

Introduction

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Soil is the great connector of lives, the source and destination of all. It is the healer and restorer and resur-rector, by which disease passes into health, age into youth, death into life.

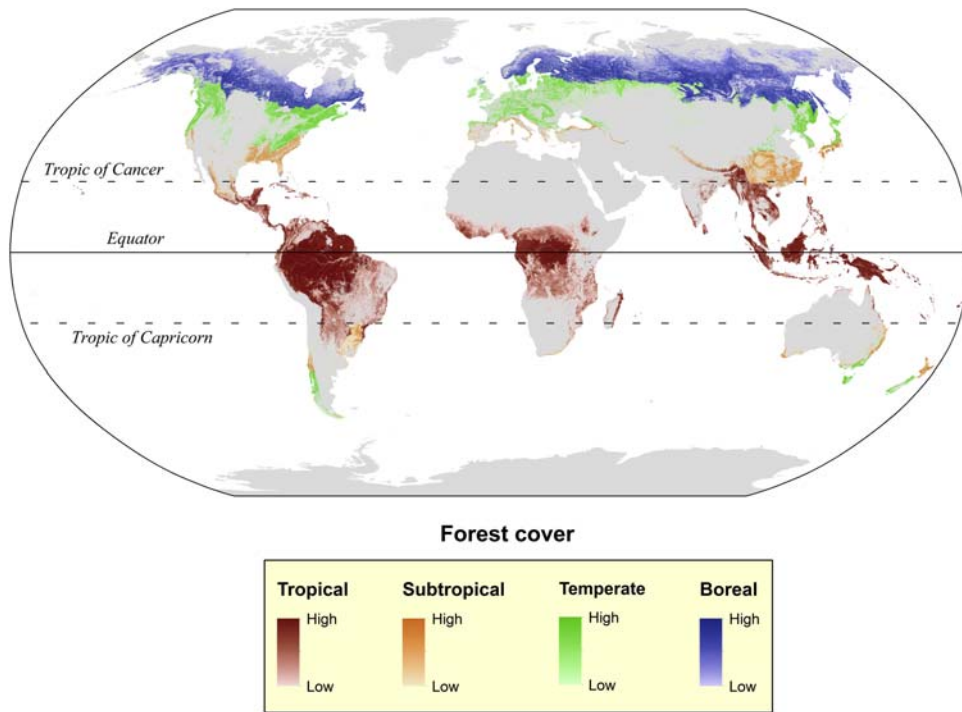
—Wendell Berry, *The Unsettling of America*.

Nearly one-third of Earth's total land area is covered by a remarkably complex and richly alive skin: *forest soil*. This layer — more membrane than crust — is of central importance to the survival of most organisms on our planet. Forest soils help provide an abundance of goods and services to humans including food, fuel, timber, medicines, water, oxygen, biodiversity, climate and hydrological regulation, not to mention a wealth of spiritual, cultural, and aesthetic benefits. For this, humanity is outright lucky but also profoundly challenged with the responsibility for stewarding this natural resource.

We asked the authors of this book to address three core questions in their chapters. First and foremost, how are forest soils faring in our rapidly changing world? Then, how are we progressing as stewards of global soils? Finally, how can we improve our stewardship to meet the challenges of a changing world? Answers to these questions are unfolding, and each chapter seeks to provide insight into the condition of Earth's forest soils, their current management, future needs, and proposed actions where current practice falls short.

Global demands on forest resources are growing (see Fig. 1.1 for a map of the world's forests), as are the corresponding risks of degrading the soil resource. Social and economic inequality strains the limits of what forest soils can provide as marginal forest lands are converted for agricultural production, or as forests are degraded by exploitive extraction of goods to support political, economic, or individual interests. Forests have also known war and the immense environmental toll it takes when serving as hiding cover, as a source of exploitable resources, or as a repository for deadly chemicals and munitions. Finally, how forest soils will respond to a changing global climate, with its volatile effect on drought, insects and diseases, and intense fires capable of rapid, short-term conversion of forests to barren landscapes of erodible soil, remains to be told. And so, the call for effective stewardship based on scientific understanding and social awareness is immediate.

Soil stewardship is a core societal commitment that requires a thoughtful blend of science (i.e., understanding system limits and possibilities), management (ecological and fiscal practicality), and

**FIG. 1.1**

Global forests in 2010.

This map was adapted from the Food and Agriculture Organization of the United Nations (FAO) report “Global Forest Resources Assessment 2010”, using forest canopy cover data accessed from <http://www.fao.org/forestry/ra/80298/en/>. Reproduced with permission.

society’s needs and preferences, all with an awareness that soil management helps determine whether a society thrives or declines. There are strong examples from the past of both routes taken by earlier civilizations (Diamond, 2005; Perlin, 2005). Today, our own path will be determined by how we integrate generations of knowledge on soil health, contemporary science and technology, social communication, and land management approaches derived from wide-ranging experiences and appreciation for the need to adapt. Perhaps most important, we have a palpable awareness of the finite nature of Earth’s resources. Valuing global forest soils, thus, is fundamental to existence on planet Earth. Or as Safford and Vallejo aptly state in Chapter 12, “The desire to repair and restore degraded landscapes is an innate human trait.”

