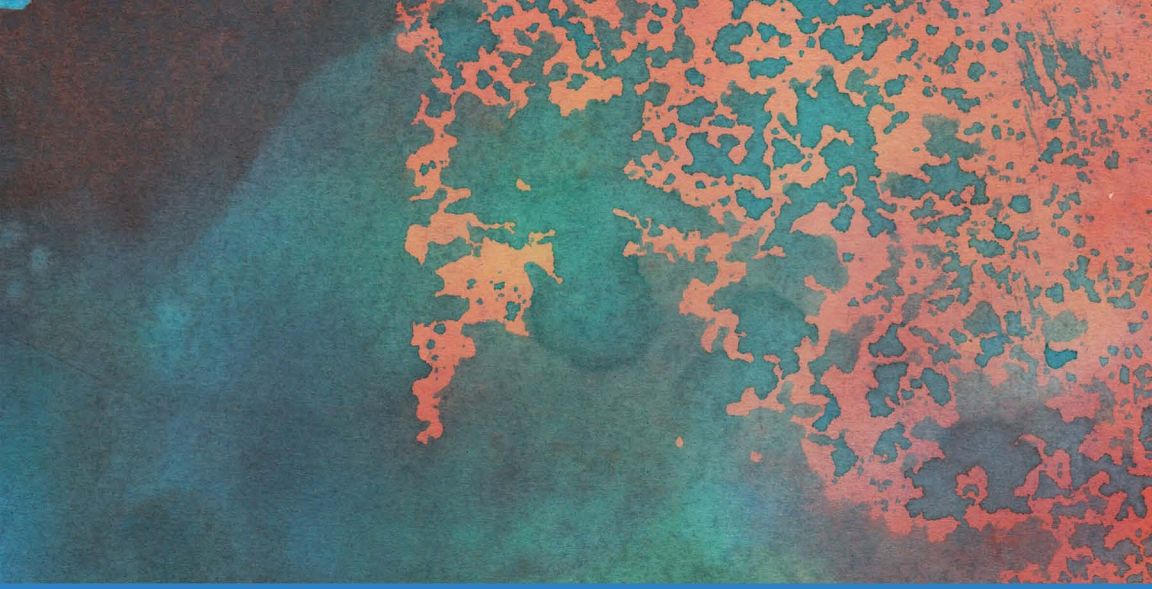
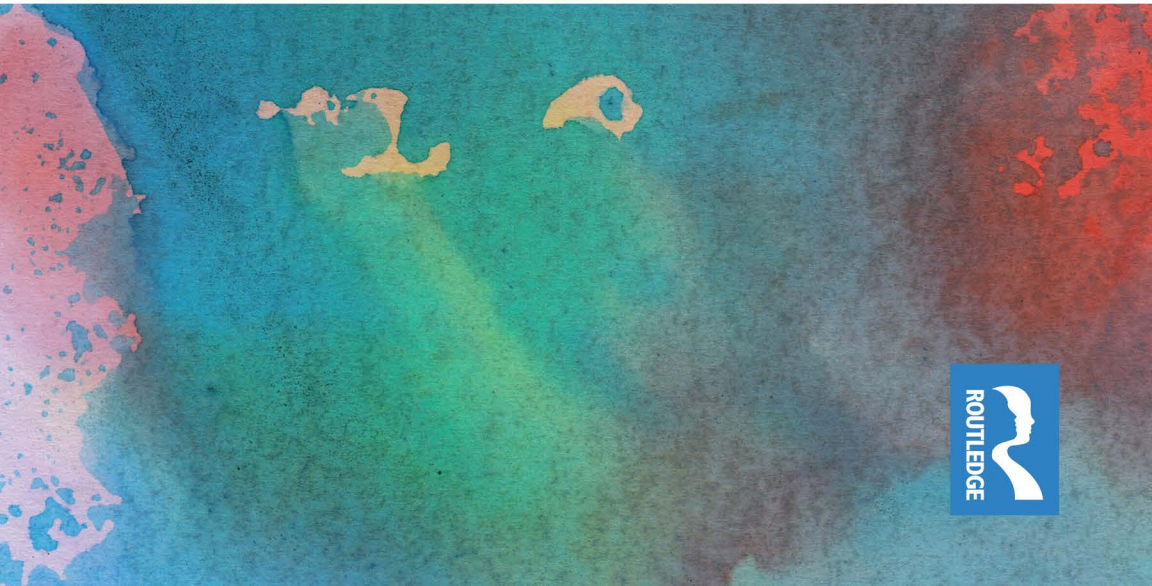


Routledge/ISDRS Series in Sustainable Development Research

TRANSDISCIPLINARITY FOR SUSTAINABILITY

ALIGNING DIVERSE PRACTICES

Edited by
Martina M. Keitsch and Walter J.V. Vermeulen



ROUTLEDGE

Transdisciplinarity For Sustainability

This volume explores interactions between academia and different societal stakeholders with a focus on sustainability. It examines the significance and potential of transdisciplinary collaboration as a tool for sustainability and the SDGs.

Traditionally, academia has focused on research and education. More recently, however, the challenges of sustainable development and achieving the SDGs have required the co-production of knowledge between academic and non-academic actors. Comprising theory, methods and case studies from a broad range of transdisciplinary collaboration, *Transdisciplinarity For Sustainability: Aligning Diverse Practices* is written by specialists from various academic disciplines and represents an important step forward in systematizing knowledge and understanding of transdisciplinary collaboration. The book is designed to provide a roadmap for further research in the field and to facilitate pursuing and realizing the SDGs.

The book will appeal to researchers and postgraduate students in a variety of disciplines such as architecture, design, economics, social sciences, engineering and sustainability studies. It will also be of significant value to professionals who are engaged in transdisciplinary collaboration that supports sustainable development.

Martina M. Keitsch is Professor for Sustainable Design and PhD Programme Leader at the Department of Design, Faculty of Architecture and Design, Norwegian University of Science and Technology. From 2019 to 2023 she has been appointed Visiting Professor at the Institute of Engineering, Tribhuvan University, Nepal. Keitsch is Project Leader of the NORAD-financed NTNU/IOE project MSESSD 'Energy for Social Sustainability' (http://msessd.ioe.edu.np/) from 2015 through the end of 2020. She is also Project Leader of the DIKU, NORPART-financed project SAMAJ, 'Transdisciplinary Education for a Sustainable Society' (https://www.samaj.online/) from 2019 to 2023. Keitsch has worked for over 20 years in the sustainable development field, mainly with industrial ecology, eco design and architecture, urban planning, stakeholder inclusion and transdisciplinary collaboration, and ethics of sustainability. Keitsch is a member of several scientific committees and a board member of the International Sustainable Development Research Society and the network Women in Design Research. She has been guest editor of four special issues for the journal *Sustainable Development*. Keitsch teaches bachelor's, master's and PhD students and has published several articles on the topics listed. Recent publications cover: sustainability and public space, transdisciplinary collaboration in renewable energy projects, sustainable design and social entrepreneurship and innovation through low carbon city design.

Walter J.V. Vermeulen is based at the Copernicus Institute of Sustainable Development at Utrecht University, Netherlands. He has long-standing experience in analyzing progress in implementing sustainability practices in business in many different countries, both inside companies and in their socio-economic networks. He especially focuses on new forms of private governance in (international) supply chains, in Europe as well as in supplier countries worldwide, and on practices of circular economy. He has also published articles on the essence of the concept of sustainable development and the social dimension and the need for transdisciplinary research. Vermeulen is Past-President of the International Sustainable Development Research Society (isdrs.org). He has also been Programme Leader of the International Master Sustainable Development at Utrecht University. See his publications: www.researchgate.net/profile/Walter_Vermeulen.

Routledge/ISDRS Series in Sustainable Development Research

Series Editors:

Pauline Deutz P.Deutz@hull.ac.uk
Peter Dobers peter.dobers@sh.se

The Routledge/ISDRS Series in Sustainable Development Research is the publishing platform of the wide community of 2500+ researchers engaged in multi-, inter- and transdisciplinary research on the need for and experiences with the transformation to a sustainable society. The International Sustainable Development Research Society aims to disseminate knowledge on sustainable development practices in all spheres of society which enables the acceleration of sustainability initiatives: cities, communities, production, innovation, consumption, biodiversity and ecosystem services, agriculture, climate, renewable energy.

