Human-Environment Interactions 2

Simron Jit Singh · Helmut Haberl
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Long Term Socio-Ecological Research

Studies in Society-Nature Interactions Across Spatial and Temporal Scales

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VOLUME 2

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Foreword

People and their changing environment: how to deal with complexity

The broad field of ecology expanded during the twentieth century as a sub-discipline of biology, in order to combine the fundamental curiosity of scientists who wished to uncover the relationships between organisms and their environment with a growing societal awareness of the fact that we are now changing these relationships, on every single square metre of this planet. Nearly all of this change is to the detriment of the functioning of plants, animals and the communities they live in. As such, ecology can be seen as a success story: environmental legislation, first in the US during the 1960s and later also in Europe, began to be informed by ecological research. Now, ecologists form a large and mature community, drawing students to most universities world-wide. However, the environment keeps changing, and environmental policies very frequently fail to take into account even the simplest concepts of ecology. For example, it seems as though few, if any, nations had established an official assessment of their own natural capital and ecosystem services before Norway recently did so.

Most dramatically, we find ourselves helplessly witnessing the loss of species at an accelerating rate, thereby eradicating the fundamental "software" that might provide essential functions ("services") from our changed environment. In addition, the level of pollutants and other disturbing compounds in the environment is increasing in most places, with improved conditions only where the impacts were seen as "too lethal" (such as in European acidified lakes during the 1980s or for chlorinated hydrocarbons in North America during the 1960s). Finally, we still do not really know where the changes in our environment are affecting people in the most direct way, and which impacts might last longer than others.

Hence, while ecology often portrays itself as being helpful to society and policy makers, most often the link between published scientific findings and societal problems is not made. Instead, many ecologists express their concern to media and policy makers with a single and undifferentiated message: stop changing our

environment, cut greenhouse gas emissions, ban the destruction of the deep sea marine ecosystem, enlarge all protected areas, etc. Nearly all public debate in response to these calls merely succeeds in generating feelings of guilt among some portions of society and opposition in other sectors, while often producing little or no policy action and only temporary reductions in the scale of environmental degradation.

One key reason for this failure is that the root cause analysis of the problem is often incomplete. Frequently, any change of the so-called "natural state" is portrayed as negative by ecologists. But even hunting and gathering of food from ecosystems inevitably has an impact on species and communities. Agriculture, in the sense of either cultivating plant species on cleared land, or herding animals in open landscapes, is more intensive, covering a broad range from low impacts to the much higher ones of agro-industrial complexes. If society is to benefit from enhanced scientific knowledge about such impacts in a useful way, then systems must be analysed from a more comprehensive, interdisciplinary and human perspective – e.g., the perspective of Long-Term Socio-Ecological Research (LTSER). LTSER benefits from the conceptual advances in social ecology, which derive from the full range of interdisciplinary approaches that have developed, and are developing, to address the complexity of systems of nature and society over long periods of time.

From this viewpoint, the aspect of benefits, or "usefulness" (which is often relegated to managers or "applied research") of scientific efforts should be distinguished from pragmatism and advocacy. Aiming to directly address public concerns in the human-environment relationship does not imply asking less profound questions than those in other fields of science. Aiming to arrive at an objective analysis of human land use and the associated changes in the composition of species, as well as their population and community dynamics, demands substantial efforts in terms of conceptual development, multi-scale gathering of data and complex interpretation. Just as putting the "S" for "Society" into "Long-Term Ecological Research" means adding an important layer to an already complex set of studies, it also means that new types of topics enter the scene, such as socioeconomics, security, equity and gender issues. In this sense, while it might be more pragmatic to document a physico-chemical change (for example, the acidification of lakes or oceans) and the associated loss of biological function, extrapolate both into the future, and then complain loudly about society's lack of willingness to "do something", a more challenging in-depth analysis would include the study of the way in which the problem is perceived together with society's willingness to act, as part of the same investigation.

This book performs a remarkable "tour de table" of modern LTSER and related studies. Why the long-term? Clearly, from a human perspective, our agricultural life support system has been attuned to a geological period of particular stability over many millennia. Anthropogenic environmental change must be seen against these rather special conditions which have caused the evolution of highly specific ways of relating to the environment (at least on northern temperate latitudes). To adjust to the dynamics now introduced into the physical and biological environment requires an understanding of systemic behaviour on a range of time-scales, at a minimum of several decades. Gathering knowledge about the longer term situation, and observing

systems over periods that extend beyond the scope of a single PhD thesis or research grant is therefore essential to the analysis of social ecology.

