SUSTAINABILITY SCIENCE

Second Edition

The fully updated second edition of this innovative textbook provides a system analysis approach to sustainability for advanced undergraduate and graduate students. To an extent unparalleled in other textbooks, the latest scientific data and insights are integrated into a broad and deep transdisciplinary framework. Readers are encouraged to explore and engage with sustainability issues through the lenses of a cultural and methodological pluralism which promotes dialogue and alliances in the search for a (more) sustainable future. Ideal for students and their teachers in sustainable development, environmental science and policy, ecology, conservation, natural resources and geopolitics, the book will also appeal to interested citizens, activists and policymakers, exposing them to the variety of perspectives on sustainability issues. Review questions and exercises provide the opportunity for consolidation and reflection. Online resources include appendices with more advanced mathematical material, model answers and a wealth of recommended additional sources.

Bert J. M. de Vries is co-founder of the Institute for Energy and Environment (IVEM) at the University of Groningen in the Netherlands, where he received his PhD on sustainable resource use. Since 1990, he has been a senior scientist at the Netherlands Environmental Assessment Agency (PBL, formerly MNP and RIVM). He has been actively involved in integrated assessment and other modelling and scenario construction. He shared in the Nobel Prize awarded to the Intergovernmental Panel on Climate Change (IPCC) in 2007. From 2003 to 2013, he was Professor of Global Change and Energy at Utrecht University in the Netherlands.

His research expertise and publications are in resource and energy analysis, modelling and policy; climate and global change modelling and complex systems modelling; philosophy and ethics of sustainable development in a worldview framework; and modelling the financial system. He has co-edited several books, including *Perspectives on Global Change: The TARGETS Approach* (Cambridge University Press, 1997).

'In this new edition, Bert de Vries sets the foundation of sustainability science through systems thinking. This could not be timelier as socio-ecological turbulence increasingly becomes the norm, as predicted in the Club of Rome report. Rooted in the history of civilizations and modernity, embedding ethics and worldview diversity, we are invited to explore how well-being, education or nature awareness may build a sustainable future, with pertinent analyses in all sectors, from forest and fisheries to water management, materials or energy. This is a must-read for all Earthlings.'

Dr Olivier Hamant, Director of the Michel-Serres Institute

'Technical and accessible are generally seen as dichotomous. De Vries proves the opposite is true with this masterful introduction to the essential building blocks of sustainability science. The book goes well beyond its promise of methodological pluralism by providing mathematical, biophysical, economic, social and cultural lenses to help us understand and respond to the ecological and climate crisis.'

Dr Piotr Magnuszewski, Scientific Director, Centre for Systems Solutions, Wrocław

'Sustainability science is the means by which a fractured and unequal world of 8+ billion people can map the systemic challenges of the Anthropocene, to bring together the transformational actions that will help us navigate the twenty-first century. Bert de Vries' seminal text provides us the worldviews, values and methods to chart these transitions to a better, more equal and sustainable world.'

Professor Aromar Revi, Director, IIHS Bangalore City Campus

'Stewarding our planet towards a safe and just future requires nothing less than a deep scientific understanding of the functioning of our Earth system, and a truly holistic view of how nature, humanity and the physical world share a common fate. This book propagates this message in a unique way, offering scholars and students a first step towards informed agency.'

Professor Johan Rockström, Director of the Potsdam Institute for Climate Impact Research (PIK); Professor of Earth System Science, University of Potsdam; Chief Scientist, Conservation International

'Bert de Vries reveals the secret to making the world sustainable. And no, it's not technology. It is our adoption of alternate worldviews that reflect our values and beliefs, such as individualism, collectivism, consumerism, or frugality. These shape our choices and actions for the planet, and determine whether we help or harm sustainability. This book is essential for anyone who wants to foster sustainability.'