This series welcomes submissions for high-level cutting-edge research books that push thinking about sustainability in new directions by challenging current conceptualizations and developing new ones. The series offers theoretical, methodological, and empirical advances that can be used by professionals and as supplementary reading in courses in sustainability science, environment and sustainability, development studies, planning, and a wide range of academic disciplines.

Titles in this series include:

Transdisciplinarity For Sustainability
Aligning Diverse Practices
Edited by Martina M. Keitsch and Walter J.V. Vermeulen

Transdisciplinarity For Sustainability

Aligning Diverse Practices

Edited by Martina M. Keitsch and Walter J.V. Vermeulen

Routledge
Taylor & Francis Group
LONDON AND NEW YORK

earthscan
from Routledge

First published 2021
by Routledge
2 Park Square, Milton Park, Abingdon, Oxon OX14 4RN

and by Routledge
52 Vanderbilt Avenue, New York, NY 10017

Routledge is an imprint of the Taylor & Francis Group, an informa business

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library

Library of Congress Cataloging-in-Publication Data
A catalog record for this book has been requested

ISBN: 978-0-367-18907-5 (hbk)
ISBN: 978-0-429-19912-7 (ebk)

Typeset in Times New Roman
by Apex CoVantage, LLC

Contents

Figures

Tables

Textboxes

Foreword

The sum is more than the individual parts is a fundamentally important insight that comes from systems theory and can be applied to many different fields – and to the way we read books/texts. Of course, the emphasis on the whole rather than parts does not mean that individual parts are somehow unimportant and should no longer be paid any attention. On the contrary, the net effect of the sum or whole can *only* be produced *because of* the parts – in the sense of how they are connected to each other.

This is particularly true and applicable for the way this new book approaches the relationship between transdisciplinarity (TD) and sustainability research – that is, research into sustainable development challenges. When read from this systems perspective – of the interplay between the sum and the parts – the reader stands to gain some valuable new perspective into why TD is an appropriate methodological response for undertaking sustainability research.

Whether reading the chapters individually or together, the net effect produced by this book is one of offering valuable new understandings and insight into the question of why certain – but not all – sustainability challenges warrant transdisciplinarity research (TDR) approaches. One of the main reasons for achieving this is that, rather than presenting TDR as some sort of a methodological panacea for *all* the sustainability challenges we currently face in the world today, this book rather focuses, as its subtitle indicates, on the aligning of diverse TDR practices.

This need for alignment emerges from a much deeper acknowledgement of and commitment to dealing with, ontologically speaking, very different kinds of contexts – not only in terms of their different spatial–geographic settings (e.g. developed versus developing worlds), but also, very importantly, in terms of the different causal dynamics (cause–effect relations) inherent in the wide range of sustainability challenges we face in the world today.

This pragmatic logic of dealing with TDR from different contextually embedded places and spaces across the world translates in this book into a very rich bottom-up, grounded theory-building approach. This means that some of the major facets of TD's history and its diverse interpretations (Chapter 2), as well as TDR methodology, are dealt with and discussed not purely in the abstract but rather by grounding them in specific contexts. From dealing with existing methodological aspects of principles and tools (Chapter 3), ethics (Chapter 4), frameworks (Chapter 5),

capacity building (Chapter 6) and innovation and problem solving (Chapter 7) to exploring new research areas/horizons such as entrepreneurship (Chapter 8) and emergent research design principles and practices (Chapter 9), topics are all approached in relation to real-life contextual settings.

Rather than being 'thin' on theory, this book follows a grounded theory-building approach that is carried out coherently throughout the book and not only culminates in a good summary in Chapter 11 but also offers a well-constructed weaving together of all the theoretical perspectives developed in the first ten chapters. The reader is ultimately presented with fresh theoretical perspectives of TD as a new, emerging research methodology capable of responding to varied sustainability challenges across the world – characterized by their complexities, uncertainties and unpredictabilities, rather than too many certainties and predictabilities.

Dr John van Breda
Centre for Complex Systems in Transition (CST),
Stellenbosch University (SU), South Africa

Acknowledgements

We would like to express our thanks to all that have enabled us to produce this book, including our chapter authors, reviewers and publishers. They have been good companions in our journey.

Thanks to: Oindrila Bose, Rebecca Brennan, Martin Calisto Friant, Kieran Campbell-Johnston, Helmut Karl Herzberg, Pauline Deutz, Annik Fet, Malin Gawell, Haley Knudson, Thomas Macintyre, Julia Pollacco, Mónica Ramos-Mejía, Lauren Rosenberg, Bijay Singh, Joachim Spangenberg, Kaustubh Thapa, Sigurd Vildåsen and, last but not least, Sjors Witjes.

Contributors

Annik M. Fet is Vice Rector of NTNU in Ålesund. She is also a professor in sustainability with a focus on environmental management, systems engineering and life cycle analysis at NTNU – a position she has held since 1999. From 2014 to 2016, she served as Director and Academic Head of NTNU's Strategic Research Area on Sustainability. Much of her experience comes from working on projects that combine education, research and partnership with industry and municipalities. She has been the leader of numerous national and international research projects within sustainability, the most recent an Erasmus+ project with academic partners in Europe, Africa and Asia. Professor Fet has extensive experience in the maritime sector and has been recognized as a Fellow by the Institute of Marine Engineering, Science and Technology (IMAResT) and is Director of Education and Research for the Norwegian Systems Engineering Council.

Malin Gawell is an associate professor at the School of Social Sciences, Södertörn University, in Stockholm, Sweden. For many years she has studied social entrepreneurship, social enterprises and different types of civil society organizations. Her research includes conceptual as well as empirical studies, many times based on action-oriented collaborative methodologies. Her special interest in entrepreneurial and innovative dynamics, combined with critical analysis, has led to contributions to the field on micro, meso and macro levels of analysis.

Martina M. Keitsch is Professor for Sustainable Design and PhD Programme Leader in the Department of Design, Faculty of Architecture and Design, Norwegian University of Science and Technology. From 2019 to 2023, she has been appointed Visiting Professor at the Institute of Engineering, Tribhuvan University, Nepal. Keitsch is Project Leader of the NORAD-financed NTNU/IOE project MSESSD 'Energy for Social Sustainability' from 2015 through the end of 2020. She is also Project Leader of the DIKU, NORPART-financed project SAMAJ, 'Transdisciplinary Education for a Sustainable Society' from 2019 to 2023. Keitsch has worked for over 20 years in the sustainable development field, mainly with industrial ecology, eco design and architecture, urban planning, stakeholder inclusion and transdisciplinary collaboration, and ethics

of sustainability. Keitsch is a member of several scientific committees and a board member of the International Sustainable Development Research Society and the network Women in Design Research. She has been guest editor of four special issues for the journal *Sustainable Development*. Keitsch teaches bachelor's, master's and PhD students and has published several articles on the topics listed. Recent publications cover: sustainability and public space, transdisciplinary collaboration in renewable energy projects, sustainable design and social entrepreneurship and innovation through low carbon city design.

Haley Knudson is a PhD candidate in the Department of International Business at NTNU – Norwegian University of Science and Technology. Previously, she was a researcher and lecturer in the Department of Industrial Economics and Technology Management on topics of CSR, environmental management, environmental goods trade and sustainable business models. She developed and coordinated the multinational CapSEM – Capacity building in Sustainability & Environmental Management – project along with Professor Annik M. Fet and has participated in many additional national and international research projects.

Thomas Macintyre recently finished his PhD in education and sustainability at Wageningen University, the Netherlands, and is Project Leader at the Colombian Foundation Mentes en Transicion. He lives and works on his agroecological farm in the coffee region of Colombia. His transdisciplinary research activities are based on community learning and action research among grassroots initiatives in Colombia, in the areas of agroecology, food sovereignty, eco-tourism, and local sustainable development. Thomas is committed to learning and working on practical projects with individuals, communities and organizations dedicated to upending the status quo, transgressing unsustainable norms and bringing about a more just, enjoyable and regenerative world.

Mónica Ramos-Mejía holds a PhD in innovation and governance for sustainable development (University of Twente, the Netherlands), an MSc in international development (University of Bath, England) and MSc in industrial engineering (Universidad de los Andes, Colombia). She is interested in the relationship between businesses, ecological sustainability and well-being. She studies organizations and actors that create room for sustainability transitions in production–consumption systems. This includes sustainable entrepreneurship, social innovation and business models for sustainability. She is mainly a qualitative researcher, interested in methods such as action research, ethnography, games-based research, transdisciplinary research and design research.