The book also reveals that there is not a single unified theory for LTSER. In some studies, the actual analysis of social dynamics goes much deeper than it does in others. We may view this rather as an asset than as a limitation. If anything, this demonstrates that there is plenty of scope for further research developments and creativity, using the work assembled here as an inspiration rather than a straitjacket.

A key aspect of developing the field of LTSER is cooperation – among disciplines of course, but also among like-minded teams in different locations. In times of limited financial resources, international cooperation in particular may provide ways to enhance the value of the various contributions. The international community presently benefits from several platforms for such cooperation, two of which are directly associated with much of the work presented in this book. At the European level, the Network of Excellence ALTER-Net, funded by the European Unions 6th Framework Programme for the Environment (2004–2009) continues to provide crucial support for the development of the LTSER concept, including the training of a large number of next-generation scientists, many of whom are now familiar with concepts of social ecology. In the United States, the LTER network is becoming more interdisciplinary, adding expertise in demography, economics, geography, political science and sociology. At the global scale, the International Council of Science (ICSU) now builds on the achievements of its Earth System Science Partnership (ESSP) by developing a new Programme on Ecosystem Change and Society (PECS) to create global linkages between scientists addressing the human-environment relationship. We have no doubt that this book will provide substantial inspiration for anyone participating in these programmes – indeed, we hope that the programmes themselves will be enhanced by the material presented here.

Wolfgang Cramer
Stephen R. Carpenter

Foreword

In the pages of this book you will find a collaborative effort uniting many disciplines to understand humanity's long relationship with nature. It is a scientific enterprise in the broadest sense, including experts in social as well as natural fields. We can be hopeful that this effort marks a major turning point in consciousness and applied intelligence.

Ecology stands at the very centre of this book, a science that has grown in scope and importance since it was first named in 1866 by Ernst Haeckel, the leading German disciple of Charles Darwin. Haeckel derived the name from the Greek word *oikos,* or household, so that ecology was meant to be the study of Nature's household, or the natural economy, including the interactions of plants and animals, their relations to the soils and atmosphere. In this book, however, ecology moves decisively beyond the purely natural to encompass human society as well. "Long-Term Socio-Ecological Research" aims to achieve a comprehensive understanding of how humans have lived within and changed ecosystems over time. Why has this new, enlarged ecology become so necessary in our time? Because the changes going on across the earth are so cataclysmic and yet so poorly understood that we ignore them at our peril. Because they require a deep historical understanding of where we have been to know where we are going.

Over the past 500 years, good science has somehow advanced against the most powerful opposition, winning more battles than it has lost. It has driven not one or two but multiple revolutions, and at this moment the interdisciplinary study of ecology may be driving us toward still another intellectual revolution. The outcome will be not merely a better understanding of the interrelationships between society and nature but also a better understanding of where our limits lie.

In their concluding commentary on the book *Limits to Growth,* published in 1972, the executive committee of the Club of Rome wrote: "The concept of a society in a steady state of economic and ecological equilibrium may appear easy to grasp, although the reality is so distant from our experience as to require a Copernican revolution of the mind." That concept of society in a steady state of equilibrium seems implicit in the very notion of LTSER; if so, it will require an intellectual revolution before it is achieved.

The call for a new Copernican revolution appears more than once in recent writing: for example, in a paper that H. J. Schnellnhuber of the Potsdam Institute for Climate Impact Research in Germany published in Nature in December, 1999. Schnellnhuber argues that just as "optical amplification techniques brought about the great Copernican revolution, which finally put the Earth in its correct astrophysical context," so "sophisticated information-compressing techniques including simulation modeling are now ushering in a second 'Copernican' revolution." We are learning to see, for the first time, that the planet is "one single, complex, dissipative, dynamic entity, far from thermodynamic equilibrium—the 'Earth system.'"

So what was the Copernican revolution about, and what might a new Copernican revolution look like? Just 50 years after Columbus's first voyage to the New World, the Polish astronomer Nicholas Copernicus published his last and greatest work, *On the Revolutions of the Heavenly Sphere.* Before Copernicus, the earth had been the fixed centre of the universe, just as Europe had considered itself the fixed centre of human history. A 100 years later, astronomers had finally accepted that the earth was only one of several planets in motion around the sun, and that the universe was far more grand and infinite in its dimensions than anyone had realised. But it was far from easy to make that shift in consciousness, and Copernican ideas would bring fierce controversy in religion, philosophy, economics and politics that would not end for centuries to come. We are still struggling with their implications today.