Dr Anupam Saraph, Sustainability and Systems Leadership Mentor

'Sustainability science has evolved over decades to address a fundamental challenge: the decline and collapse of socio-ecosystems driven by a political economy too narrowly defined by goals and policies of only one or a few disciplines. Bert de Vries ably succeeds in showing how to expand the range of enquiry to embrace perspectives from many disciplines, as well as from the wider world of enterprise and governance. But he further offers a unique perspective that makes this edition of his text invaluable in showing how to look below the transdisciplinary layer that defines trends, causal mechanisms and policies to see the worldviews and paradigms that generate and sustain them. Using systems science to integrate horizontally across disciplines, and vertically from trends down to mental models, offers the reader the most comprehensive set of analytical tools in the sustainability field. Essential reading.'

Dr Jan Sendzimir, International Institute for Applied Systems Analysis

'*Sustainability Science* by Bert de Vries presents a truly transdisciplinary and pluralistic approach to understanding human–environment interactions for improving and maintaining human well-being. Guided by worldview frameworks and systems thinking, this book impressively integrates the myriad parts of geography, ecology, philosophy, epistemology, history, culture, ethics and religion into the whole of sustainability. It is remarkably comprehensive, insightful and thought-provoking.'

Dean's Distinguished Professor of Sustainability Science Jianguo (Jingle) Wu, Arizona State University; Editor-in-Chief of *Landscape Ecology*

Sustainability Science

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Bert J. M. de Vries
Utrecht University

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PART VI CLOSURE

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Abbreviations

ABMs	Agent-based models	www.openabm.org
AI	Artificial intelligence	
ATAG	Air Transport Action Group	
BBN	Bayesian belief networks	
BCE	Before Common Era; Before Christian Era	
BINC	Bio-, information-, nano- and cogno [technologies]	
BMI	Body mass index	
BP	Before Present	
BP	British Petroleum	www.bp.com
CA	Cellular automata	https://cell-auto.com/
CAS	Complex adaptive systems	
CBA	Cost–benefit analysis	
CBD	Convention on Biological Diversity	www.cbd.int/
CBR	Crude birth rate	
CCS	Carbon capture and storage	
CCUS	Carbon capture, utilization and storage	
CDR	Crude death rate	
CE	Common Era; Christian Era	
CF	Carbon footprint	
CFCs	Chlorofluorocarbons	
CGE	Computable general equilibrium [models]	
CLD	Causal loop diagram	
CMLCA	Chain management by life cycle assessment	
CNG	Compressed natural gas	
CPRs	Common pool resources	

CoP	Conference of the Parties (on Climate)	https://unfccc.int/
CSD	Commission on Sustainable Development (UN; 'Brundtland Commission')	www.un.org
CSO	Civil society organization	
CSS	Complex systems science	www.santafe.edu/what-is-complex-systems-science
CT	Comprehensive technological progress	
DER	Dissipative use and extraction ratio	
DFR	Dissipative use and final production ratio	
DMC	Domestic material consumption	
DMF	Domestic material flow	
DSS	Decision support system	
[D]WSI	[Dynamic] Water Stress Index	
EEA	European Environmental Agency	www.eea.europa.eu/
EF	Ecological footprint	
EROEI	Energy returned on energy invested	
ES	Ecosystem services	
EU	European Union	
EV	Electric vehicle	
FAO	Food and Agriculture Organization (UN-based)	www.fao.org/home/en/
F[N]AWS	Forest [not] available for wood supply	
FIRE	Finance, insurance and real estate	
FWE[M]	Food–water–energy [–materials]	
GCM	Global change model	
GC-IAM	Global change – integrated assessment model	www.iamconsortium.org/
GCP	Gross cell product	
GDI	Gross domestic income	
GDP	Gross domestic product	
GEO	Global Environmental Outlook	www.unep.org
GHG	greenhouse gas	
GIS	Geographical information system	
GMO	Genetically modified organism	
GNP	Gross national product	
GPI	Genuine progress indicator	
GWP	Gross world product	

