



PURSUING SUSTAINABILITY

A Guide to the Science and Practice

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**PURSUING
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Preface

This book provides a general framework to help people interested in mobilizing knowledge to promote sustainability. We wrote it to complement the many excellent books, courses, and programs that are focused on specific aspects of sustainability: works on the use of land and water, the production of energy and food, corporate responsibility, the challenges of governance and conflict resolution, the pursuit of poverty alleviation and equitable growth. Our goal is not to supplant those more focused efforts but, rather, to sketch a broad perspective on sustainability that places those efforts in a broader context, with an appreciation for the interrelationships among them. The book could therefore be used as a companion or background reading for courses on topics such as sustainable energy, agriculture, or urbanization. It could also serve as a short guide or primer for students and practitioners at all levels who are seeking a more systematic and comprehensive platform on which to base their own pursuits of sustainability.

To these ends, we have tried to write this book as if it is part of a conversation with our readers over important issues in sustainable development, rather than as an argument that we want to win. This has meant keeping the text as short and readable as possible, leaving out many important topics. It has meant, due to our collaboration, addressing a broader sweep of the vast range of material relevant to sustainability than any of us could have done alone; but within that range, we have focused on telling a decidedly interdisciplinary story. Our goal of preparing an accessible primer or companion guide has led us to avoid extensive citations in favor of suggestions for a limited number of “further readings” at the end of the book. It has also involved a constant battle against disciplinary jargon—a battle that we know we haven’t

altogether won. An extended glossary of essential terms, linked to places where those terms are first introduced in the text, is our attempt to limit the resulting damage. We hope that the result of our efforts, combined with your own personal passions, knowledge, and experience, will help you join us in nudging the world along a transition toward sustainability. All our children, grandchildren, and generations beyond are counting on it.

Acknowledgments

The ideas in this book reflect our own personal learning through decades of individual research, teaching, and outreach efforts, but most especially they reflect what we have learned from a number of close colleagues. Among the great many people to whom we give our thanks we owe a special debt to Partha Dasgupta, Bob Kates, Bill Turner, Lin Ostrom, John Schellnhuber, and John Bongaarts. With them, we have tried in large and small ways to formulate a clear statement of what is needed for a transition to sustainability. To them, we say thank you for the inspiration, ideas, and encouragement to keep at it.

Many others have motivated and inspired us. We especially thank Peter Vitousek, Anni Clark, Carla Andersson, Stephen Carpenter, Roz Naylor, Ruth DeFries, Ganesh Shivakoti, Danny Lam, Diana Liverman, Julia Novy-Hildesley, Banny Banerjee, Theo Gibbs, and our children, Liana and Michael Vitousek, Graham and Adam Clark, and Markus Andersson.

The book has benefited from the advice of many reviewers. To them we give all our thanks (and assign no blame). Kai Lee, Ruth DeFries, and Kimberly Nicholas provided incredibly useful in-depth reviews of the first draft, and Kai and Kim went on to provide equally high-quality comments on the second. Noelle Boucquey, Andy Lyons, Jesse Reeves, Alan Zarychta, Kelsey Cody, and many students in our undergraduate classes at Stanford, Harvard, and University of Colorado wrestled with and commented on the book in its early drafts.

The various versions of this book could not have been completed without the intellectual and logistical contributions of Noelle Boucquey and Peter Jewett. To them we give our deep thanks for helping make the book a reality.

Over the years, many funders supported the research and actions that led us to this book, and we thank them all. For the book writing, we are particularly thankful for partial support from Italy's Ministry for Environment, Land and Sea, and, of course, our universities.

PURSUING SUSTAINABILITY

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CHAPTER 1

Pursuing Sustainability: An Introduction

Sustainability is a term we hear all around us. Corporations brand themselves as sustainable and attempt to build sustainability goals, measures, and metrics into their business plans and supply chains. State and local governments set sustainability targets and pursue them, installing efficiency standards and practices, encouraging the use of public transportation systems, and incentivizing citizens to reduce, reuse, and recycle. Universities compete for sustainability awards that recognize efforts ranging from improving energy and water use efficiency to curricular offerings. Researchers focus their attention on the development of new knowledge and technologies to promote sustainability. Consumers consider sustainability concerns as they buy organic, or buy certified sustainable seafood or wood products. Citizens strive to reduce their environmental footprints on the planet out of a sense of responsibility to their children and grandchildren.

Sustainable development, likewise, is a widely used term. It frequently appears in high-level discussions of the United Nations, the World Bank, and non-governmental organizations (NGOs) such as CARE and WWF and is a fundamental objective of the European Union and of many nations rich and poor. The World Business Council for Sustainable Development counts many leading global companies among its members. These and similar organizations invest in efforts to help countries, companies, and communities “develop” not just in the near term but for the long-term benefit of people.