Can we be sure that another, post-Copernican revolution is in the making? Do we have enough information to judge? The idea of a comprehensive perspective of "socio-ecology" does seem to be emerging, a science to which ecologists, geologists, climatologists, historians, geographers and others are contributing. It promises to provide a new understanding of the natural world and of our place in it. Whether this awareness adds up to a revolutionary change in understanding, to a new human way of thinking that accepts the ecosphere's limits and conserves its systems, we will not know for a long time to come. But such a revolution is possible, and we might even say inevitable. We are being driven by material changes that render old ideas outdated and even dangerous to our survival.

Donald Worster

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With most creative and intellectual processes, achievements can rarely be credited to the efforts of single authors or editors alone. This volume is no exception. The current work is an outcome of unwavering support from a number of institutions, research networks and individuals who all deserve our heartfelt thanks.

The genesis of this effort can largely be attributed to the ALTER-Net process – A Long-Term Ecosystem and Biodiversity Research network of excellence mobilised and established with generous funding from the European Commission's 6th Framework Programme (2004–2009). Led mainly by natural scientists, integrating the social dimensions in the European Long-Term Ecological Research (LTER) was no easy task. In the years that followed, intense dialogues between the natural and social scientists involved eventually led to promising outcomes thereby enhancing the utility of LTER for society, denoted by the expansion of "ecological" in LTER to "socio-ecological" in LTSER. We would like to thank the ALTER-Net project and network co-ordinators, Terry Parr and Allan Watt, as well as the commission's project evaluator, Martin Sharman, for their support in providing this impetus.

A crucial role in spearheading these early discussions, besides some of the editors, was played by Verena Winiwarter, Sander van der Leeuw, Angheluta Vadineanu and Eeva Furmann, who paved the way for a European LTSER agenda, while conceptual rigour was provided by Marina Fischer-Kowalski and Anette Reenberg. Alongside this, the constant feedback received from the 30 members of the LTER-Europe Expert Panel on LTSER, mainly composed of LTSER Platform managers and primary investigators, cannot be underestimated. They actively tested the LTSER approach across Europe and fed their experiences back into further refining the LTSER concept.

However, it was not only developments in Europe that inspired this work in the first place. The goal of this volume at the outset was to crystallize the state-of-the-art in LTSER research and this would not have been achieved without the support of a number of pioneering colleagues in the US. We particularly want to thank Charles Redman, Nancy Grimm, Morgan Grove and Carole Crumley for their encouragement in the project and/or contributions to this book. The current volume has also greatly benefitted from the knowledge generated in a number of European research projects over the past years. Indeed, several contributions to

this book draw heavily on research undertaken in such projects. We particularly want to thank the Austrian Science Fund (FWF) for their financial support for the projects 'Global HANPP' (P16692), 'Analysing Global HANPP' (P20812-G11) and 'GLOMETRA' (P21012 – G11), and to the European Commission's 7th Framework Programme for the project 'VOLANTE' (265104). We are grateful for continuing support by the Austrian Federal Ministry of Science and Research (BMWF) within the proVISION programme as well as by the Austrian Academy of Science (ÖAW) in supporting the implementation of the first explicit LTSER Platform worldwide. Across the Atlantic, we sincerely wish to acknowledge the financial support of the US National Science Foundation ULTRA-Ex Program and the American Recovery and Reinvestment Act.

The editors are extremely grateful to two donors for their financial support in the editorial process that has enhanced the quality of this book enormously. The English language check was made possible by support from the Austrian Science Fund's (FWF) Translation and foreign language editing of stand-alone publications programme. The ALTER-Net New Initiative Fund supported the initial editorial and exploratory phase of this book project. We extend our heartfelt thanks to Ursula Lindenberg for her competent language editing skills which she delivered meticulously and on time. The editors are especially grateful to Irene Pallua and Georg Schendl for their painstaking and careful proof-reading of the manuscript ensuring compliance with Springer guidelines. This is by no means a trivial task. Without the enduring and dedicated efforts of these colleagues the book would have fared poorly. Last but not least, we would like to thank Jennifer Baka from the Yale School of Forestry and Environmental Studies, for her careful reading of the chapters and critical feedback, and for her help with the figures in the introduction to this book.