H(A)LE(Y)	Healthy (adjusted) life expectancy (years)	
HDI	Human Development Index	https://hdr.undp.org/data-center/human-development-index#/indicies/HDI
HE	Health expenditures	
HEM	Health education mobility	
HLO	Harmonized learning outcome	
IAM	Integrated assessment model	www.iamconsortium.org/
IATA	International Air Transport Association	
ICT	Information and communication technology	
IEA	International Energy Agency (OECD)	www.iea.org
IFS	International financial system	
IGBP	International Geosphere-Biosphere Programme	www.igbp.ch
IHDP	International Human Dimensions Programme	www.ihdp.org
IIASA	International Institute for Applied System Analysis	www.iiasa.ac.at
IMAGE	Integrated model to assess the global environment	www.mnp.nl/imagethemasites.pbl.nl/en/
IMF	International Monetary Fund	www.imf.org
IOM	International Organization for Migration	www.iom.int/
IPBES	Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services	https://ipbes.net/
IPCC	Intergovernmental Panel on Climate Change	www.ipcc.ch
IPR	Intellectual property right	www.wipo.int/about-ip/en/
ISEW	Index of Sustainable Economic Welfare	
ITQ	Individual transferable quota	
IUCN	International Union for the Conservation of Nature	www.iucn.org
IU	Intensity of use	
IUU	Illegal, unreported and unregulated [catch]	
LCA	Life cycle analysis	
LDC	Load duration curve	
LE	Life expectancy	

LICs	Low-income countries	
LNG	Liquefied natural gas	
LULC	Land-use land-cover (change)	
MAS	Multi-agent simulation [models]	
MDGs	Millennium Development Goals	www.un.org/millenniumgoals/
MEA	Millennium Ecosystem Assessment	www.millenniumassessment.org
M[E]FA	Material [energy] flow analysis	
MF	Material footprint	
MFA	Material flow analysis	
MLP	Multi-level perspective	
MNC	Multinational corporation	
MNE	Multinational enterprise	
MPA	Marine Protected Area	
MSC	Marine Stewardship Council [label]	www.msc.org
MSY	Maximum sustainable yield	
NA	Network Analysis	
NDC	Nationally Determined Contribution (UNFCCC)	
NDP	Net domestic product	
Netlogo 4.1	Netlogo agent-based simulation modelling software	https://ccl.northwestern.edu/netlogo/
NFL	Negative feedback loop	
NGO	Nongovernmental organization	
NIMBY	Not In My BackYard	
NPP	Net primary production	
NPV	Net present value	
OECD	Organisation for Economic Co-operation and Development	www.oecd.org
PAGES	Past Global Changes network	https://pastglobalchanges.org/
PBs	Planetary boundaries	www.stockholmresilience.org/research/planetary-boundaries/the-nine-planetary-boundaries.html
PBL	PlanBureau voor de Leefomgeving	www.pbl.nl
PFL	Positive feedback loop	
PGs	Public goods	
ppm(v)	Parts per million (volume)	
PPP	Purchasing power parity	
PSIR	Pressure–state–impact–response	
R&D	Research and development	

RBFM	Rights-Based Fishery Management	
RCPs	Representative Concentration Pathways	
RD&D	Research, development & demonstration	
RPR	Reserve production ratio	
SA	Sustainability assessment	
SCC	Supply cost curve	
SDGs	Sustainable Development Goals	https://sdgs.un.org/goals
SDI	Sustainable Development Indicator	
SDIS	Sustainable Development Information Systems	
SES	Social-economic situation	www.resalliance.org
SES	Socio-ecological systems	
SFA	Substance flow analysis	
SNA	System of national accounts	https://unstats.un.org/unsd/nationalaccount/sna.asp
SRES	Special report on emission scenarios	
SSPs	Shared socio-economic pathways	
Stella®	Stella system dynamics modelling software	www.iseesystems.com
T&D	Transport and distribution	
TFR	Total fertility rate	
TMB	Travel money budget	
TMR	Total mobilization rate	
TTB	Travel time budget	
TURF	Territorial user rights in fisheries	
UBI	Universal basic income	
UDHR	Universal Declaration of Human Rights	www.un.org/en/about-us/universal-declaration-of-human-rights
UN	United Nations	www.un.org/
UNCCD	UN Convention to Combat Desertificaton	www.unccd.int/
UNCED	UN Commission on Environment and Development ('Brundtland Commission')	
UNDP	UN Development Programme	www.undp.org
UNDRR	UN Office for Disaster Risk Reduction	www.undrr.org/

