Environmental Literacy in Science and Society

From Knowledge to Decisions

In an era where humans affect virtually all of the Earth's processes, questions arise about whether we have sufficient knowledge of human–environment interactions. How can we sustain the Earth's ecosystems to prevent collapses and what roles should practitioners and scientists play in this process? These are the issues central to the concept of environmental literacy.

This unique book provides a comprehensive review and analysis of environmental literacy within the context of environmental science and sustainable development. Approaching the topic from multiple perspectives, it explores the development of human understanding of the environment and human–environment interactions in the fields of biology, psychology, sociology, economics, and industrial ecology.

The discussion emphasizes the importance of knowledge integration and transdisciplinary processes as key strategies for understanding complex human–environment systems (HES). In addition, the author defines the HES framework as a template for investigating and transforming sustainably coupled HES in the 21st century.

Roland W. Scholz chairs the Natural and Social Science Interface in the Department of Environmental Sciences at the ETH (Swiss Federal Institute of Technology), Zurich. A mathematician, psychologist and decision theorist by training, he is particularly interested in environmental systems analysis, human–environment interactions, environmental decisions, and risk assessment. He has led numerous large-scale transdisciplinary processes to foster sustainable transitions of urban and regional systems.

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Roland W. Scholz
ETH Zurich
Institute for Environmental Decisions
Chair of Natural and Social Science Interface

Some chapters are coauthored by Claudia R. Binder, Fridolin Brand, Justus Gallati, Daniel J. Lang, Quang Bao Le, Roman Seidl, Timo Smieszek and Michael Stauffacher

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To Maya

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Acknowledgments

Accidents can happen, often when one least expects them. On April 14, 2006, Dana, an escaped Doberman pinscher, knocked me off my bicycle when I was training for the forthcoming racing season. When viewing my fight to recover from brain injury, it was René Schwarzenbach, the Dean of the Department of Environmental Sciences, ETH, who seized the chance. Noticing that I was not yet prepared to struggle through the daily research, teaching and transdisciplinary project obligations of my institute, he suggested: "Now you have more time than before. Stop writing papers and write a comprehensive book on what you have elaborated in the last two decades." I took the challenge. Thus, one could say that this book is a product of an accident.

"You," in this place, is definitely not only "I, myself." As it is with staged races in cycling, which I experienced as a late competitive (hobby) racing cyclist, you can only finish if you have an excellent team. A staged race asks you to cope with a multitude of exigencies in a wide range of profiles, including flat and mountain stages. Thus you must have a strong team of specialists and helpers for all situations, especially if the race has 20 stages. Sometimes, you even need people to push you uphill!

However, preparing for a race is as important as running it. The 20 chapters that this book offers for the reader are the result of 29 "reader circle" exercises. I consider these to be a kind of pre-race exercise, in which the territory for each of the 20 chapters, or "stages," of the book was thoroughly scouted.

The very idea of writing this book emerged from the insight that environmental and sustainability sciences needed a "theory and resource book" that supports coupled human–environment and transdisciplinary research. Just before the bicycle accident, a blueprint of this book took shape through my work with Claudia R. Binder, Daniel J. Lang, and Michael Stauffacher and other former senior researchers from my team.

Let us go back to the cycle race metaphor. Race teams need coaches, proper training and workout partners, and a dedicated technical staff.

I consider the reviewers of different track sections to be my coaches and the members of the "reader circle" to be my training partners.

In the biology part, which tendered some previously unknown terrain and steep heliclines, I needed some more coaches. Here Peter Edwards, Theo Koller, Jukka Jokkela, Bo Samuelson, Beda Stadler, and Josef Zeyer drilled me. Patricia Holm, Walter Schaffner, and Gottfried Schatz helped me in difficult parts of the route. In psychology, Michael Siegrist and Paul Vlek, and in sociology, Andreas Diekmann, Matthias Gross, Gerhard Lenski, and Klaus Seeland were my coaches. Economics again was a demanding section, and I want to thank Catharina Bening, Stefanie Engel, Bernard Lehmann, Markus Ohndorf, and John Tilton. In the new terrains of industrial ecology, Volker Hoffmann and Reid Lifset, and in the modeling section, Andreas Ernst and Wander Jager took the coaching job. My special thanks go for Tim McDaniels, Cliff Davidson, and Anton J. M. Schoot Uiterkamp, and particularly Charles Vlek, who meticulously challenged me in most of the stages.