Lauren Rosenberg lives and works in Burundi, East Africa, and leads a team of 42 full-time employees and 480 seasonal labourers who work for Long Miles Coffee Project (www.longmilescoffeeproject.com). An unplanned visit to Burundi in 2012 sparked a curiosity for learning about coffee production in one of the world's poorest nations; this unexpectedly led to Lauren embarking

on a transdisciplinary PhD research journey that was jointly supervised and nurtured by Utrecht and Stellenbosch Universities.

Bijay Singh is currently a PhD candidate at the Institute of Engineering, Nepal. Despite working as an architect in the construction industry, he soon found he preferred practising at the community level. Bijay lives in Kathmandu, Nepal, where he is involved in different community-based projects that involve collaboration with local stakeholders. He is passionate about doing research on knowledge integration processes in collaborative projects.

Joachim H. Spangenberg is Research Coordinator at the Sustainable Europe Research Institute SERI Germany in Cologne. With a PhD in economics but an academic background in biology and ecology, he is an inter- and transdisciplinary researcher by education and dedication. He works on sustainable development strategies, environmental conflicts, sustainable consumption, biodiversity conservation by pressure reduction, ecosystem services and their valuation with a focus on the limits of economic measurement. Joachim is a member of the Scientific Committee of the European Environment Agency, the Steering Committee of the Ecosystem Services Partnership ESP and the Executive Committee of the International Network of Engineers and Scientists for Global Responsibility INES. For more information, please visit http://seri.academia.edu/JoachimHSpangenberg or www.researchgate.net/profile/Joachim_Spangenberg.

Walter J.V. Vermeulen is based at the Copernicus Institute of Sustainable Development at Utrecht University, Netherlands. He has long-standing experience in analyzing progress in implementing sustainability practices in business in many different countries, both inside companies and in their socio-economic networks. He especially focuses on new forms of private governance in (international) supply chains, in Europe as well as in supplier countries worldwide, and on practices of circular economy. He has also published articles on the essence of the concept of sustainable development and the social dimension and the need for transdisciplinary research. Vermeulen is Past-President of the International Sustainable Development Research Society (isdrs.org). He has also been Programme Leader of the International Master Sustainable Development at Utrecht University. See his publications: www.researchgate.net/profile/Walter_Vermeulen.

Sigurd Vildåsen is a senior researcher at NTNU and SINTEF, Norway. His transdisciplinary research activities are based on project collaboration with actors from the manufacturing industry in the context of the UN Sustainable Development Goals. He works specifically on issues related to circular business models and is involved in the upcoming ISO standard on circular economy (ISO/TC 323). Dr Vildåsen has ten years of experience as a committee and board member in Tekna, Norway's largest society for graduate professionals, and is a national board member of the UN Global Compact. Moreover, he

is an executive board member in the International Sustainable Development Research Society (ISDRS).

Sjors Witjes is Assistant Professor of Corporate Sustainability at Radboud University in the Netherlands. Sjors has been part of corporate sustainability and innovation processes in Europe, Latin America and the US and has supported the United Nations, national governments and standardization organizations to enhance corporate sustainability. In his academic work, Sjors applies TD approaches in his research and education while supporting organizations by reflecting on their contribution to a more sustainable society.

1 Aligning diverse practices of transdisciplinarity for sustainability

Introduction

Martina M. Keitsch and Walter J.V. Vermeulen

> The anthropologist must get up at first light and remain alert until the last of the natives has gone to sleep (even then he sometimes has to watch over their slumber). He must try to pass unnoticed, and yet always be at hand. He must see everything, remember everything, take note of everything. He must be ready to make the most of a humiliating indiscretion, to go to some snotty-nosed urchin and beg for information and keep himself ever in readiness to profit by a moment of complaisance or free-and-easiness. Or, it may well be, for days together a fit of ill humour among the natives will compel him to shut down on his curiosity and simulate a sombre reserve. The investigator eats his heart out in the exercise of his profession: he has abandoned, after all, his environment, his friends, and his habits, spent a considerable amount of money and time, and compromised his health. And the only apparent result is that his presence is forgiven by a handful of wretched people who will soon, in any case, be extinct; whose main occupations are sleeping and picking their lice; and whose whim can decide the success or the failure of his whole enterprise.
>
> (Claude Lévi-Strauss 1972, section 373)

As considerable as this description may sound to many academic field workers, it also depicts the traditional role of a researcher: testing theories, applying methods and gathering findings for the sake of generating new knowledge. However, this volume does not deal with traditional types of research. *Transdisciplinarity for Sustainability: Aligning Diverse Practices* is a book in which researchers across disciplines such as economy, ethics, management, design architecture and social science come together to discuss professional and personal narratives of transdisciplinary research and practice.

The first ideas for this book emerged during the annual conferences of the International Sustainable Development Research Conference in the last few years. In the tracks for Theme 1 of this society, regarding the fundamental approaches of sustainability research, various cases of TD research have been presented, and discussions included questions about communalities and diversity in methodological approaches and their implications. A book focusing on possibilities for aligning such diverse practices thus seems to be welcome in several ways. Contributors to this book draw from a rich body of research to examine the role of

transdisciplinarity and how it can add to realizing sustainable development, with all its challenges and opportunities. The authors of this volume discuss theories, tools, ethics, education and practice, as well as the roles of various stakeholders in concrete collaboration projects.

The book explores how diverse views, values and sources of knowledge in transdisciplinary research, often neglected in traditional academic enquiries, can be a valuable resource for sustainable development. Reference is made to transdisciplinarity in planning, education, environmental management, higher education and social sciences. This includes a discussion on how embedded ideas and values of all stakeholders can promote or impede knowledge generation. Each chapter draws on specific research, describing the context, explaining the methodology and illuminating important findings for transdisciplinarity.

Since researchers and students struggle to get an overview of the diverse discourses, Chapter 2 of this volume elucidates some crucial choices for the research design when applying transdisciplinarity. The chapter refers to sustainability science, which emerged as an interdisciplinary field addressing nature–society metabolism. The authors briefly thematize concepts of multi-, inter- and transdisciplinarity and introduce more recent transdisciplinarity concepts. Transdisciplinarity (TD) goes beyond intra-science collaboration and acknowledges a close collaboration with societal stakeholders. The chapter describes the history of transdisciplinarity, first in various disciplines and second in the field of sustainability science. This discussion also comprises arguments for surpassing interdisciplinarity in the context of sustainability. The authors conclude that overlapping and diverging assumptions in sustainability concepts have implications for the design and implementation of transdisciplinary research.

Chapter 3 discusses methodological features and principles to provide an overview of available tools for transdisciplinary researchers in the field of sustainability science. Transdisciplinary research entails a complex system of knowledge integration and aims for a comprehensive understanding to initiate societal transition towards sustainability. Methods of research address, among others, processes of organizing a network of knowledge carriers. The chapter describes strategic choices on different levels: for the research project, for the portfolio of the researcher and for the research institute. Conclusively, the authors summarize ideas relating to the architecture of an open and flexible transdisciplinary research process. They frame the intertwined cycle of knowledge production in science and interventions in practice and underline the importance of multi-actor collaboration at all levels, by integrating approaches available in methodological literature into a six-step process model for transdisciplinary research. Acknowledging the essential flexibility in the design of TD research processes, they discuss eight key guiding principles to be applied in TD.

The aim of Chapter 4 is to make ethics accessible to transdisciplinarity by presenting a systematic overview of ethical ideas present in TD literature. It discusses transdisciplinary collaboration (TDC) and ethics with a focus on sustainability issues, more specifically questions and challenges related to sustainable planning and design within the limits of ecosystems. The chapter illustrates and analyzes

how concepts can be applied in a TDC process related to sustainability, with the help of an example from planning and design practice in a rural area in Nepal. The chapter suggests an integrative ethical approach to TD and emphasizes two conditions for successful transdisciplinary collaboration: diversity and openness.

Chapter 5 elaborates on the conceptual work underpinning TD by addressing questions on how to conduct a TD project; how to deal with stakeholders; and how to coordinate the internal and external relations of research projects. The chapter presents a bottom-up approach of modifying concepts and identifying gaps, such as the qualifications required to successfully conduct TD research. It describes challenges identified by practitioners over 25 years of TD research in the field of sustainability science. Collecting and discussing TD research experience, the chapter illustrates an innovative way of developing criteria and advice applicable for TD practitioners. Ex-ante (and ongoing) reflection, understanding stakeholder diversity, recognizing projects as agents and comprehending methodological diversity are seen as key elements for dealing with the multiple TD challenges. Adding to the six-step model in Chapter 3, a six-step, step-by-step approach to support successful TD planning and implementation, based on past experience, is conclusively suggested.