While the terms *sustainability* and *sustainable development* are often used by different communities of people, the vast majority of these uses have something very important in common: a realization that our ability to prosper now and in the future requires increased attention not just to economic and social progress but also to conserving Earth's **life support systems**: the fundamental environmental processes and natural resources on which our hopes for prosperity depend. Because of that commonality, we use the terms interchangeably. We believe that the take-home messages of this book are important for both.

THE EVOLUTION OF SUSTAINABILITY THINKING

Sustainability is an old idea. Societies for centuries have recognized the importance of demanding no more of the environment than it can supply over the long term. This recognition is evident in long-standing ideas about fallowing fields and conserving game and protecting water sources. The concept of sustainable development in its modern form, however, was most famously articulated by the United Nations World Commission on Environment and Development (WCED) in 1987. As Gro Brundtland, the commission chairwoman, wrote at the time: "Environment is where we live; and development is what we all do in attempting to improve our lot within that abode. The two are inseparable."¹ The commission argued that *sustainable* development "meets the needs of the present without compromising the ability of future generations to meet their own needs." And its carefully documented report left little room for doubt (among those willing to confront the evidence) that a transition toward sustainable development would have to arrest and reverse the increasingly global and accelerating degradation of Earth's environment and natural resources.

Since the Brundtland Commission's call for global action the UN has reinforced the urgency of a **sustainability transition** through numerous conferences and agreements. Over many years and several iterations, the international community has developed consensus on a wide-ranging set of sustainable-development goals,² and in pursuit of those goals, numerous efforts at the global, national, and local levels have been launched. They aim to reduce hunger and poverty; improve

access to health care, family planning, and education; increase agricultural production while reducing environmental degradation; and halt the degradation of Earth's life support systems. Today, thousands of governmental and non-governmental organizations, private firms, and individuals all over the world have adopted the idea of sustainability and have started to allocate attention and resources to sustainable development programs. Corporations have developed metrics to track the economic, social, and environmental impacts of their actions. Cities around the world have created and joined associations designed to share best practices and encourage progress. Regional and national efforts are to be found in every part of the world. Scholarly organizations such as the world's national science and engineering academies and numerous professional scientific associations have also engaged in the effort. And international consortia such as the World Business Council for Sustainable Development and the Science and Technology Alliance for Global Sustainability have built cross-sectoral communities of actors from private and public organizations to chart strategies for progress toward sustainability goals. (We provide in appendix B a short list of the Internet resources we have found most useful for keeping abreast of rapidly changing initiatives around the world that are pursuing sustainability.)

As a result of these many initiatives, people's vision of sustainable development has been rapidly evolving. It has matured from simple relationships that see human prosperity primarily in terms of economic growth, to a focus on human needs as called for by the Brundtland Commission, to the ever more encompassing and nuanced views centered on social well-being being advanced today (see chapter 2).

A benefit of this expanding framing of sustainability has been the creation of an ever-broader "tent" under which the multiple constituencies of scholarship, advocacy, and action are now working to promote sustainable development. This inclusiveness, however, creates an increasing risk of losing sight of the sustainability forest for its many individual trees and the concomitant temptation for everyone engaged to fall back into activities focused on individual disciplines or sectors. Progress toward sustainability requires commitment to such details—to the individual trees of our global system as well as the particular con-

texts in which they must be nurtured if they are to contribute to sustainable development. But progress also requires a broader perspective on how the parts of the forest depend on one another, interact, and co-evolve. We have tried to provide one such perspective with this book.

SCIENCE FOR SUSTAINABILITY

Meeting the challenges of sustainable development requires action that changes the status quo. Because too many powerful interests have a stake in resisting such change and in continuing “business as usual,” meeting the challenges of sustainable development will require a deep and broad commitment to social agitation, to stirring things up. Contributions to this agenda of agitation and action are needed not just from self-described activists but also from political and business leaders, civil society, medical professionals, educators, and individual citizens. In addition, however, sustainable development requires contributions from *scientists*, a term we use to encompass all sorts of scholars committed to figuring out how the world works—natural and social scientists, humanists, policy analysts, engineers, medical scientists, and all their many kindred.

Just what are the roles for science and scientists in promoting sustainable development? We explore many specific contributions throughout this book. In general, however, the roles of science include helping society to see where present trends are taking us, to discover or design new technologies and policies that might change our course, and to evaluate the possible trade-offs and implications for future generations of implementing such alternatives. Or, in the words of Nobel Laureate Amartya Sen, the role of science is to help assure that the social agitation seeking to promote sustainable development is *informed* agitation.