The team mates in the "reader circle" were Fridolin Brand, Thomas Flüeler, Peter de Haan, Justus Gallati, Bastien Girod, Fadri Gottschalk, Berit Junker, Thomas Köllner, Daniel Lang, Quang Bao Le, Marco Morosini, Siegmar Otto, Roman Seidl, Timo Smieszek, and Michael Stauffacher, who ran many or all legs of the race with me. As one can see, the last stages of writing the books' contents, involved breaking new ground, and I was grateful to find among these team mates several experienced external coaches and a team of inspiring "co-racers."

I was also fortunate that several PhD and masters students dedicated some of their time and focus to helping me find the straightest and surest track for my message. Here, this team of "junior cyclists" includes

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Laura de Baan, Mónica Berger González, Yann Blumer, Julia Brändle, Matthias Dhum, Rainer Gabriel, Martin Hitziger, Grégoire Meylan, Corinne Moser, Matthias Näf, Anja Peters, Alexander Scheidegger, Andy Spörri, Anna Stamp, Saša Parađ, Evelina Trutnevyte, Andrea Ulrich, Timo von Wirth, Stefan Zemp, and, in particular, Pius Krütli, who provided most significant support in the transdisciplinarity stage.

The technical staff included mechanics, masseurs, and a procurement team. Here Sandro Bösch and Rebecca Cors took on special roles. Sandro meticulously tracked mountains of book material, which were permanently upgraded to a whole text, and designed the large numbers of figures. Rebecca was the kneader of the text. She worked through all parts of the book as a sparring partner, checking for cohesion and coherence. She cooperated with Stefanie Keller, Erin Day, and Devon Wemyss, who not only checked the English but helped to improve the understandability of this multidiscipline book.

As racers need many bottles of liquid to drink each day, a writer of a book needs many resource books each week. Here my thanks go to Ursula Müller and her team, who acquired many, sometimes difficult to find, books, and to Robert Bügl, Silvia Cavelti, Marco Huber, and Andrea Ziegler, who ensured that all the bottles put into the reference list were properly prepared. Cyclists of today need sophisticated electronic equipment for keeping records and communicating with other team mates, before and during the race. We were fortunate to have team mate Andarge Aragai, who provided just the right software and hardware to keep our work going around the clock.

Special thanks go to my personal assistant Maria Rey. One of her main tasks before the bicycle accident was to coordinate my ambitious cycling training schedule with my full research and teaching agenda. While this book introduced new and unexpected challenges here, she managed it with an agility and reliability that makes her an invaluable part of the team, and we learned that managing a multistage book writer is even more difficult than managing the scheduling of an ambitious hobby cyclist.

Dominic Lewis, from Cambridge University Press, may be seen as a "tour-de-book-chef." The team was surprised as to how easy it was to communicate with him and how patiently and clearly he responded to special requests. It was most impressive to see how Dominic's technical (editorial) staff – Sarah Beanland, Abigail Jones, and Megan Waddington – allowed for an absolutely frictionless and satisfactory concourse.

Naturally, of utmost importance if you undertake such a big project, is your home base. Writing such a book changes one's life and entails an intense two-shift work week, which, in this case, endured over several years. Here my wife Maya – to whom this book is dedicated – has been the ultimate backup. She has been a counterpart in many vivid discussions about the book's essential messages, and a wonderful helper in the long course of recovering after the bicycle accident.

What began as an opportunity soon developed into an obligation. Those who share the experience with me and know what it means to write a challenging book or to participate in a staged race would most certainly agree that these trials often become an obsession.

