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Christiane Runyan and Paolo D'Odorico
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GLOBAL DEFORESTATION

Forests cover 41 billion hectares or 31% of the global land surface, yet 8,000 years ago they covered nearly 50% of the global land surface. While the rate of deforestation has decreased since the 1990s, the current rate is still 13 million hectares per year, and this has widespread environmental impacts. For example, forest cover loss affects the hydrological functioning of watersheds, biogeochemical cycling and the availability of nutrients, carbon dioxide sequestration, and climate change. The adverse impacts of deforestation are recognized as a serious issue by governments globally.

Global Deforestation provides a concise but comprehensive examination of the variety of ways in which deforestation modifies environmental processes, as well as the societal implications of these changes. The book stresses how forest ecosystems may be prone to nearly irreversible degradation. To prevent the loss of important biophysical and socio-economic functions, forests need to be adequately managed and protected against the increasing demand for agricultural land and forest resources. The book:

- describes the spatial extent of forests, including methods used to detect forest cover and its current and historical changes, leading to an understanding of the past and present drivers of deforestation;
- presents a theoretical background to understand the impacts of deforestation on biodiversity, hydrological functioning, biogeochemical cycling, and climate;
- bridges the physical and biological sciences with the social sciences by examining economic impacts and socioeconomic drivers of deforestation;
- reviews the rich body of literature on deforestation and synthesizes information across disciplines, allowing readers to learn about deforestation on an interdisciplinary level without having to consult multiple texts and journal articles.

This book will appeal to anyone in search of a comprehensive yet concise reference on deforestation, including graduate and undergraduate students, researchers and policymakers in environmental science, ecology, forestry, hydrology, geography, biogeochemistry, plant science, ecohydrology, and environmental economics.

Christiane Runyan is a lecturer in Hydrology and Water Resources in the Advanced Academic Program of the Zanvyl Krieger School of Arts and Sciences at Johns Hopkins University. Her research examines how deforestation affects the dynamics of hydrological and biogeochemical processes, and includes modeling the control that vegetation has on the soil's physical and biogeochemical conditions.

Paolo D'Odorico is Ernest H. Ern Professor of Environmental Sciences at the University of Virginia. His research focuses on the role of hydrological processes in the functioning of terrestrial ecosystems and societies. He was awarded the Sustainability Science Award from the Ecological Society of America in 2009, and he was made a Fellow of the John Simon Guggenheim Memorial Foundation in 2011. He edited *Dryland Ecohydrology* (2006, Springer), co-authored *Noise-Induced Phenomena in the Environmental Sciences* (2011, Cambridge University Press), and *Elements of Physical Hydrology, Second Edition* (2014, Johns Hopkins University Press).

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Preface

Deforestation disrupts hydrological processes, climate, biogeochemical cycling, and socioenvironmental dynamics. It can lead to irreversible losses of biodiversity, natural capital, and rural livelihoods, while favoring an unsustainable use of natural resources and enhancing unbalanced relationships between private benefits and public losses associated with land clearance. Deforestation is a *disturbance* because it leads to biomass losses over timescales much shorter than those needed for forest regeneration. In some cases recovery is not possible because the disturbance induces a shift in forest ecosystems to a permanently deforested state by impacting the availability of resources and environmental conditions that are necessary for forest regeneration.

According to the 2010 Food and Agriculture Organization (FAO) Forest Resource Assessment, forests cover 41 billion hectares, or 31% of the global land surface, yet used to cover nearly 50% of the global land surface 8,000 years ago. While the current rate of deforestation has decreased since the 1990s from 16 million ha yr^{-1} to 13 million ha yr^{-1}, it remains relatively high. Deforestation alters the coupled natural and human systems with important impacts on the potential for forests to regenerate. Understanding these impacts is also important in light of international programs that seek to provide financial incentives for reduced deforestation and have an estimated market potential of U.S. $10 billion.

This book is motivated by the need for a comprehensive cross-disciplinary analysis of the existing literature on global deforestation. We review the geography of deforestation, analyze the major drivers and effects of forest loss, and examine theories as well as empirical evidence on how forests affect their natural environment. We stress how forest removal may cause the loss of important ecosystem functions, leading to a permanent and nearly irreversible shift to a treeless state. We investigate the biotic-abiotic feedbacks that determine the stability and resilience of forest ecosystems and analyze the socioeconomic processes underlying current patterns of deforestation. While doing so, we review a large number of recent studies on this body of literature and synthesize information across disciplines, thereby bridging the physical and biological sciences with the social sciences.

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This analysis addresses a broad readership of ecologists, hydrologists, economists, biogeochemists, geographers, resource analysts, and policy makers whose work is related to deforestation. As such, it was written with the goals of readability and accessibility by both social and natural scientists. While providing a relatively thorough synthesis of research that is currently spread across a diverse and broad body of literature, this book is not intended to be a comprehensive treatise on deforestation; this is a fast-moving research field that produces new important contributions every day. It would not be possible to contain in this volume a complete analysis of this growing body of literature.

This book would have not been possible without the help, motivation, and support of our colleagues, families, and institutions. We are grateful to Deborah Lawrence (University of Virginia) for her unfailing support through years of continued collaboration and companionship. We are truly indebted to her for drawing us into this research field and inspiring this work. Christiane Runyan thanks her husband, Joshua, daughter, Georgiana and son, Waylon, for the support they have provided during the time it has taken to write this book. We are grateful to the University of Virginia, Department of Environmental Sciences, for providing the academic environment that stimulated our work. We also thank Michelle Faggert and Kailiang Yu of the University of Virginia for thier assistance with formatting and artwork. We acknowledge the support of the Vice President for Research Office at the University of Virginia and the National Social-Environmental Synthesis Center (SESYNC) of the University of Maryland.

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