In Chapter 6, a transdisciplinary capacity building project is presented in the field of sustainability and environmental management. The goal of this interuniversity project, with partners from Uganda, India, Nepal, Norway, the Netherlands and Portugal, was to develop sustainability and environmental management curricula and industry training seminars that meet local, regional and international needs and to train students, university staff and companies. The chapter introduces a stepwise model of environmental management and sustainability tools to frame the project's activities, which facilitated the cooperation of academics from multiple disciplines for the development of material for academic and practical use. Practical application of environmental management and sustainability methods were made an accessible part of local business capacity with help of case studies. The authors conclude with a recommendation to explicitly implement stakeholder collaboration across partner universities to achieve more extensive TD in capacity building projects.

Chapter 7 further discusses joint knowledge creation in the field of architecture and design. Knowledge is an integral part of innovation and problem-solving strategies. Problem solving is often accompanied by knowledge generation and involves a wide range of disciplines and associating experts. The overall resulting knowledge, often referred to as scientific knowledge, is fundamentally a combination of scientists' expertise, achieved from methodologies in their respective disciplines. The role and contribution of societal knowledge is less recognized, as is the significance of interplay between different knowledge types. This chapter refers to transdisciplinary collaboration to illustrate some of the crucial choices a practitioner in a design project has to make, depending upon the context. The chapter presents challenges associated with knowledge integration, based on four aspirations of transdisciplinary research, and analyzes epistemological challenges by reflecting on the oscillating role of the practitioner in an architecture project in

Nepal. Transdisciplinary characteristics of the project are outlined, and reflective practices in each phase based on the practitioner's transcending role in knowledge generation and integration are evaluated. In conclusion, the importance of reflective practice in sustainability research that aims at transdisciplinary collaboration is highlighted.

Chapter 8 refers to sustainable development in the field of entrepreneurship by presenting a transdisciplinary approach within the field. The chapter starts with a discussion of the historical evolution of entrepreneurship from a transdisciplinary lens and explains that even though the term TD has not yet been used in the field until recently, clear transdisciplinary features are visible and have influenced the evolution of entrepreneurship over time, e.g. through collaboration projects within and beyond the academic sphere. Through an analysis of recent entrepreneurship concepts, the author shows that knowledge generation in the field is significantly influenced by certain types of transdisciplinary collaboration. The chapter concludes by showing that impacts may in practice only be visible over longer terms. It also argues that one needs to view transdisciplinary processes beyond individual projects since substantial problems and complexity are beyond the scope of individual cases. Finally, it observes that processes of transdisciplinary approaches are by definition not smooth, and there are many different actors and aspects that need to be coordinated and integrated.

In Chapter 9, the role of higher education and the types of knowledge production in which researchers engage within sustainability teaching and learning are thematized. The chapter points out that most TD research and practice is designed and evaluated within a developed world context; studies from the developing world are almost non-existent. The author introduces Emergent Transdisciplinary Design Research (ETDR) as a context-relevant methodology for students undertaking TD research in a developing country and presents a case study from rural Burundi, East Africa, to illustrate how ETDR can be operationalized within PhD research. Challenges to conducting TD research as an individual researcher in a high-risk context with low levels of social and educational quality are discussed. The chapter illustrates how societal problems can be tackled in an individual transdisciplinary research effort by using ETDR but also illustrates the dilemmas for young researchers and their academic institutions.

Chapter 10 raises critical questions on knowledge co-production needed for meeting the 2030 agenda for sustainable development and the role that transdisciplinary research plays regarding social sciences. The authors claim that despite the increasing literature on transdisciplinary research, significant practical and ethical issues to realize transdisciplinary research 'in the field' often go unaddressed. They employ a novel dialogical approach to highlight the multi-stranded perspectives. The chapter connects theory and practice through co-author narratives in responding to questions such as *how do underlying assumptions involved in TD research affect the research process?* and *how can TD research lead to enhanced sustainability outcomes in the context of the 2030 agenda?* The chapter reveals inherent tensions and paradoxes of diverse perspectives, values and knowledge systems in society with the aim of introducing TD for sustainability as a reflexive practice that questions taken-for-granted theories, practices and policies.

The brief summary of the chapters demonstrates that transdisciplinarity is a multi-perspective endeavour. The volume intends not just to transgress the boundaries of our disciplines but also to bridge the gap between theory and practice by looking in both directions, towards the efforts of academics to develop sustainable solutions and towards the efforts of practitioners and stakeholders in implementing them. Establishing common ground for transdisciplinary research is challenging. Sources and generation of knowledge are heterogeneous, originating from various fields, such as the natural sciences, social sciences, lay actors and various social sectors. Transdisciplinarity approaches differ, practice is scattered and methodologies are often applied pragmatically. Acknowledging the polyvalent character of transdisciplinarity, this volume illustrates the range and influence of ideas, methods and applications from different academic disciplines rather than presenting a 'how to' guide to transdisciplinarity.

Discussing concepts and implications for research and rich examples of practice, this book will be key reading for postgraduate and doctoral students in sustainability studies and across a range of disciplines, including economy, ethics, management, design, architecture and social science. It will be of interest to academics teaching research methods and developing transdisciplinary research, and to professionals working in transdisciplinary collaboration projects that facilitate sustainable development.

Reference

Claude Lévi-Strauss, Tristes tropiques, translated from the French by John Russell. Publisher, New York, Atheneum. Creation Date, 1972, c1961.

2 History and mapping of transdisciplinary research on sustainable development issues

Dealing with complex problems in times of urgency

Walter J.V. Vermeulen and Sjors Witjes

2.1 Introduction

Transdisciplinarity as a research approach is widely recommended for addressing sustainability issues. Transdisciplinary research practices have emerged in 'sustainability science' as an integrating field of science, as well as in a wide range of disciplines contributing to the analysis and problem solving of the many interrelated issues covered by the concept of sustainable development. These issues include climate change, loss of biodiversity, resource depletion, human health impacts, inequality in labour conditions and distribution of wealth, poverty and societal instability (for more detailed discussion on the concept of sustainable development, see Vermeulen, 2018).

This chapter briefly shows the history of the concept of transdisciplinarity. First, from a wider perspective, it discusses the emergence of the concept of transdisciplinarity in various disciplines. Second, it shows how it has been adopted in the field of sustainability sciences as a core research approach needed to address the persistent and urgent challenges mankind is facing.

Sustainability science itself has been developed as an interdisciplinary field of research addressing the complex nature–society metabolism: human society exploiting social and ecological resources without precautionary attention for the direct, indirect and long-term impacts of this (Vermeulen, 2018). Sustainability sciences, which can be seen as the joint mobilization of insights picked from all relevant branches of the 'tree of wisdom', combine knowledge from the fields of environmental studies, development studies and all available basic disciplines in natural and social sciences. It emerged at the beginning of the 21st century, stressing the sense of urgency of the various persistent sustainability issues, which had previously been studied more in isolation (Kates et al., 2001; Kates, 2002; Parris and Kates, 2003).

Within the context of the second United Nations conference on sustainable development in Johannesburg in 2002, the link was made with an earlier and wider development of scientists calling for academic work to better connect to societal needs, now also framing sustainability sciences as essentially a form of 'transdisciplinary research' (Daschkeit, 2006; Potschin and Haines-Young, 2006; Jerneck

et al., 2010). In the same period, many scientific disciplines developed specialized streams of research addressing sustainability issues as well.

The concept of transdisciplinarity goes back to the 1960s and earlier (Miller et al., 2008; Jahn et al., 2012). One of the original publications on this, by the Austrian-American Erich Jantsch, stressed the need for collaborative forms of science which successfully contribute to solving societal issues, or as he phrased it in those days: adapting universities 'as a means of increasing the capability of society for continuous self-renewal' (Jantsch, 1970, 1972, p. 12). Jantsch introduced the concepts of multidisciplinarity, pluridisciplinarity, crossdisciplinarity, interdisciplinarity and transdisciplinarity in the context of critical debates in sociology of science/philosophy of science on the role of universities in society. This early debate on transdisciplinarity focused on the need to create collaboration between natural sciences, social sciences and humanities and justified the normative approach in scientific work and 'education for self-renewal'. But for a long time, this debate was mostly an intra-academic debate among scientists reflecting and debating their scientific practice. They stressed the need for collaboration for system thinking within sciences, which was first established in so-called more purpose-oriented fields of social sciences (like policy science, urban planning and the earliest programmes addressing environmental problems) (Jantsch, 1970, pp. 416–421). Transdisciplinarity in this context was described as 'coordination of the whole university system toward a common goal' (Jantsch, 1970, p. 413), without any reference to connecting to societal stakeholders yet, rather addressing university administrators.