While I have many to thank for contributing to the writing of the book who are not mentioned above, the responsibility for its content, however, remains my own.

International praise for Environmental Literacy in Science and Society

"Roland Scholz has written a visionary book that for the first time comprehensively approaches modern sustainability challenges by recognizing the critical role of integrated human, natural, and built domains in the complex systems that characterize the Anthropocene. It is an important step forward in our ability to understand, and respond ethically and rationally to the demands of environment, technology, and society in a context of complexity that is increasingly beyond traditional disciplinary and policy approaches for linking theory and practice."
Braden Allenby, Lincoln Professor of Engineering and Ethics and Professor of Law, Department of Civil and Environmental Engineering, Ira A. Fulton School of Engineering, Arizona State University, USA

"Society has yet to make the 'great transition' toward sustainability. We still increasingly appropriate the world's non-renewable resources, fail to safeguard ecosystem services on which civilization depends, and elect irresponsible government leaders. What is the solution? In this brilliant work, Roland Scholz addresses these issues head-on in a remarkably open and honest exploration of human-environment systems. Scholz argues that we need new knowledge and new science to tackle these challenges: the 'environment' must be redefined as a co-evolving system coupled to human systems. Furthermore, he demonstrates that interdisciplinary research is not enough – we need transdisciplinary research to integrate our scientific knowledge in a way that results in sustainable decision making. The book is critically important in providing a roadmap to begin the transition to a sustainable world; the reader experiences an unforgettable journey toward ecological literacy, achieving a sufficient understanding of human-environment interactions to manage the earth's biogeochemical cycling in a sustainable way. With over 7 billion people on the planet, it is a journey we have no choice but to take. This is a must-read for anyone who relies on planetary resources and ecosystem services."
Cliff Davidson, Thomas C. and Colleen L. Wilmot Professor of Engineering and Director of the Center for Sustainable Engineering, Center for Energy and Environmental Systems and Department of Civil and Environmental Engineering, Syracuse University, USA

"Developing adequate solutions for human-environmental problems requires both substantive expertise and a deeply interdisciplinary perspective. Anyone who doubts this assertion need spend but a few minutes reading almost any part of Roland W. Scholz' monumental work on Environmental Literacy to have their doubts erased. In addition to thoughtful theoretical discussion they will find case after case of detailed worked-out examples that illustrate both the complexity, and the exciting intellectual challenges, that face students and professionals working to create a better and more sustainable world."
M. Granger Morgan, Lord Chair Professor in Engineering; Professor and Department Head, Engineering and Public Policy; Professor, Electrical and Computer Engineering and Heinz College, Carnegie Mellon University, USA

"Half a century ago Rachel Carson published her book *Silent Spring*. It marked not only the beginning of the modern environmental movement but it also laid the foundation for the strongly interdisciplinary field of environmental sciences. The field emerged from a range of contributing natural and social sciences disciplines. Over the years it was shaped and codified in innumerable papers and books. Following the emergence of the concept of sustainable development it also further developed into specific disciplines like sustainability science. Still one of the grand challenges of any field of science remained. No one had yet succeeded in creating an overarching synthesis of the field. That is until now. In his monumental magnum opus *Environmental Literacy* Roland Scholz not only presents

an outstanding in-depth analysis and splendid review of the field but he goes far beyond it. He also presents a strategic framework to address the many challenges we 21st-century humans are facing in our interactions with the environment. Moreover he convincingly shows the preconditions for using a framework for effective and feasible strategic decision making and action. It requires a good integrated knowledge of disciplines like biology, psychology, sociology, economics and industrial ecology as well as a genuine understanding of the transdisciplinary processes that characterize human–environment systems. In conclusion, Scholz's book is both a sparkling sourcebook and an advanced textbook for sustainability science. It is also the first successful attempt to produce a convincing theory of coupled human-environment systems. And finally, it presents a strategic framework for environmental decision making and action based on that theory."