Contents

Acronyms

ALTER-Net	A Long-Term Biodiversity, Ecosystem and Awareness Research Network
BEC	Baltimore Ecosystem Study
CBD	Convention on Biodiversity
CBNA	Alpine National Botanical Conservatory
CEM	Commission on Ecosystem Management
CZO	Critical Zone Observatory
DEHI	Danube Environmental History Initiative
DIVERSITAS	An international Programme on Biodiversity science
DPSIR	Driver-Pressure-Impact-State-Response
EBONE	European Biodiversity Observation Network
EEA	European Environment Agency
e-MORIS	Electronic-Monitoring and Research Information System
EnvEurope	Environmental quality and pressures assessment across Europe
ERA	European Research Area
ESEE	European Society for Ecological Economics
ESI	Ecosystem Service Initiative
ESSP	Earth System Science Partnership
EVALUWET	European Valuation and Assessment Tools Supporting Wetland Ecosystem
EXPEER	Experimentation in Ecosystem Research
ExtremAqua	Influences of Extreme Weather Conditions on Aquatic Ecosystems
FCM	Fuzzy Cognitive Maps
FP	Framework Programme
GEA	Global Energy Assessment
GISP	Global Invasive Species Programme
GLEON	Global Lake Ecological Observatory Network
GLORIA	Global Observation Research Initiative in Alpine Environments
GLP	Global Land Project
GMBA	Global Mountain Biodiversity Assessment
HEF	Human Ecosystem Framework

IBP	International Biological Programme
ICP	International Cooperative Programme
ICPDR	International Commission for the Protection of the Danube River
ICSU	International Council for Science
IGBP	International Geosphere-Biosphere Programme
ILTER	International Long-Term Ecological Research Network
INSPIRE	Infrastructure for Spatial Information in the European Community
IPBES	International Platform on Biodiversity and Ecosystem Service
IPCB	International Press Centre for Biodiversity
IPCC	Intergovernmental Panel on Climate Change
ISEE	International Society for Ecological Economics
ISSE	Integrative Science for Society and the Environment
IUCN	International Union for Conservation of Nature
JPI	Joint Programming Initiative
LECA	Laboratory of Alpine Ecology
LIFE+	The Financial Instrument for the Environment
LTER	Long-Term Ecosystem Research or Long-Term Ecological Research
LTER-Europe	Long-Term Ecosystem Research Network Europe
LTER Site	Long-Term Ecosystem Research Site
LTSER	Long-Term Socio-Ecological Research
LTSER Platform	Long-Term Socio-Ecological Research Platform
MAB	Man and the Biosphere Programme
MEA	Millennium Ecosystem Assessment
MoU	Memorandum of Understanding
MSP	Math-Science Partnership
NCEAS	US National Center for Ecological Analysis and Synthesis
OOI	Oceans Observatory Institute
NAS	National Academy of Sciences
Natura2000	An ecological network of protected areas within the European Union
NCA	National Climate Assessment
NEHN	Nordic Environmental History Network
NEON	National Ecological Observatory Network
NESS	Nordic Environmental Social Science
NoE	Network of Excellence
NSF	National Science Foundation
PAME	Participatory Assessment, Monitoring and Evaluation
PECS	Programme on Ecosystem Change and Society
PPD	Press-Pulse Dynamics Framework
PTA	Participatory Technology Assessments
PVA	Population Viability Analysis
RCN	Research Coordination Network
SCOPE	Scientific Committee on Problems of the Environment
SEBI	Streamlining European Biodiversity Indicator

SEIS	Shared Environmental Information System
SERD	Simulation of Ecological Compatibility of Regional Development
SMCE	Social Multi-Criteria Evaluation
TEEB	The Economics of Ecosystems and Biodiversity
TERENO	Terrestrial Environmental Observatories
TFRN	Task Force on Reactive Nitrogen
ULTRA-Ex	Urban Long-Term Research Areas Exploratory Projects
UNECE	United Nations Economic Commission for Europe
UNEP	United National Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organisation
URGE	Urban Rural Gradient Ecology project
UTC	Urban Tree Canopy
WFD	EU Water Framework Directive
WSSD	World Summit on Sustainable Development

List of Boxes

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