UNEP	UN Environment Programme	www.unep.org
UNFCCC	UN Framework Convention on Climate Change	https://unfccc.int/
UNFPA	UN Population Fund	www.unfpa.org/public
UNICEF	UN International Children's Emergency Fund	www.unicef.org/
UPF	Ultra processed food	
USLE	Universal soil loss equation	
Vensim®	Vensim system dynamics modelling software	www.vensim.com
VOCs	Volatile organic compounds	
WCED	World Commission on Environment and Development	
WEC	World Energy Council	www.worldenergy.org
WEF	Water–energy–food [nexus]	
WHO	World Health Organization (UN-based)	www.who.int/en/
WMO	World Meteorological Organization	www.wmo.ch
WRI	World Resources Institute	www.wri.org
WSSD	World Summit on Sustainable Development (Johannesburg 2002)	
WTO	World Trade Organization	www.wto.org
WWC	World Water Council	www.worldwatercouncil.org
WWF	World Wildlife Fund	https://wwf.org/
WWII	World War II	

Units

kt	kton or one thousand (thsd) or 10^3 ton
mln	million (10^6)
Mt	Mton or one million (mln) or 10^6 ton
bln	billion (10^9)
Gt	Gton or one billion (bln) or 10^9 ton
toe	ton of oil equivalent
kWh(e)	kilowatt hour (electric)
MWh(e)	megawatt hour (electric) or one thousand kWh

Foreword

I have been a great fan of Bert de Vries' very successful textbook on sustainability science that appeared ten years ago now. It is a well-rounded overview of the field, which includes the main perspectives prevalent in the community of sustainability scientists, as well as a comprehensive overview of questions, debates, conceptual and technical approaches, and tentative answers. Students using this textbook and adopting its contents will gain a solid and wide-ranging perspective on the field.

This second, enlarged and updated, edition extensively elaborates and details two of the main themes of the first edition: (1) the background, history and origins of our current modern approaches to the topic, and (2) the importance of worldviews in gaining understanding of the sustainability conundrum. In this edition, the author has adopted a truly integrated socio-environmental perspective to discuss the sustainability challenges in the Anthropocene. That perspective acknowledges the fundamental role of societal decision-making and behaviour in driving the complex system that is responsible for environmental change.

In doing so, the author has chosen to focus on a major domain that has thus far received insufficient attention: the important role of different cultures' 'worldviews' in shaping societies' interaction with their environments. Those worldviews are the result of the local or regional articulation between environmental conditions and the dynamic structure of their inhabitants' information gathering and processing. De Vries thus emphasizes that to understand the sustainability challenges (including climate change), it is insufficient to outline what is seen through the natural science lens at the global level. One has to focus as much on the local and regional level at which different groups of people are impacted by, and impact upon, the dynamics of socio-ecological change.

The past 50 years have hugely enhanced our knowledge of the natural processes in the world. But our knowledge of the role of dominant views in society and the resultant decision-making concerning their interaction has not received commensurate attention. Indeed, it is only about 15 years ago that the role of society in environmental change has been widely acknowledged in academic research. In the political domain, that acceptance is even more recent. This shift in perspective has mobilized various branches of the social sciences, essentially at two levels. At the individual level, increasing attention is being devoted to individual cognitive habits and capabilities, and their impact on people's perspectives on the environment,

eliciting inherent biases in perception and cognition. At the collective level, some research has been devoted to describing and understanding, in particular instances, some of the societal dynamics impacting on environmental change.