Ton Schoot Uiterkamp, Professor of Environmental Sciences, Center for Energy and Environmental Studies, University of Groningen, The Netherlands

"Collective environmental and social problems constitute the dark side of increasing wealth for growing human populations. Roland Scholz strongly pleads for broad, multi- and interdisciplinary thinking about human–environment interactions. In the author's view, human and environmental systems cannot be separated. Rather, their interaction should be the central topic of our visions, methodologies and strategies. For natural scientists and technologists this requires a basic familiarity with how human individuals and societies function. For behavioral and social scientists it demands a solid appreciation of specific environmental problem domains. By consequence, actual policy-making should rest upon integrative teamwork. Scholz's book provides for an inspiring boost to our own environmental literacy, what it is and how it historically developed. It's a fruitful basis for extensive student courses. And it may well serve as a reference book for scientists, policy-makers and other key actors who want to improve and reflect on sustainable transitions."

Charles Vlek, Professor of Environmental Psychology and Decision Research, Department of Behavioural and Social Sciences. University of Groningen, The Netherlands

Preamble

Key questions

This book addresses three major questions:

Q1 Who *invented the* (concept of) *environment*, why, when and in what manner?

Q2 What rationales do we find in different human systems and environmental systems, and how do they interact?

Q3 Do we need a "*disciplined* (i.e. discipline-grounded) *interdisciplinarity*" in *transdisciplinary* (i.e. theory–practice-based) *processes* to cope successfully with the challenging *environmental problems* of the twenty-first century?

Figures

There are a few figures that represent essentials of this book and which are referred to throughout the text. These figures are marked with an asterisk and can be found separately on the foldout page at the end of the book.

Overview: roadmap to environmental literacy

Natural and social environments are constantly adapting to changing demands from human systems. This particularly holds true as we see increasing impacts on the natural environment and resources from human systems. A key question is whether societies and their subunits have sufficient knowledge about the structure, dynamics, limits, and potential of human–environmental systems to function and evolve in a sustainable manner. And what role can science take to help in this venture? We deal with these fundamental problems under the heading of environmental literacy. "Environmental literacy" means the capacity to perceive, appropriately interpret, and value the specific state, dynamics, and potential of the environmental system, as well as to take appropriate action to maintain, restore, or improve these states. This book elaborates what knowledge and capabilities should be available in science and society to develop suitable strategies for coping with critical interactions of human systems with environmental systems. This should ultimately help to avoid the unintended and unpleasant environmental rebound effects of human action, and allow us to cope with conflicting interests which may hamper sustainable transitions.

Given these societal and scientific challenges, this book is a source book for those interested in the following questions related to environmental literacy:

- Why and when was the concept of the environment developed?
- Do we have to redefine the environment when facing that most processes in the material–biophysical layer of the Earth are affected by human action?
- How do various scientific disciplines deal with the interrelationship between human systems and the environment?
- How can we distinguish the material–biophysical environment, which includes the built environment, from the social-epistemic environment, which is historically and culturally shaped?
- When, why, and in what context are human systems concerned about the state, dynamics, potential, and negative impacts of environmental states and resources?
- What drives human systems (such as individuals, groups, companies, and societies) to exploit, protect, or sustainably cope with the environment?
- How can conflicts and dilemmas between individual and societal environmental behavior (i.e. interferences between the micro and the macro levels of human systems) be explained?
- What constitutes sound environmental literacy, sustainability learning, and sustainable behavior?

Preparing for map reading

Part I of this book consists of three chapters that illuminate why environmental literacy is of interest and what it is. We define different types of human and environmental systems and explain how these systems relate and interact. We further introduce some tools (i.e. epistemological assumptions) that are helpful to better understand what the reader will encounter in the different stages of the journey.

From the origins to the future of environmental literacy

To read our answers to the questions above, the reader can continue in Parts II–VI on a journey from the history to the future of environmental literacy in science and society. We introduce epistemological assumptions as prerequisites for coping better with the challenges of examining environmental literacy.