When we, the authors of this book, first began working on sustainability issues, lots of relevant science and technology were being done, but there were few places in which those who were doing them could escape their disciplinary homes to come together in collaborations centered on sustainable development. Today, things have changed. Like the fields of health or agricultural science before it, **sustainability sci-**

ence has emerged as a field focused on creating and harnessing many different kinds of knowledge to help address social problems. In particular, it is a field that tackles directly the numerous problems involved in pursuing sustainable development. To that end, sustainability science strives to integrate study and practice through use-inspired research. It includes the contributions of many different kinds of basic science and the contributions of people involved in the design and implementation of policy, technology, and practices. The field also carries out the unique and critical role of striving to integrate those knowledge bases and to build on them in new ways, developing knowledge to support decision making for sustainability goals. Ultimately, sustainability science is about increasing our knowledge of and ability to manage the interactions between environmental and social systems that set the stage on which sustainable development plays out.

We have a good deal to say later in this book about the general characteristics of such **social-environmental systems** and of the common challenges people face as they guide those systems along paths toward sustainable development. To bring specificity to those generalized discussions, however, we have found case studies useful. We introduce in the next section of this chapter four such studies that represent the kinds of challenges facing sustainable development and the types of work sustainability scientists do in helping to meet those challenges.

SUSTAINABILITY CHALLENGES IN THE REAL WORLD: FOUR CASE STUDIES

As noted in the previous section, we have selected four case studies to illustrate just how challenging it is to determine what to do to promote sustainability over the long term. The cases take place in a wide variety of settings—high-tech science laboratories, fields of small-scale farmers, neighborhoods of one of the world’s most cosmopolitan cities—but they share some central features. The cases are alike in that they showcase people trying to make good things happen for themselves and the people in their communities, struggling to deal with unintended consequences, and continuing to push for progress despite failures and setbacks. The cases show that even the most well-intentioned interventions

can go awry for many different reasons, including not considering them in the context of the full social-environmental system, not building appropriate and useful knowledge and getting it into the hands of the right decision makers, not working effectively within governance systems that allow sustainable decisions, and not having good luck. Each case has unique lessons to share, and together they give us concrete experiences through which to think about sustainability concepts.

These cases form a starting point for this book. We draw from them in all chapters of the book as we share our perspectives on what we think are the most critical lessons for those of us who are pursuing sustainability. We present short introductions to each case next and provide more detailed treatments in appendix A. We believe that most readers will find it helpful to read the fuller treatments in the appendix before getting too far along in the book.

London

The London case highlights the challenges of thinking analytically about development over the multigenerational time periods central to concerns about sustainability.

London today is widely recognized as a leading world city. It regularly scores at or near the top of surveys about sustainability and quality of life in urban areas, racking up especially high scores for its international clout, its technological savvy, and its livability; doing well on economy, governance, and many dimensions of environment; but still struggling with air pollution and social inclusion.

This has not always been the situation for London. On the contrary, London's current high but uneven prosperity rests on a history of more than a thousand years of collisions with the environment, some very like those being experienced in today's rapidly growing "new" cities. Two related themes have run through these collisions, both relevant to cities everywhere.

One involves the constant struggle to secure the basic food, fuel, and material resources needed for a growing city and at the same time to dispose of the waste products resulting from the use of those resources. Failures to handle these resource and waste flows directly resulted in multiple episodes of food shortages and consequent malnutrition for

the poor, the intermingling of human waste and drinking waters, chronic air pollution, and growing vulnerability to flooding.

The second recurrent theme in the relationship of London to its environment centers on its population's battle with communicable disease. The odds in this battle were clearly affected by repeated failures to solve the resource management issues noted previously, but they also involved the dynamics of resistance and immunity in a closely packed settlement increasingly exposed to diseases imported from remote corners of the world.

In grappling with these problems, growing numbers of Londoners pursued short-term personal gains that repeatedly inflicted long-term large-scale costs of social and environmental degradation that eventually became untenable. But with each setback, society responded with a mix of political activism, scientific discoveries, technological inventions, social adjustments, and new forms of governance that—together with events occurring in the wider world beyond London—opened the way for the next round of development initiatives. These invariably led to their own surprises and readjustments, the most recent or persistent of which are being publicly debated in the context of the London Plan, an organic document that charts the city's goals and strategies for a sustainability transition.

Nepal

The Nepal case focuses on the multiple pathways through which irrigation technology has been deployed to reduce food insecurity. It highlights the importance of involving technology users in the design and operation of technology-augmented systems.

Growing food in Nepal is a challenging prospect. With most of the country mountainous, and area for agriculture very limited, Nepali people have always been susceptible to food shortages. By the late twentieth century, the growing rural population was becoming chronically food insecure. One possible solution that had been successfully pursued elsewhere was to introduce improved irrigation technology to increase the amount of food produced on land already under agriculture. But when the Nepali government and foreign partners began to construct advanced irrigation systems to replace the more primitive