In this early context, transdisciplinary research was defined as 'the coordination of all disciplines and interdisciplines in the education/innovation system on the basis of a generalized axiomatics (introduced from the purposive level) and an emerging epistemological pattern' (Jantsch, 1972, p. 16). With this emphasis on higher level understanding of complex phenomena, academic education was framed as 'essentially being an important, or even the most important agent of innovation' (Jantsch, 1972, p. 12). In this sociology of science/philosophy of science debate, Jantsch refers to the developmental psychologist Piaget, who in those days introduced the views on four levels of understanding. The fourth-highest level was the 'derived epistemological' level, which was described as 'where all sciences are related to each other, where a generalized epistemology begins to emerge, and where approaches can be unified on the basis of a generalized axiomatics' (Jantsch, 1972, p. 17). In this sense, transdisciplinarity was originally seen as an intra-academic practice: scientists with an understanding at the highest level are delivering the needed societal change. As expressed in Figure 2.1, transdisciplinarity was in these early days about organizing knowledge creation at the most-inclusive epistemological level for the purpose of bringing progress to society. Figure 2.1 shows that scientific knowledge creation addresses both the physical world and the social world. The diverse scientific community, with its main disciplines, is shown as the circle in the middle; the natural sciences are shown at the left and the social sciences and humanities more to the right. The various (mono-)disciplines all separately focus on certain aspects of the real-world phenomena related to the physical and the social world.

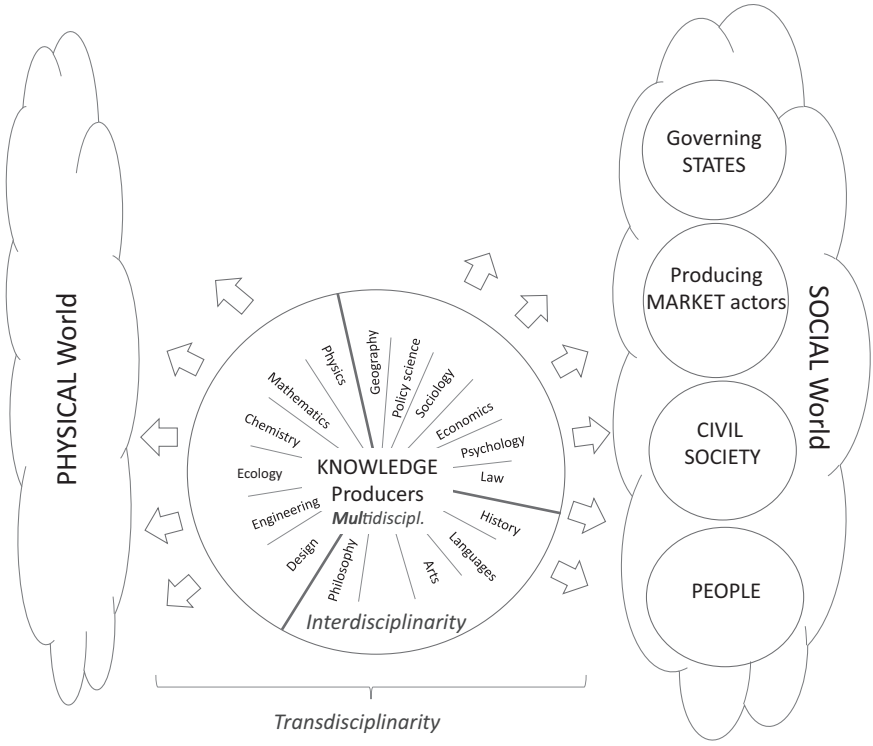


Figure 2.1 Various approaches in connecting scientific disciplines: mono-, multi-, inter- and transdisciplinarity

Multidisciplinarity refers to the connecting knowledge in approaching an issue, using various perceptions of a range of disciplines, while each discipline works in a self-contained manner with little cross-fertilization among disciplines, or synergy in the outcomes. Interdisciplinarity refers to a form of coordinated and integration-oriented collaboration between researchers from different disciplines (Hirsch Hadorn et al., 2008, pp. 428–429; Mauser et al., 2013).[1] In this way, multi- and interdisciplinarity refer to increasing levels of collaboration, while in the view of Jantsch, transdisciplinary research includes the creation of a useful unifying theory. This can be called 'intra-academic transdisciplinarity'.

After these early views, discourses on transdisciplinarity have emerged slowly, in many different disciplines, all oriented towards contributing to solving persistent societal problems. There is a stronger uptake of the concept after the change of the millennium, resulting in more than 12,600 publications (in Scopus) through the end of 2018 (see Figure 2.2).

As mentioned earlier, various social sciences, including psychology and humanities, comprise the largest group adopting the concept (see Figure 2.3), reaching out to their 'research objects' with many forms of 'action research', some also

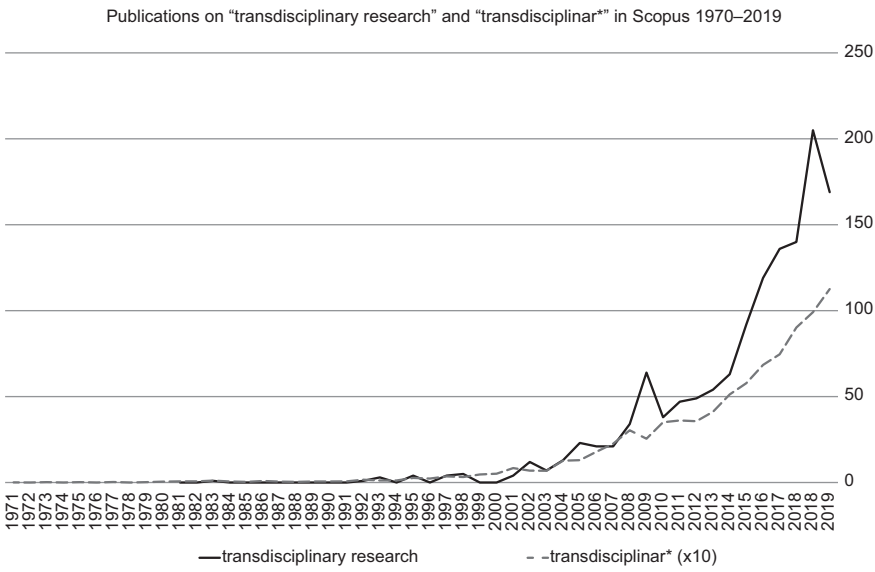


Figure 2.2 Publications on ‘transdisciplinary research’ and ‘transdisciplinar*’ in Scopus 1970–2019

aiming towards empowerment of weaker groups in societies (MacDonald, 2012). The third largest group of researchers is in health-related disciplines where close engagement with users of medical solutions has been elaborated as a form of transdisciplinary research. Also, business and organization-oriented researchers have been active in transdisciplinary forms of research. But the field of sustainability-related sciences is the second largest group in producing such research work (this category includes the Scopus subject areas of energy, environmental science, agricultural and biological sciences and earth and planetary sciences in Figure 2.3).

2.2 The historical development of transdisciplinarity

Zooming in on scholars in sustainability-related sciences, one can see the top ten researchers (see Table 2.1), who are for the most part closely connected and also often publish together.