After this initial descent into the origins of environmental literacy, we wander through a handful of scientific disciplines. These stages of our journey will not always be the most convenient ones. Depending on the

disciplinary background of the reader, he or she will sometimes have to row upstream. We start with biology, where we learn about the origins of human knowledge about organismic environments and about how societies can successfully conserve and develop this knowledge. We also explore those biological principles that are of special interest for mastering sustainable development. We make an excursion to the frontline of research on microstructures, such as the cell, and the immune system. Here we can discover how important the environment is for these systems and how they process environmental information. A comparative view of large-scale biological systems reveals that they are strongly affected by human systems and miss the essential self-regulating, homeostatic properties of microstructures.

We then look to psychology to gain an understanding of the biophysical, social, and cognitive foundations of human perception, decisions, and behavior. The sections on psychology also provide insight into the drivers of individuals and small groups when interacting with the material and social environment.

In the next stage, sociology, we focus on theories that consider the natural environment and technology as significant factors of societal development. Just as with psychology, we meet approaches that provide insights into the drivers of societies in human–environment interaction and that explain why and when environmental issues raise concern. However, we will learn that we can find a material–biophysical layer in many but not all sociological approaches. In some they are hidden, in some they do not exist.

The last stage in looking at social sciences is economics. Following our own curiosity we explore the roles that material, biophysical, land and other resources play from the view of classical and neoclassical economics, and the types of goods that are dealt with in this discipline. In new terrains of economics, we will see that economists make highly controversial assumptions about how one should deal with natural resources and the material–biophysical environment. Some seem to be reckless, whereas others seem overly troubled about their future markets and companies. We also learn that many ideas from other sciences have invaded the new subfields of economics that deal with the environment.

Next, we look at industrial ecology, a small but steadily growing discipline investigating how companies, industrial branches, and trade can reinvent themselves to reduce environmental impacts resulting from production, business, and services. Here we encounter some engineering methods that allow the assessment of manmade environmental impacts. But we also look at some special sites, such as eco-industry parks, from which we can learn to better cope with material flow. What is more, we see how industrial ecology offers broad, long-term perspectives and strategies for the future of environmental literacy. This offers a global view that highlights the fundamental changes that the landscape of human–environment interaction has undergone in the past and also the new structures and components that this landscape might exhibit in the future.

Our journey could have taken another route with different stops. Besides biology, we could also have looked, for instance, at geology, and, instead of industrial ecology, at civil and environmental engineering. Naturally, other disciplines, such as geography or anthropology, could deserve their own chapter. However, we think that the selected disciplines allow the demonstration of why and when various types of contributions to environmental literacy emerged in academic disciplines.

The reader might ask why we are not visiting some new, exotic and more exciting domains, such as environmental or sustainability sciences. These two disciplines are the current home base of the author, and scientists from these disciplines are the most likely to use our roadmap to promote environmental literacy. As key question 3 of the Preamble indicates, we explore each discipline both for its unique knowledge and for the value it can bring to investigations that involve more than one discipline. We call this perspective, common to environmental and sustainability sciences work, "disciplined interdisciplinarity."

Provisions for traveling beyond the boundaries of disciplines and sciences

The first part of the journey highlights how many issues from different disciplines are indispensable to cultivate environmental literacy. But knowledge from lone disciplines only takes us partway toward answers to today's environmental problems. In Part VII, this book introduces three new perspectives that are required to take us further.

The first is that today's environmental problems cannot be managed without incorporating analysis of human systems that affect many processes on all levels,

from molecular up to global biogeochemical processes of the material–biophysical environment. This asks for redefinition of the environment and the destination of the journey. We will discuss a new goal for the second stage of the journey, which includes an anthropocenic redefinition of the environment.

Second, environmental literacy requires an integrated view of knowledge about the environment and human–environment interactions. This requires new techniques of making and processing pictures. We will see how "integrated modeling" becomes a vital means of extending environmental literacy and allows a deeper understanding of what we have seen. This will facilitate in taking an *interdisciplinary* view.

