

# EXPLORING SUSTAINABILITY SCIENCE

A SOUTHERN AFRICAN  
PERSPECTIVE

EDITORS

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Exploring Sustainability Science  
A Southern African perspective

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“Sustainable development in South and southern Africa poses challenges to our traditional approaches to research. The complex interactions between society and our life-supporting systems require a coordinated response that goes beyond the boundaries of single disciplines, that cuts across our separate research institutions and that transcends the current gap that exists between knowledge producers and knowledge users. Sustainability science, as outlined by the authors of this timeless text, provides the promise of a research approach that links knowledge with action and has the potential to enhance the contribution that South African scientists and their collaborators within the innovation system can make to a more sustainable society.”

**Dr Phil Mjwara**

*Director General  
Department of Science and Technology  
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“From time to time the CSIR has international peer reviews of its research activities. This volume responds to a recent review of environmental research undertaken at the CSIR where it was noted that the organisation has the potential to provide greater leverage for sustainable development. The reviewers felt that the CSIR’s research strategy should be more clearly directed by the challenges of sustainable development in southern Africa. They felt opportunities should be optimised to address these challenges through integrated research and dialogue with knowledge users in government and civil society. This volume makes a key contribution to the understanding of sustainability science within the regional context. I believe that sustainability science has the potential to become a key vehicle through which the CSIR can strengthen its contribution to sustainable development, fulfilling its mandate to contribute to the improvement of the quality of life of the people of South Africa.”

**Dr Sibusiso Sibisi**

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## FOREWORD

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This book constitutes a welcome and valuable contribution to the emerging field of sustainability science. The field in general, like the particular work reported here, has a long history reaching back into early efforts to bring scientific research to bear on problems of renewable resource management and environmental protection. Over the last quarter century, however, it has become increasingly clear that efforts to sustain productive ecosystems – indeed, to sustain the functioning of the earth’s life support systems more generally – cannot succeed unless they simultaneously address people’s needs to use the earth for relieving hunger and poverty and advancing human prosperity. Reciprocally, the evidence grows more compelling with each passing year that social and economic development cannot be sustained unless we attend to the well-being of environmental and resource systems that nourish us as individuals and as civilizations.

Sustainability science is a response of the international research community to the emergent social consensus on the need for knowledge to promote a transition toward sustainability. In this, it has much in common with the emergence of “agricultural science” and “health science”, which were responses of earlier research communities to emergent social needs and scientific opportunities of their times. In all of these cases, the goal has not been for creating yet another new academic discipline, but rather for integrating multiple traditions of disciplined research and relevant practice to address specific problems. Sustainability science differs from its predecessor fields of use-inspired research in at least three ways. One is the very scope of the problems it addresses, encompassing the full range of human needs from health, water and food to energy, materials and the built environment, and focusing on the interdependencies among efforts to meet those needs. Another is its insistence on grappling with rather than assuming away the dynamical complexity that arises from interactions between tightly coupled human-environment systems. Finally, sustainability science is distinguished by its insistence on treating seriously the adaptation of generalizable scientific insights to place-based context and practice, bridging the boundaries between research science, practitioner experience and traditional knowledge in its efforts to generate usable knowledge. Together, these defining peculiarities of sustainability science have combined to make it a vibrant if still somewhat adolescent field that is beginning to mature in a variety of ways around the world.

It is as a window on the development of sustainability science in the particular context of southern Africa that the present volume makes its central contribution. The last decade has produced a number of global perspectives and initiatives on sustainability science, the generalizable findings of which are increasingly appearing in peer-reviewed journals of the international scientific community. Increasingly, however, some of the most compelling sustainability science work has been rooted in

the specific challenges and opportunities of particular places and regions. Examples are too many to be listed here, though a representative collection can be accessed through the 'Programs' listing on the electronic "Forum on Science and Innovation for Sustainable Development" (<http://sustainabilityscience.org>). Africa has not been absent from these regional initiatives, with contributions ranging from early studies by the African Academy of Sciences, through key contributions to the regional studies of the Millennium Ecosystem Assessment and IPCC. The present volume, an early result of the new CSIR program on sustainability science, is a welcome addition to the field. It brings to an international audience a wealth of relevant field experience from researchers grappling with the special sustainability challenges of southern Africa. In addition, however, it advances original contributions to the general conceptual and methodological development of sustainability science. Particularly welcome are the reflections here on approaches for integrating scientific research and experiential knowledge to address sustainability challenges, and on the challenges of promoting adaptive learning in sustainability science programs.