We developed the concept for this book based on this implied principle and the desire to share compelling success stories, evidence of impending train wrecks, and strategies for addressing the uncertainties associated with managing (active or passive) global forest soils. The catalyst for the book also comes from a class taught at the University of California, Davis (*Forests and Society*), where students are introduced to the natural history of forests; forest use and misuse through the millennia; origins of modern-day forest conservation; and current global issues. This volume extends far beyond

the surficial introduction to global forests brought to light in the classroom, with chapters written by internationally recognized leaders in forest soil science and ecology that provide critical analyses on the state of global forest soils and attention to the interconnectedness of soils, trees, and other forest-dwelling organisms (from microbes to moose, and from protozoa to people).

Why soil? The simple answer comes from Dan Binkley (Chapter 2) in his poetic statement, “Imagine a world without soil.” Luckily forest soils do exist in a fantastic assortment of colors and chemistries and capacities to sustain life. Soil is foundational, like air and water, and is honored by gardeners, farmers, foresters, and everyday people alike as a necessity of life on earth. Its intrinsic properties that support life can be seen as far back as the writings of the ancient Roman poet Vergil (70–19 BC), who wrote: “*Earth that is black and, when you drive your share in, looks rich, and crumbly soil is mainly best for crops; no other land sees straining oxen draw more wagons home.*” Indigenous cultures personify soil as a living entity that nurtures, provides sustenance, and supports growth and prosperity, while recognizing the need to protect and replenish her to ensure this support continues in perpetuity. These sentiments are echoed by more contemporary authors such as Aldo Leopold and Wendell Berry, whose writings convey the importance of soil stewardship to society and self — and not just for physical sustenance but for psychological and spiritual health. These poets, practitioners and philosophers would point out a conundrum in today’s fast-paced, technology-driven society: how do we sustain soil so that life can continue to prosper while participating in market-based activities that often neglect the needs of natural resources? They would surely lament the notion of soil as ‘dirt’ — boring, brown, something to be left behind in the push to engage the modern urban economy. But they would find comfort with the recent shift in public attitudes toward soil, a soil renaissance of sorts exemplified by the explosion of urban gardens and events such as the FAO-sponsored “World Soil Day” or the Smithsonian National Museum of Natural History’s featured exhibit, ‘Dig It! The Secrets of Soil’. They would also delight in the proliferation of phrases such as “Soils sustain life” from the Soil Science Society of America; “It all begins and ends with soil” from Jane Goodall’s Roots and Shoots program; or “I love soil” bumper stickers in a multitude of languages. Such grassroots outreach provides evidence that soils are not taken for granted by today’s societies.

Yet moving beyond a simple, intuitive understanding of soil’s importance requires knowledge of the elaborate physical structure, chemical reactions, and biological processes we depend upon for survival. It requires an appreciation of difficult-to-predict changes in soil properties at spatial scales ranging from the intimate (pedon) to the landscape, regional, and even global level. In short, it requires a better understanding of how soils change with time, climate, vegetation, topography, and, most importantly, human intervention. Clearly, soil is among the most complex systems on Earth (Science, 2004). This can cause soil scientists to become frustrated when informing land managers, policy makers, or the public about best practices, exasperated by our own statements of “it depends” or “it varies from site to site.” The chapter authors collectively crush this stumbling block by first acknowledging the complexity of soil, then offering succinct evidence of when, where, and how soils matter (or not).

Many soils deserve high marks for their ‘inner strength’, their tolerance of external stressors, and their resilience to natural or anthropogenic disturbance. Still, drama sells tickets and it can be more effectual to focus on examples of detrimental soil change (e.g., excessive erosion, nutrient loss, or compaction) or impending risks from climate change rather than on the business-like nature of well-managed forest soils. Also, there’s the reality that says soils are but one piece of a complicated puzzle of how we manage, conserve, and value global forests. For example, conversion of forests to