What De Vries' current approach introduces is the essential link between these two levels: an attempt at understanding the structuring dynamics that are responsible for the emergence and interactions of different worldviews among different societies. It does so by devoting major attention to a comparative study of different worldviews and to the main factors responsible for them. This effort shows that we urgently need to articulate the universalist tendencies of the climate and environmental, earth and engineering sciences. Without it, we will not succeed in understanding and dealing with the sustainability conundrum that currently threatens people worldwide.

The differences between the East Asian traditional worldview and the Euro-American one illustrate this beautifully. The latter perspective separates subject and object, nature and culture into different categories and assumes oppositions between each of these sets. The East Asian perspective views what seem to Europeans and Americans to be fundamentally different entities to be part of a single perspective that unites 'A' and 'non-A'. Somewhere in China, I heard a beautiful illustration of that difference.

'A man has a stick and wants to separate the two ends of the stick. So he proceeds to cut the stick in two. But then he discovers that instead of two separate categories representing the two ends of the stick, he has two sticks, each with two connected ends. He repeats the exercise and then has four sticks, each with two ends. Separating the ends is impossible because they are inherent parts of the sticks.'

Thus, in this perspective one cannot focus on oppositions such as 'object' and 'subject' but must focus on the relationship between the two. This emphasis on relations instead of differences implies a transcendence of dominant worldviews in order to focus on the relationships between social and environmental dynamics, rather than on them separately. Humans are seen as part of the natural world, and thus the 'objective' perspective on development and sustainability is exchanged for a perspective in which the relationships between humans and nature are an integral part of the complex system of the Anthropocene. The emphasis hereby is on the evolution and well-being of the community within the planetary boundaries, rather than of the individuals. Integrating different worldviews, both from diverse corners of both the Northern and the Southern hemisphere will contribute to the diversity of perspectives that has been essential in allowing humanity to survive all its trials and tribulations.

I hope this very brief description of the innovative character of this textbook will seduce the readers and will contribute to the development of a genuinely transdisciplinary perspective that brings together environmental and societal approaches in a joint effort to understand the current predicament of mankind and the pathways towards development that can be sustained.

Sander E. van der Leeuw
Tréhorenteuc

Preface

When I started writing the book *Sustainability Science* in 2006, as part of teaching the course *Sustainable Development: An Integrating Approach* at Utrecht University, about 1.2 billion people used the Internet. In 2006, the term social media was hardly known. The financial crisis in 2008 seriously afflicted neoliberal exuberance, but it was seen by most people as a temporary interruption of a worldwide march to progress after governments came to the banks' rescue. The United Nations Climate Change Conference in Copenhagen in 2009 was seen by many as a failure, at a time when 'climate sceptics' seemed to be gaining the upper hand. When the book was published in 2012, the notion of *sustainability science* was about 10 years old and only had a few hits in an Internet search.

In 2022, working on a second edition of the *Sustainability Science* book, I feel like I'm living in a different world. More than half of the world population has access to Internet and the two major social platforms are used by over 2 billion people. It has brought previously unimaginably fast and broad access to an exponentially growing amount of 'data' – which because of their very overload has made them and the derived 'facts' increasingly dubious. It has also intensified undercurrents of resentment about the rising – and blatantly visible – inequities in a globalizing capitalist world and about injustices in the colonial past. The ongoing trade liberalization, globalization and financialization of the world system in the second decade of the century accelerated consumerism, with China playing a major role. At the same time, ongoing accumulation of money, food price crises, migration and armed conflicts – and their mediatization – intensified the sense of uncertainty and loss of control among many people.

In spring 2020, the COVID-19 pandemic brought a halt to economic activity in large parts of the world and was plausibly related to global changes in land use. This time, governments responded with massive financial support to keep economies floating, but in the process the dominant economic theory of market economies was dealt another blow and governments came to the rescue with almost the opposite medicine. The pandemic and the Russian invasion of Ukraine alerted the world to the vulnerability of growing interdependencies and the deficiencies and weak spots of liberal-capitalist democracies.