Third, we will notice that, in the first stages, disciplinary scientists face limitations in acquiring all the information about the environment. Thus, we, along with these scientists, have to leave our travel route and step into real-world cases to gain valuable additional information from directly talking, interacting, collaborating with, and getting first-hand information from the people and human actors who are directly experiencing, benefiting from, and interacting with the environment. This provides a completely new perspective, which we call *transdisciplinarity*. We will see that the people incorporated in transdisciplinary processes benefit from and appreciate these mutual learning processes.

Extending environmental literacy: the human–environment systems Postulates and the HES framework

After this intermediate stop and reorientation, we explore new territory and the character of the journey changes. It will slightly resemble an excursion into more complex domains. Instead of the environment, human–environment interactions become the object and objective of the journey. It becomes difficult to keep track of our place, to figure out where to go first, and to know what we need to move toward these new destinations. Thus we offer Part VIII as a guidebook that outlines seven Postulates, or assumptions, for investigating human–environment systems (HES). This travel guide consists of seven Postulates, the HES Postulates. The HES Postulates depict the constituents of the HES world, how HES behave, how they can be classified, and of what they are and are not aware. We also examine the drivers of human systems and the conflicts that may exist between individual agents or subunits and superordinate systems. The latter can be communities or societies.

An important point of the guidebook is that we have to conceive HES as coupled, inextricably intertwined, systems. However, the guidebook also explains that we must first have a thorough look at the environment, in particular at the material–biophysical environment if we want to understand what a specific HES looks like, how it evolved and what future development might take place. The HES are explained by a Postulate that describes different types of feedback loops that may be at work in HES.

We will see that the HES Postulates draw on what we have learned when looking at the scientific disciplines in the first part of the journey. Our knowledge of social sciences, for example, will help us to understand the interests and values that underlie the rationale of human systems when interacting with the environment.

Having become familiar with the individual Postulates, we know how the Postulates relate to each other and how they can work together during an investigation of an environmental issue. We put forth this HES framework as a template for transdisciplinary collaboration.

Four cases for demonstrating HES literacy

Equipped with the HES framework, we are prepared to take a closer look at the challenges and threats of human–environment interactions. In Part VIII, we make four excursions, each of them demonstrating the improved environmental literacy gained by working with the HES Postulates.

Trip 1 looks at epidemic and pandemic threats. Using the HES Postulates we learn that the outbreak of pandemics is shaped by more than the mechanisms of viruses and bacteria. The type and severity of pandemics, and the unexpected rebound effects that may result from various pandemic management approaches, ask for an examination of the behavioral, contact, and mobility matrices of human systems. A look at micro and macro structures and their interactions is needed here.

Trip 2 involves an excursion to Switzerland. We scrutinize how transdisciplinary processes involving scientists and key agents, as well as people from the region, are helping government and industry to better adapt to market and environmental constraints. We learn that transdisciplinary processes are

useful to identify robust orientations to find sustainable solutions.

Trip 3 looks at how HES manage basic supply services. The jaunt takes us to Sweden, where we encounter unexpected limits to biofuel resources. Here we see how proper identification of secondary feedback loops is a key feature of sustainability learning.

Lastly, trip 4 provides profound insights into the difficulties that human systems and societies face when making trade-offs and protecting natural resources in the anthropocenically formed environment. The case we look at is the dilemma of establishing a recycling management system for some minerals (i.e. phosphorus) when simultaneously aspiring to eliminate and dispose of material matter (e.g. carcass meal and bones), which includes high concentrations of the said mineral but also dangerous pathogens.

Upon our return from these trips, we check whether the guidebook and the HES framework have served as an effective compass for environmental literacy as we have defined it above. To do this we compare the HES framework with alternative travel guides.