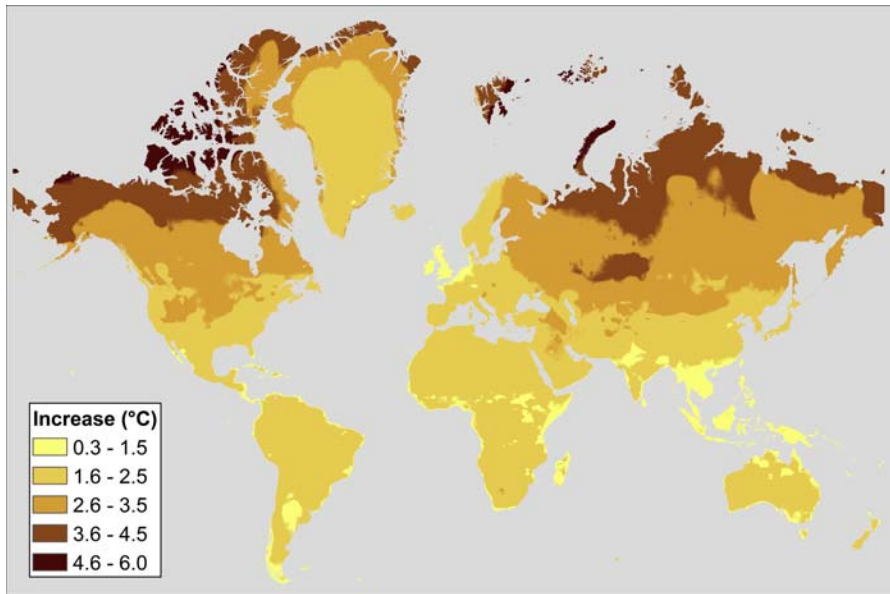


FIG. 1.2

Projected global temperature increase by 2050 compared to 1960–90 using IPCC greenhouse gas concentration scenario RCP6.

Graph produced in ESRI, ArcGIS Online (https://landscape6.arcgis.com/arcgis/rest/services/World_Temp_Chng_2050_60/ImageServer) with data from Climate Community System Model 4, National Center for Atmospheric Research.

palm oil production and the many other forms of deforestation have consequences for wildlife survival and biodiversity, for local economies and global trade, yet effects on soil properties may be much more muted. This is in contrast with climate-driven permafrost melting in northern reaches of the boreal forests, which will radically transform these soils from a sink of global carbon to a major source of devastating greenhouse gases. Indeed, projected changes in global temperatures during the 21st century (Fig. 1.2), along with other global stressors, vary considerably by latitude and location. Here we see warming in boreal forests about 3–5 times greater than in forests of Southeast Asia by 2050. Thus, a principle challenge facing natural resource managers that this volume addresses is the need to recognize when and where soil management is crucial for the well-being of forests and society, and when it serves as a supporting cast member.

We hope you find the book an informative, thought-provoking, and above all critical assessment of global forest soils in a changing world. While not intended to be an exhaustive examination of every forest soil topic — past, present, or future — the book seeks to provide an in-depth synthesis of how forest soils are responding to change and what actions can be taken to increase their resilience. Our intent is to help readers meet daily challenges of preparing multi-resource environmental science and policy documents, to help land managers develop soil conservation strategies fine-tuned to their local conditions, and to serve as an important reference source for all interested in a big-picture assessment of global soil issues and environmental topics.

The book is divided in three sections. First is an introduction to the natural history and long-term management of forest soils, with complementary chapters on human and natural drivers of global change; history of forest soil management and research; and cultural awareness and the diversity of approaches toward soil stewardship. The second section provides in-depth descriptions and syntheses of individual forest biomes — boreal, temperate, tropical, wetlands, urban — and their current and anticipated adaptations to climate change. The final section offers practical considerations for the management and use of global forest soils, with topics ranging from soil carbon management; soil physical, chemical, and biological health; soil rehabilitation; modern techniques and applications of soil mapping; biochar amendments for enhancing carbon storage and soil health; socioeconomic awareness; and ecosystem management and restoration in boreal and Mediterranean biomes.

The life-giving properties of soils discussed in this book speak to the essentiality of resource conservation and stewardship in our ‘journey’ to sustain global forests. Forest soil stewardship implies “learning from doing”, building on existing knowledge and experience, evaluating the effectiveness of forest policies and management decisions, and adapting new approaches to keep pace with emerging demands and ecosystem stressors. Here the ultimate goal is to conserve global soils for generations. For all time.

Acknowledgments

This book is, foremost, an expression of the collective knowledge, expertise, and wisdom of the contributing authors. We thank them for their unconditional willingness to contribute, their good spirit in responding to our near-endless queries and nagging, and their patience with the process. They would agree that their chapters benefitted from the insightful feedback provided by an array of external reviewers, and we thank all reviewers on their behalf. Special thanks go to Ross Gerrard for his efforts in producing many of the high quality maps presented in the book; and our sincere appreciation goes to Hilary Carr, Elsevier content manager, for leading the way and for keeping us in line with her positive approach whenever we drifted. Finally, a heartfelt shout out of reverence and appreciation goes to the soils of the world. Matt, Christian, Dave, Debbie (note: we are listed in alphabetical order but contributed equally as editors).

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