Transdisciplinarity’s take-off occurred in the first decade of the 21st century, when various books, workshops and conferences set the scene, including the International Transdisciplinarity 2000 Conference organized by ETH Zürich (Klein et al., 2001; Jahn et al., 2012) and a special symposium within the International Sustainable Development Research Society’s (ISDRS) annual conference in June 2005 in Helsinki, resulting in a special issue (Posch and Scholz, 2006; Scholz et al., 2006; Wiiek et al., 2006). The Swiss government strongly supported the development of transdisciplinary research during this period. All of these activities

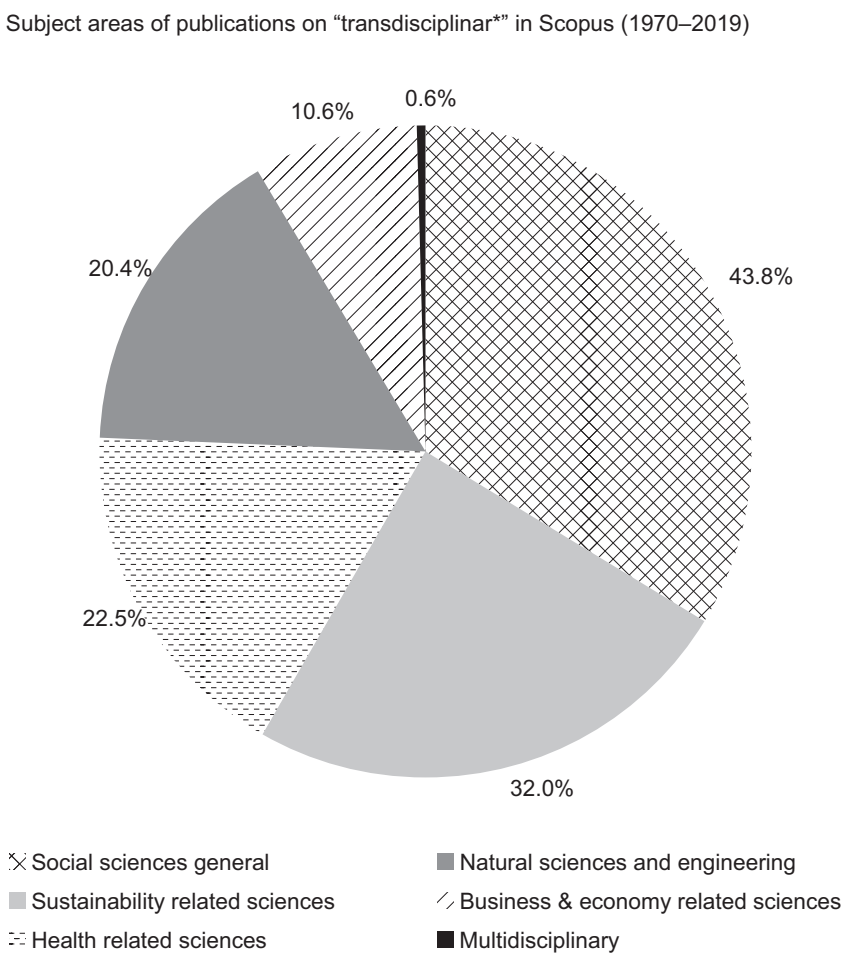


Figure 2.3 Subject areas of publications on 'transdisciplinar*' in Scopus (1970–2019)

have built very strongly on ideas brought forward in the 1990s by sociologists and philosophers of science regarding 'mode 2 science' (Gibbons et al., 1994; Gibbons, 1999; Gibbons and Nowotny, 2001) and 'post-normal science' (Funtowicz and Ravetz, 1994a, 1994b), discussed in section 2.3.

In this period, this earlier intra-academic discourse started to meet practitioners of new transdisciplinary forms of research. Some claim that the take-off of transdisciplinarity is also rooted in the emerging practices of collaborative, open policy and 'co-production' programmes in countries like Switzerland, Denmark and the Netherlands in this period (Thompson Klein, 2004, p. 517), which will be discussed in section 2.3. Table 2.1 shows the main authors in the field and the topics they have examined, partly on the methodology and its implications and

Table 2.1 Top 10 authors in Scopus on transdisciplinarity in the field of sustainability sciences

Rang	*Name*	*Institution*	*# of articles*	*Some main publications*	*Topic area*
1	Scholz, R.W.	ETH Zurich, Switzerland	47	(Laws et al., 2004; Scholz et al., 2006; Sell et al., 2006; Walter et al., 2007; Hansmann et al., 2009; Shiroyama et al., 2012; Yarime et al., 2012)	Methodology of transdisciplinarity; cases in higher education; cases on innovation, forestry, phosphorous
2	Pohl, C.	ETH Zurich, Switzerland	30	(Pohl, 2005, 2008, 2011; Hirsch et al., 2006; Pohl and Hirsch Hadorn, 2007, 2008a; Hirsch Hadorn et al., 2008; Pohl and Hirsch Hadorn, 2008b; Pohl et al., 2010; Wuelser et al., 2012)	Methodology of transdisciplinarity; cases in low income countries
3	Lang, D.J.	Leuphana University of Lüneburg, Germany	29	(Scholz et al., 2006; Lang et al., 2012; Brandt et al., 2013; Withycombe Keeler et al., 2016)	Methodology of transdisciplinarity; cases in higher education
4	Stauffacher, M.	ETH Zurich, Switzerland	24	(Scholz et al., 2006; Lang et al., 2012; Groß and Stauffacher, 2014)	Methodology of transdisciplinarity
5	Wiek, A.	Former ETH Zurich, Switzerland, Arizona State University, USA	19	(Scholz et al., 2006; Walter et al., 2007; Brundiers et al., 2010; Wiek et al., 2011; Lang et al., 2012; Wiek and Iwaniec, 2014; Withycombe Keeler et al., 2016)	Methodology of transdisciplinarity; cases in higher education; impacts of transdisciplinary research
6	Fam, D.	University of Technology, Sydney, Australia	14	(Lopes et al., 2012; Fam and Mitchell, 2013; Mitchell et al., 2015)	Methodology of transdisciplinarity; cases in water management and sanitation
7	Bouma, J.	Wageningen University, NL	13	(Bouma, 2015)	Cases in agricultural sciences
8	Mitchell, R.C.	Brock University, St Catharines, Canada	13	(Carew and Mitchell, 2008; Mitchell and Moore, 2015; Mitchell et al., 2015)	Methodology of transdisciplinarity; cases in water management and sanitation; pedagogy
9	Moore, S.A.	Brock University, St Catharines, Canada	13	(Mitchell and Moore, 2015)	Methodology of transdisciplinarity; cases in higher education; social sustainability; pedagogy
10	Schäpke, N.	Leuphana University of Lüneburg, Lüneburg, Germany	13	(Wittmayer and Schäpke, 2014; Schäpke et al., 2018)	Methodology of transdisciplinarity; cases in sustainable energy

partly presenting examples of its application in the context of various societal challenges. The table shows that many of these scholars are engaged in working towards a shared and elaborated methodology and demonstrates this with examples of various sustainability issues while also reflecting on the new forms of higher education teaching needed for this.

One needs to be careful with this approach of identifying key authors via Scopus, as it may be biased towards richer countries, with their strong academic practices oriented towards journal publication. There are many efforts to position science as a change-maker in African and Latin-American contexts which are not visible through this approach (Hall, 1992, 2005), since little evidence of this can be found by means of an English language-based literature review with Scopus or Web of Science.

2.3 Defining transdisciplinarity

Transdisciplinary researchers in sustainability sciences do not all present the same definitions and practical methods, but a clear common line in the transdisciplinary approach can be identified. It builds on ideas about 'mode 2' and 'post-normal' science. In the first published handbook in this field, Pohl and Hirsch Hadorn stated that transdisciplinary research is needed

> when knowledge about a societally relevant problem field is uncertain, when the concrete nature of problems is disputed, and when there is a great deal at stake for those concerned by problems and involved in dealing with them. Transdisciplinary research deals with problem fields in such a way that it can: (a) grasp the complexity of problems, (b) take into account the diversity of life-world and scientific perceptions of problems, (c) link abstract and case-specific knowledge, and (d) develop knowledge and practices that promote what is perceived to be the common good.
>
> (Pohl and Hirsch Hadorn, 2007)

Also see Hirsch Hadorn et al. (2008), p. 432; Stock and Burton (2011), and in a comparable mode, Lang et al. (2012), pp. 26–27.

This description contains three elements common to the debate on transdisciplinarity, bringing together three major ambitions for scientists who intend to engage universities 'as a means of increasing the capability of society for continuous self-renewal', as cited here. These ambitions relate to challenges of *pluralistic scientific and non-scientific knowledge creation* at a high level of integration; to addressing the features of *'messy' societal problems*; and to dealing with the *urgency and persistency* of (sustainability) challenges. Figure 2.4 illustrates the wider background behind these three ambitions, which will briefly be discussed.

