic preliminary concepts and elaborates the scientific understanding of the relationship between natural resources and climatic drivers, influence of climate change on agriculture, forest, water resources, etc. The book has been separated into six major themes, each having subject-specific chapters to develop the concept and to present the findings in a lucid way that is useful for a wide range of readers. While the range of applications and innovative techniques is constantly increasing, this book provides a summary of key case studies to provide the most updated information. Chapters incorporate multi-source data and information that offer critical understanding to explain the causes and effects of environmental changes linked to natural resource management. This book will be of interest to researchers and practitioners in the field of environmental sciences, remote sensing, geographical information, meteorology, sociology and policy studies, etc. related to natural resource management and climate change. Also, scientists and graduate and post-graduate level students of various disciplines will find valuable information in this book. We believe that the book would be read by people with a common interest in sustainable development and other diverse backgrounds within earth observation.

The scientific quality of the book was ensured by a rigorous review process where leading researchers from Australia, Canada, India, Indonesia, Japan, Malaysia, Sri Lanka, and the USA participated to provide constructive comments to improve the chapters. Due to the confidentiality of the review process, we are unable to provide their names; however, we are deeply indebted and thankful for their voluntary support. On behalf of the team of authors, we express our gratitude to the entire crew of Wiley for all kind of assistance to make this a successful endeavor.

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Section I

Sustainable Natural Resource Management

1

Impact of Local REDD+ Intervention on Greenhouse Gas Emissions in East Kalimantan Province, Indonesia

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1.1 Introduction

1.1.1 Tropical Deforestation

Initially, carbon was stored in the forests (Houghton 2012), but once the forests were logged and cleared, carbon (i.e. both above and below ground) was released into the atmosphere (Baccini et al. 2012) mostly in the for of carbon dioxide (CO_2). However, the decomposition or burning of the forest may also release small amounts of methane (CH_4) and carbon monoxide (CO) (Achard et al. 2014; Rosa et al. 2016; Bebber and Butt 2017; Brinck et al. 2017; Pearson et al. 2017). Thus deforestation received high attention from the scientific community (Rosa et al. 2016; Sierra et al. 2012; Zarin 2012) on carbon emissions (Numata et al. 2011; Houghton 2012; Le Quéré et al. 2015), especially in the tropics, where deforestation is responsible for 17%–25% of carbon dioxide (CO_2) emissions into the atmosphere (Le Quéré et al. 2015). So tropical deforestation is one of the leading causes of global carbon emissions and biodiversity loss (Brun et al. 2015). Therefore, understanding its drivers is crucial for improving policies and measuring current forest trends toward a more climate- and biodiversity-friendly outcome (Hosonuma et al. 2012). Also, the Forest Resources Assessment (FRA) of the Food and Agriculture Organization of the United Nations (FAO) provides a complete measurement of above-ground carbon stocks for tropical forests (FAO 2006, 2010, 2015).

1.1.2 REDD+

Reducing emissions from deforestation and forest degradation (REDD+) now constitutes the international convention for mitigating climate change, particularly in forest-rich developing countries (Gullison et al. 2007; Arima et al. 2014). The "+" after REDD

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comes from more recent dialogs that have broadened the mechanism's scope to recognize carbon benefits of forest conservation, sustainable forest management (SFM), and the sequestration potential of afforestation and reforestation (Venter and Koh 2012). The REDD+ mechanism is the most prominent of recent attempts to mitigate climate change (Agrawal et al. 2011). Furthermore, leakage policies of REDD+ should be monitored, measured, and mitigated to guarantee their effectiveness (Atmadja and Verchot 2012).

Reducing emissions from deforestation by 2020 could bring the international community nearer to the goal of less than 2 degree increase in global average temperature change (Zarin et al. 2016). Furthermore, more than 180 governments, private companies, indigenous peoples, and non-governmental organizations have signed the New York Declaration on Forests (NYDF) in September 2014 (UN Climate Summit 2014). Within the REDD+ policy framework, developing countries might develop national systems for carbon accounting (Angelsen 2009; Logan-Hines et al. 2012).

Developing countries are encouraged to develop national strategies and action plans for REDD+ by identifying the drivers of deforestation (Hosonuma et al. 2012). In the past three decades, satellite-based observations of forest cover change provide an alternative to estimate deforestation rates regularly across space and time (Zhuravleva et al. 2013; Kuenzer et al. 2014; Kamaruddin et al. 2015). At continental to global scales, forest cover maps and change in cover are increasingly being generated from various satellite data sources (Potapov et al. 2012; Kim et al. 2014; Margono et al. 2014). In the latest development, Landsat images have been used to determine tropical deforestation rates (Broich et al. 2011; FAO 2011; Lehmann et al. 2014; Estavillo et al. 2013; Zhuravleva et al. 2013; Potapov et al. 2012). Also, previous studies of forest cover change datasets have been integrated with satellite-based forest biomass information to quantify changes in forest carbon stocks (Baccini et al. 2012; Achard et al. 2014; Tyukavina et al. 2015). However, they might show diverse results due to their different methods for mapping and analyzing.

1.1.3 REDD+ in Indonesia

At the COP 15–2009 of the United Nations Framework Convention on Climate Change (UNFCCC), Indonesia voluntarily agreed to reduce emissions by 26% and up to 41% with international support by 2020. This commitment was submitted as Indonesia's Nationally Appropriate Mitigation Actions (NAMA) in 2010 (Indonesia 2013). Since the commitment, Indonesia made some policies, including Presidential Regulation No. 61 of 2011 (Indonesia 2011b) on the national action plan of REDD+ and Presidential Regulation No. 71 of 2011 on the implementation of the National GHG inventory (Indonesia 2011c). Those regulations mandate different government bodies to provide national, local, and corporate GHG inventories annually. Based on its nationally determined contribution (NDC) submitted to the UNFCCC on September 24, 2015 (Indonesia 2016), Indonesia committed to reducing GHG emissions by 29% under BAU (business as usual) scenario by 2030 unconditionally, and up to 41% conditionally. To meet the objective, Indonesia recognizes the requirement for consolidating both methods and data sources to guarantee a high degree of precision.