The vision on future environmental literacy

The journey closes in Part IX by identifying key components that may promote environmental literacy ("Sustain–abilities", see Chapter 20.4.1). These are the new fields of environmental and sustainability sciences that cope with inextricably coupled HES. The HES framework, based on disciplined interdisciplinarity, allows a thorough investigation and understanding of complex environmental problems. Transdisciplinarity includes processes which use knowledge from theory and practice to generate socially robust solutions for sustainable development.

How to access the chapter overviews

After the novelist-like overview, the reader can best gain access to the content of the book by reading the sections "What to find in this part" on the front pages of all nine parts and of the 20 chapters. A closer look at the roadmap and its extended legend on pages xxii–xxiii may also help to understand the structure, main subject matters and the storyline of this sourcebook.

Who should use this book?

The overview suggests that this book might be of interest to those who are curious about how the environment interacts with human systems and how human systems, from the individual through groups, organizations, companies, communities and society to the whole human species, can become capable of adequately adjusting and adapting to the continuously changing and increasingly anthropocenically shaped environment.

These primary readers are researchers from the emerging fields of environmental and sustainability sciences who are interested in human-environment interactions or systems. Clearly, it is also relevant to anthropologists, human ecologists, geographers, and environmental planners, or people working in the hyphenized fields of sciences, such as environmental–psychology, -sociology, or -economics. Readers will also no doubt include people from the natural sciences, including ecology and those working with the climate and atmosphere. The book will also be of interest to those working in environmental chemistry and those in different branches of engineering sciences, such as industrial ecology, may learn from the comprehensive, integrative, coupled system perspective which looks at the constraints, feedback loops, and regulatory mechanisms of HES.

Environmental literacy is not only seen from an academic learning perspective but is rather focused here on what we call *societal didactics*. Thus, it should contribute to societal learning about how to cope with environmental challenges and provide access to the rationale of human–environment interactions. Further, this vision and the practice of transdisciplinarity were motivators for writing the book. However, as expressed in the Preamble, establishing a thorough, discipline-grounded interdisciplinary knowledge about HES, which favors transdisciplinary processes that deal with the current and future environmental challenges, is the very vision and mission of this book.

Legend of the roadmap

The concept map shows how the ideas in this book relate. The figures in the concept map come from informational boxes that are sprinkled throughout the book and tell stories from around the world, both historic and contemporary, that illustrate our message.

Our starting point is the question, "Who invented the environment?" Chapter 1 describes how humans' awareness of their impacts on the environment developed and when and why the concept of the environment was invented. Chapter 2 provides a first definition of environmental literacy and introduces the value that transdisciplinarity can bring to how humans address environmental issues. Chapter 3 introduces the concept of environment based on an organismic, cell-based definition of the human individual and the complementarity of material–biophysical and social-epistemic levels of human and environmental systems. Here we describe the basic ontological and epistemological assumptions that underlie our world view and thesis.

To discuss the issue, "What disciplines can and can't tell us," we review contributions to environmental literacy from five academic disciplines – biology, sociology, psychology, economics, and industrial ecology – in Parts II through VI. Taking two chapters to cover each discipline, we review the history of mind for each, examining which aspects of human–environment interactions were of interest during different time periods. We also review key theories from each discipline and prospective future perspectives that can inform environmental literacy.

In Part VII, Chapters 14 and 15 describe the pivotal, integrating function of "managing interfaces to become literate." We examine how knowledge integration and transdisciplinarity help us to decrease the complexity of environmental issues, which warrant an "Anthropocenic redefinition of the environment in a coupled human–environment setting."

We put forth seven Postulates, P1 to P7, to organize the complexity of today's environmental issues and related research.

The HES framework is a methodological schema for employing the Postulates in an integrated manner when investigating environmental issues.

To give readers a feeling for the HES framework in action, Chapter 18 presents four case studies.

Chapter 19 compares the HES framework with alternative approaches and shows what added value it can provide.

The last chapter presents "Perspectives for future research in human–environment systems," and links the coupled systems and the transdisciplinary perspective (see bottom left of the concept map and key question 3).