Yet, the notion of sustainable development is becoming more widespread as more and more people started to be concerned about enduring and worsening

environmental destruction and economic inequity. With the official acceptance of the Sustainable Development Goals (SDGs) by the United Nations in 2015, humanity had orchestrated an overarching framework to guide such concerns. Climate change in particular started to worry people, when scientists estimated global average land–sea temperature in 2008–2012 to be 0.47°C and in 2015–2019 to be 0.72°C higher than the 1961–1990 average. Since the Paris Agreement on Climate in 2015, the already visible signs and impacts of climate change are taken much more seriously in government circles and by the population. Climate scepticism lost its appeal; corporations are sued for their misinformation and lack of action.

Underneath deeper changes are taking place. Indeed, it seems as if ongoing trends that many scientists were already aware of have suddenly penetrated the consciousness, concerns and communications of large groups of people. It feels as if the cracks in Modernity, which had been growing in the changing scientific and cultural landscape of the twentieth century, have suddenly become visible and forced themselves upon millions of people. Women and men embrace the promises of emancipation and liberation in a world which is confronted with social and economic injustices and environmental deterioration. People with their everyday subsistence and reproduction troubles rediscover their deep connections with their own territory and with other species (including humans) and start to live on feminine Earth among other living beings small and large – instead of in an abstract masculine universe of scientific and economic laws, as Latour sketches in his 2021 essay *Où suis-je? (Where am I?)*. It has also dawned upon many people that there is, contrary to the proclamation of former UK Prime Minister Margaret Thatcher, such a thing as *society* – a collective which cannot be dismissed or denied with reference to the failure of former communist regimes. Perhaps, and in weird ways magnified by social media platforms and the corporate and state powers behind them, individualism has reached its limits and constructing solidarity acquires new relevance.

Both societal and personal developments inspired me to work on this second edition of *Sustainability Science*, in the conviction that offering (young) people a genuinely holistic and transdisciplinary outlook on how we can create a more humane and sustainable world is well worth my effort and that of many others.

During most of my academic life, I have been wondering what and how to teach about sustainability and sustainable development. This book is based on three personal convictions. The first one is that humanity faces a transition period in which many ideas, habits and expectations will be challenged and scientists should, therefore, offer an *integrating perspective* on how developments are connected and may unfold. This implies that all scientific disciplines can and should contribute to the content of sustainability science.

Second, the conceptualization of sustainable development as a guiding principle for the twenty-first century is still fragmented, and this should change. We need a new science, one that uncovers the unity of science and mobilizes understanding and offers context. One that uses the novel ways to access information (Internet, platforms, Wikipedia, etc.) and engages in the real world (stories, simulation games, etc.). I follow others in using the term *sustainability science* to summarize this new science and the efforts to develop it.

A third conviction is that sustainable development can best be defined in terms of *quality of life* and that the pluralism in people's values and ideas about what quality of life is for them should be acknowledged explicitly. This implies the framing of sustainable development as a global challenge within local diversity, capacity and contingency.

To operationalize these convictions, I use three threads in this book which I consider essential and complementary:

- Historical knowledge: what is the state we're in and how did we arrive there?
- Cultural pluralism: appreciating diversity in values and beliefs and how to handle them; and
- Disciplined thinking: what are the rules about acquiring and sharing knowledge?

Although there is not a single historical account, it is important as part of education to construct a mindmap of major past events and the various perspectives on and narratives about them. This facilitates acquiring an appreciation for pluralism in values and beliefs (which I refer to as *worldviews*). This in no way exempts us from the duty to use the capacity for logic and disciplined thinking and to communicate the scientific knowledge resulting from it. Moreover, because sustainability science is in its very essence *inter/transdisciplinary*, the gaps between the scientific disciplines have to be diminished by introducing some basic methods and concepts which inherently go beyond traditional disciplines.