To close on a personal note, we are particularly grateful that much of the work involved in assembling this volume took place while co-editor Mike Burns was our guest as a Giorgio Ruffolo Research Fellow in the Sustainability Science Program at Harvard University. Mike's wise, probing and enthusiastic participation in the program helped set a standard to which the rest of us were only too happy to aspire. We're delighted to have this book as a legacy of his time with us, and look forward to opportunities for continued collaboration across our diverse but complementary perspectives on the field of sustainability science.

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# 1

## INTRODUCTION

### EXPLORING SUSTAINABILITY SCIENCE FROM A SOUTHERN AFRICAN PERSPECTIVE

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*Mike Burns and Alex Weaver*

#### ASKING SOMETHING ADDITIONAL OF SCIENCE

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This volume is the product of what has essentially been an ‘experiment’ guided by an overarching research question that asks whether it is possible to: (i) assemble a team of researchers from a variety of disciplines and research institutions; (ii) persuade them to explore the concept of *sustainability science*, which was novel to most involved; and, (iii) to have the team emerge from the research process inspired about putting the learning gained to practical effect in improving and sustaining the quality of life of the people of southern Africa? As originators of this ‘experiment’ we believe that we can confidently answer its research question, in the affirmative.

Although the authors who have contributed to this volume were not previously familiar with the concept of sustainability science, they were easily able to endorse its *raison d’être* and to accord fully with its defining attributes, which we will describe shortly. Whilst this is somewhat of an unquantifiable experimental outcome, the suite of chapters that follows provides a more tangible measure in this regard. Presented with different writing styles and research approaches, exhibiting traces of the authors’ disciplinary origins, the reader will note many areas of novelty in science that offer different possibilities for increasing its impact on sustainable development. Novelty is apparent in the exchange of ideas between the philosopher, systems modeler and urban planner relating to complexity and ecosystem theory, which is infused into their mathematical and conceptual frameworks for understanding and building desired resilience within complex social-ecological systems (chapters 2, 3, 14 and 15). The reader will note, for example, the ecological

theory that is threaded into the research of the political scientist and anthropologist who, drawing on metaphors and quantitative data generated by natural scientists, analyze the policy implications of looming water shortages on rural communities in South Africa (Chapter 10). Theory on transdisciplinarity will be seen to provide the foundation for research undertaken by conservation biologists, who explore ways of bridging disciplinary and implementation gaps in order to promote biodiversity conservation in practice (Chapter 5). Also, the reader will note the collaboration between university and science council and between the traditionally separated disciplinary structures within these institutions, which has enabled the research presented in this volume – a bridging and integrating phenomenon that will be shown to be a fundamental attribute of sustainability science.

The origin of this volume can be traced to the conclusion of an international review panel, that environmental research undertaken within South Africa's Council for Scientific and Industrial Research (and by implication, other South African research institutions) has the potential to provide greater leverage for sustainable development in southern Africa. In order to achieve this, the panel recommended that the organization's research strategy should be more clearly directed by the particular challenges of sustainable development in southern Africa and the opportunities to address these through integrated research and dialogue with potential knowledge users within government and society, where there is executive responsibility for sustainable development.

As researchers to whom these recommendations were directed, we grasped little at the time of what the review panel meant by the term *sustainability science*. It was not clear to us how research institutions such as our own, and other institutions with whom we were encouraged to collaborate, should approach research differently from established practice. It was clear that the message was not one of abandoning disciplinary research in areas where we are contributing productively, but that something additional was required. We now understand this to be *transdisciplinary research focused on human-environment relationships, through which divides between disciplines and between knowledge producers and users are bridged in order to practically advance sustainable development in southern Africa*.

From the above, it is apparent that sustainability science requires clarity regarding particular priorities of sustainable development. In the next section, we discuss some aspects of these priorities that apply to southern Africa. The discussion is of a general nature, since we accept that sustainability issues emerge in context-specific situations, which we cannot address in this chapter, but which other authors do in later chapters. In presenting this discussion we first consider what Kates and Dasgupta (2007) describe as the 'responsibility' of science, which is to describe, explain causation and co-devise or inform interventions for sustainable development in Africa. Thereafter, we focus on what we regard as some important defining attributes of sustainability science, before summarizing the learning gained