Developments in modes of knowledge production have been fuelled by authors like Jantsch (mentioned earlier) in the 1970s and Gibbons, Funtowicz and Ravetz in the 1980s and 1990s (Funtowicz and Ravetz, 1994b; Gibbons et al., 1994).

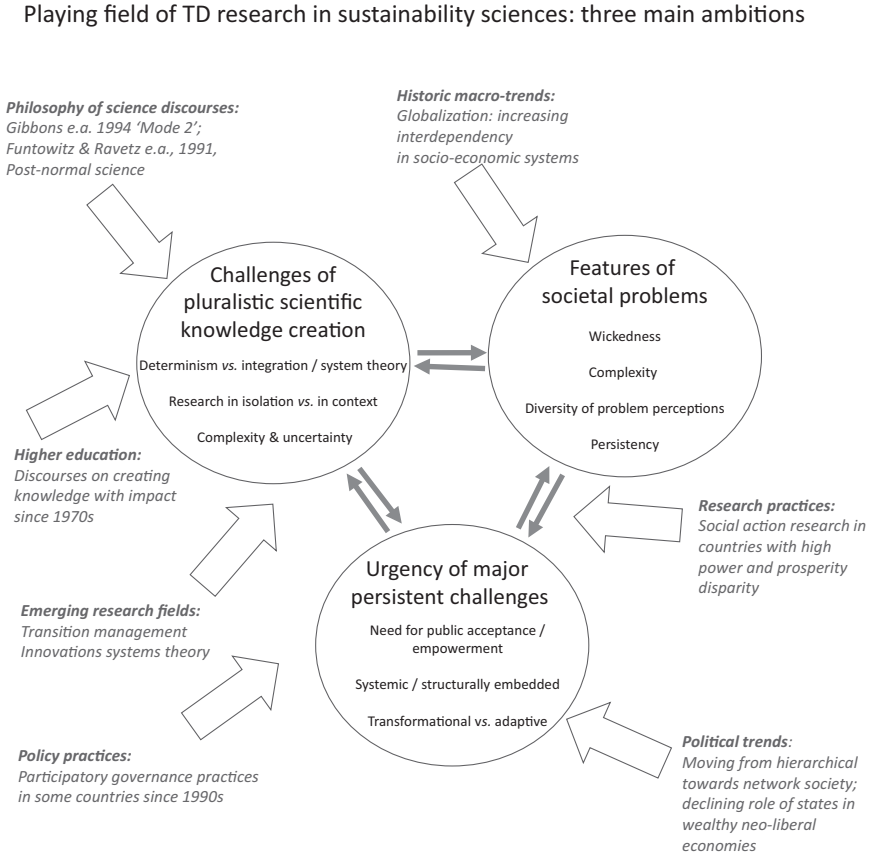


Figure 2.4 Playing field of transdisciplinary research in sustainability sciences: three main ambitions (in black/background sources in blue, italic)

The challenges of *scientific knowledge production* have been stressed by Gibbons, Nowotny and others with 'mode 2 science' – the problem-oriented and interdisciplinary nature of knowledge production in contrast to traditional theory and curiosity-led fundamental knowledge production (Gibbons et al., 1994; Nowotny et al., 2003). They also observed that science is no longer the single domain of academia: many other 'knowledge producers' are playing an essential role in making knowledge useful for societal actors like government and industry. Simultaneously, they argued that the growing role of government funding and industry-oriented research (in the triple helix of nation-state, academia and industry; Etzkowitz and Leydesdorff, 2000) would better explain the development in science and innovation than the orientation on traditional, fundamental and disciplinary 'Mode 1' knowledge production. Such problem-oriented forms of applied

research have been growing both inside and outside universities (research institutes, consultancy etc.). Gibbons et al. framed 'mode 2' explicitly as transdisciplinary, with three main features: 1) problem-solving orientation: having its own practice-related research approaches; and as result of that, 2) communication of results going beyond the (disciplinary) scientific arena, addressing practitioners involved; and 3) different dynamics in its application outside specific disciplines (Gibbons et al., 1994, pp. 4–7). They explicitly refer to the original 'universal theory' ambition of Jantsch and others and observe that such attempts only survived in small scientific niches. They contrast their use of the concept of transdisciplinarity as 'continuous linking and re-linking, in specific clusterings and configurations of knowledge which is brought together on a temporary basis in specific contexts of application' (Gibbons et al., 1994, pp. 27–30), mainly in science and technology-related research fields. Stakeholder involvement is explicitly pursued in their publications for the purpose of getting better shared knowledge.

Funtowicz and Ravetz introduced the concept of 'post-normal science', adding another element to this observed diversity of knowledge producers and practices: the nature of complex problems in practice requires new ways of assessing solutions, especially in the areas where science and policy meet. Responding to traditional forms of risk assessment, they call for new forms of communication about uncertainty and quality assessment, and suggest new forms of extended peer communities (Funtowicz and Ravetz, 1994a, 1994b).

Simultaneously internationalization and globalization of the economic system has contributed to the increasing *complexity of societal problems*. Policy makers are confronted with issues on which stakeholders' views differ fundamentally. They respond from different value sets and worldviews. Solutions for these issues often mutually affect each other, while they are often beyond the scope of power of individual policy makers at national or lower levels of government. These issues are described in the literature with various concepts: 'complex problems', 'messy problems' or 'wicked problems'. They have gained increasing attention in policy science, urban planning, management and design (Rittel and Webber, 1973; Ackoff and Vergara, 1981; Pacanowsky, 1995; Waddock, 1998) as problems for which a purely scientific–engineering approach cannot be applied because of the lack of a clear problem definition and differing perspectives of stakeholders and value judgements (Schwarz and Thompson, 1990).

This view on the nature of sustainability problems has also resonated in many policy projects, starting, in various contexts, in the late 1980s/1990s. One of the key messages for addressing wicked problems has been to engage stakeholders with conflicting interests in the process of policy development and formulation from the start, in so-called open or interactive policy making. Connected to those policy innovations, scholars like Susskind et al. and Friend and Hickling have been actively collaborating in policy making on environmental topics in both the USA and various European countries: they have designed flexible approaches for working in multi-stakeholder settings, collectively engaging in joined problem analysis, creating shared problem perceptions and leading this towards collaborative problem solution (Friend and Hickling, 2005) (see also Acland, 1995;

Healey, 1997; Vermeulen et al., 1997; Susskind et al., 1999). Simultaneously, various scholars (Checkland and Scholes, 1999; Lawrence and Deagen, 2001; Kasemir, 2003; Schwarz, 2005; Kaner et al., 2014) have developed practitioner guides describing collaboration processes as sequences of, first, jointly describing the issue at stake from a diversity of perspectives; and second, integrating these views in a holistic system view, allowing for key causes and connected routes to solutions to be searched for, after which solutions are jointly evaluated and decision-making on implementation is prepared.

In the field of policy science, this has stimulated a special branch of research on participatory policy making, co-production policy, co-creation, open planning, self-governance and interactive governance (OECD, 2001; Singleton, 2002; Abelson et al., 2003; Bulkeley and Mol, 2003). Here the existence of wicked problems is also connected to distributed power of decision-making between actors within organizations or in inter-organizational settings. The practices of participatory policy making have attracted a large deal of attention and critical evaluation research (Steelman and Ascher, 1997; Driessen et al., 2001; Vermeulen, 2002; Bingham et al., 2005). Some of the criticism relates to the observation that creating shared policy agendas in multi-stakeholder settings often still lacks the power of final decision-making and full implementation of the results of such processes (Coenen et al., 1998; see for example Busenberg, 2000).

Such multi-stakeholder governance has been applied in many sub-fields of environmental policy making, also linking it to long-term-oriented innovation policies in which scenario development and long-term planning are combined. By applying methodologies like backcasting, consensus conferences, citizen juries and more (Armour, 1995; Dreborg, 1996; Fixdal, 1997; Faucheux and Hue, 2001; Cuhls, 2003; Quist and Vergragt, 2006), scientists have acted both as knowledge providers and as process architects in joint settings with governmental and societal stakeholders. Some of these practices have addressed extremely complex issues, including sustainability issues on the global scale, such as a global multi-stakeholder project on phosphorous management (Scholz et al., 2013). These participative and anticipatory approaches have also been addressed in the field of management studies (Robinson, 2003; van de Ven and Johnson, 2006).