These three threads were also leading in the first edition of *Sustainability Science*. All three are addressed in Parts II–IV of this second edition. In discussing these chapters, a friend of mine suggested I should title the book *Sustainability Philosophy*. I decided to stick with *Sustainability Science* for this second edition, as it is successfully establishing itself as a novel branch of science (§2.3).

The first edition of *Sustainability Science* was the outcome of eight years of teaching the course *Sustainability Science: An Integrating Perspective* for students of the MSc Sustainable Development at the Copernicus Institute of Sustainable Development at Utrecht University. I revisited the first edition with new insights in the scientific literature, with new data published since 2012 and with my own experiences and conversations with and between other people. The introduction of the SDGs and recent events, insights and policies about climate change and **biodiversity** are new, for instance.

I pay explicit attention to the rise and tenets of Modernity and to its opponents and ethics, as a background to the use of worldviews in the sustainability discourse (Part II–III). Some epistemological and methodological background are indispensable for the organization of thoughts and debates. Hence, two chapters on scientific methods and concepts are included (Part IV). I limited the number of mathematical equations in order to make the book accessible to readers of different levels of mathematical skill. However, because formal modelling can be of great use in clarifying assumptions and communicating insights, I have put some relevant mathematics on the website www.sustainabilityscience.eu. In the thematic chapters, exercises and worldview-related statements and discussions are used to help students to engage with real-world experiences and situations (Part V). I prioritize

discussion of the (end-)user/consumer aspects, in an attempt to reorient the sustainability discourse from supply to use. The book includes more in-depth treatment, complementary material and narratives in text boxes, mostly in direct connection with one of the thematic issues. Because of space limitations, I put many more of them on the website www.sustainabilityscience.eu.

There are many different angles from which one can look at development, quality of life and sustainability. My aim is to describe the many data, theories and movements in a common framework. After all, sustainability science still suffers from the blind-men-and-the-elephant syndrome: based on limited experience, methods and knowledge, each claims to have the truth. While researchers zoom ever more in, my goal is to zoom out.

The discourse on sustainability has expanded so much and in so many directions, that it seems overwhelming to put the endless flows of information and insights, not only in the scientific literature but also in the grey overlap with nongovernmental organizations (NGOs) and media, in the larger context. One runs the risk of being a dilettante, involved in tinkering or *bricolage* – someone who does not really understand what he is writing about. Such doubts and concerns are justified, I told myself. But it has not deterred me from going, encouraged by the support from colleagues and friends with a similar ambition.

One should not be under the illusion that this book is 'scientific' in the sense of value-free, as the natural sciences are widely thought to be. It can't be. The worldview framework I present is also not science in the way social sciences are conceived in the mainstream. It is a conceptual framework to be applied and experimented with. Although parts of the content have been published in peer-reviewed scientific literature, the litmus test of scientific quality, much of it was actually reviewed in the many encounters with people and their insights and circumstances.

Because the flood of data, theories, models, games and narratives keeps growing, I cannot and do not claim completeness or representativeness. No doubt, the treatment of some topics is biased because I was trained in physics and chemistry, and because I know certain persons and books and do not know others. Some natural science topics did not get the attention they deserve: the latest research on feedbacks in the climate system, recent discoveries about microbial soil life… psychology and subdisciplines in geography and economics, such as landscape and urban sustainability, remain underexposed. Also, engineering details and legal aspects are hardly addressed. In some places, I use rather old literature because either it belongs to what I consider great or pioneering works or because newer data and analyses in the field did in my view not add significant value.

Lastly and perhaps most importantly, this book has a 'Western' bias in the sense that I am raised and live in the Western world of Modernity and in the tradition of the Western sciences. Although I have travelled and worked outside the 'Western world', I do not pretend to understand the depth of Indian, Chinese, Japanese, or other cultures on topics such as the view of Nature and the role of religion and community. Occasionally, I touch upon it, but it deserves a much bigger place. Indeed, I expect that this other 'cultural DNA' will enrich the sustainability discourse in the coming decades and I hope that the worldview framework in this book will help this to happen. So, let's now talk about the content.