With increasing upscaling and complexity of sustainability problems, some scholars recently introduced the concept of 'super wicked problems' (Lazarus, 2013). This special class of wicked problem has been described by adding the *notion of urgency*: describing them with four key features: 1) time is running out; 2) those who cause the problem also seek to provide a solution; 3) the central authority needed to address them is weak or non-existent; and 4) irrational discounting occurs that pushes responses into the future (Levin et al., 2012). This feature of urgency is especially relevant in the field of sustainability, where decades of international policy attention have not yet brought the major transitions that are required. On a global policy level, the United Nations framed sustainability as the programme to address persistent environmental problems, reducing still-increasing inequalities and growing ecological, climate and health threats in a

context of growing conflicts and stating that 'we are determined to take the bold and transformative steps which are urgently needed to shift the world on to a sustainable and resilient path' (United Nations, 2015, pp. 5, 8). Comparable global reports stress the same sense of urgency in the areas of climate changes (IPCC, 2014), inequality (Alvaredo et al., 2017), biodiversity (Secretariat of the Convention on Biological Diversity, 2014) and more.

In summary, the three main ambitions inspiring transdisciplinary researchers require them to balance challenges of *scientific knowledge creation* with a high level of integration, while addressing *'messy' societal problems* and also dealing with the *urgency and persistency* of (sustainability) challenges. Transdisciplinary scholars work with diverse combinations of attention for these foci. To use a culinary metaphor, this results in various '*tastes*' *of transdisciplinarity*, adding different doses of these components to their research projects. These tastes can mainly be distinguished by which groups of stakeholders are invited to the 'research table'.

Some scholars focus mostly on *complexity issues* in sustainability sciences and possibly still pursue a unifying theory (Jantsch, 1972; Max-Neef, 2005; Mittelstrass, 2011; Nicolescu, 2012; Mitchell and Moore, 2015), with some engaging in complex modelling. This first group shares the idea of building 'better' models and a higher-level understanding and of enabling the production of future scenarios which allow for (participatory) policy formulation (Rotmans, 1998; Quist and Vergragt, 2006). This 'vintage' taste can be called *intra-academic transdisciplinarity* and also relates to interactive technology foresight. Here, the stakeholder involvement is limited and instrumental, aiming at creating better models (theoretical or used for forecasting and scenario building). Stakeholder involvement is mostly restricted to industrial representatives, sometimes adding civil society organizations, but rarely citizens.

Other scholars stress problem solving and implementation support, closely linked to local, regional, national and sometimes even supranational policy making: this taste can be described as *solution-driven transdisciplinarity*. Also, the in the emerging field of transformational governance and transition management (Smith et al., 2005; Kemp et al., 2007; Geels, 2012; Feola, 2015), stakeholder involvement is more extended – mostly civil society, often industrial representatives, sometime individual citizens.

A third group of scholars stresses empowerment and the need to combat persistent and urgent (social) sustainability issues; for this, they claim that inclusion of non-academic knowledge sources is needed. Some call it transgressive social learning (Lotz-Sisitka et al., 2015). It partly builds on a longer tradition of participatory action research and pedagogy of the poor (Freire, 1970) or, more recently, 'emergent transdisciplinarity' (van Breda and Swilling, 2018). This taste can be labelled as *fairness-driven transdisciplinarity*. Stakeholder involvement here, more than in the other tastes, stresses the involvement often weakly represented citizens and their networks in civil society, while including policy makers but far less often market actors.

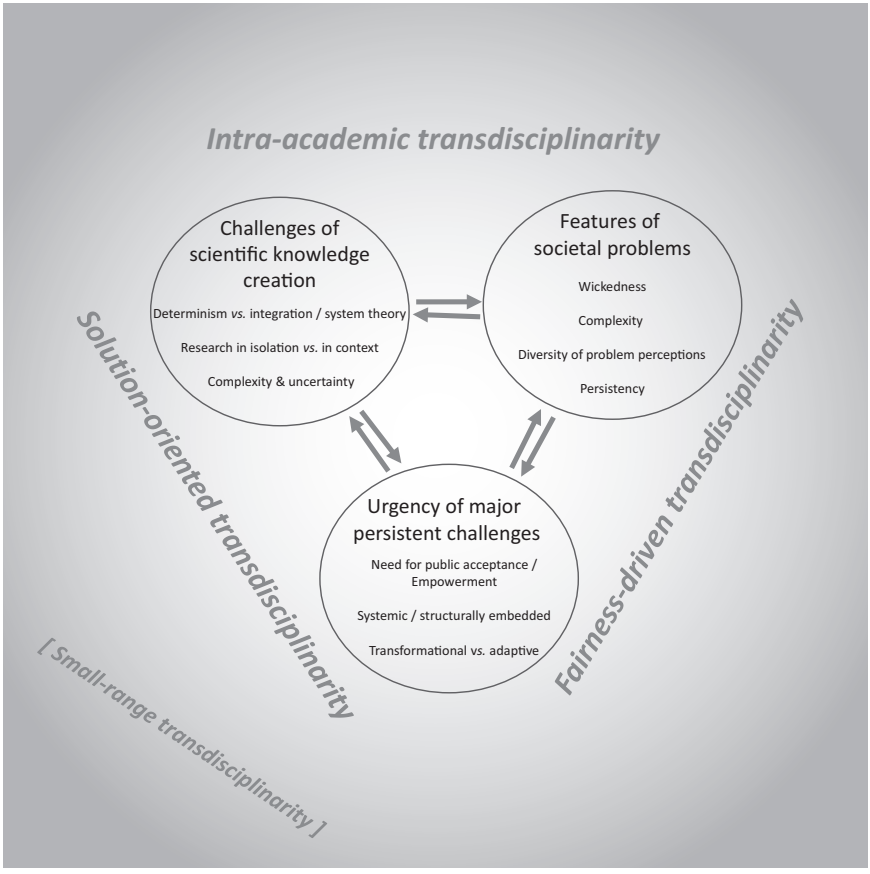


Figure 2.5 Playing field of transdisciplinary research in sustainability sciences: three tastes of transdisciplinarity (+small-range transdisciplinarity)

Using the Figure 2.4, the three 'tastes' can be presented as in Figure 2.5, illustrating that these tastes of transdisciplinarity represent different combinations of ambitions, with differences in aspirational foci. The core of this figure is white and the corners are grey, to indicate diversity in practice, depending on the extent and diversity of non-academic stakeholder involvement in the research process. At the grey borders of the figure would be projects with only few academic and non-academic stakeholders, as in many consultancy projects (small-range transdisciplinarity).

In practice, the concept of transdisciplinarity is used in many cases with weaker connections to the scientific views and ambitions described earlier, but where some form of outreach from academia to users of knowledge and their products exists and is taking place, in more traditional consultancy or client-driven applied research work (see Hirsch Hadorn et al., 2008, p. 33, for an

useful distinction). In such cases, the problem is not as wicked, messy or complex as suggested in the literature discussed previously, and the scope of stakeholder involvement can also be very limited. However, in line with increasing attention by funding agencies for research impact and 'research utilization', they often require direct collaboration with market actors, governments or civil society actors. This taste of transdisciplinarity can be described as *small-range transdisciplinarity*. It links explicitly to the knowledge needs of (some) non-academic actors but is often less complex, less ambitious and less stakeholder-inclusive; even though it may address societal needs, it lacks explicit empowerment ambition. In practice, research funding agencies (on both a national and also supranational level, like EU Horizon 2020) increasingly demand impacts in society, but in the funding application procedures still require very detailed project proposals; these form a barrier for open transdisciplinary research processes, where the research question and approach are part of the process. This leads to serious limitations for transdisciplinarity-oriented researchers (Mitchell et al., 2015; De Jong et al., 2016; Gaziulusoy et al., 2016; Zscheischler et al., 2017)

The main differences between the three tastes are in how, and to what extent, stakeholder involvement is required and organized: that is, what roles are given to stakeholders in the research process.

Comparable classifications of transdisciplinarity are also available in the transdisciplinarity literature. Pohl et al. described three forms of transdisciplinarity which they call 'A', 'B' and 'C' (Pohl, 2011, p. 611). Popa et al. presented a matrix to describe various forms (Popa et al., 2015, p. 250). Max-Neef used a dichotomy, distinguishing strong and weak transdisciplinarity (Max-Neef, 2005). Finally, Balsiger distinguishes between 'soft', 'hard', 'reflexive' and 'inclusive' (Balsiger, 2015).

We can combine these classifications and clarify how they relate to the three tastes by adding in the stakeholder engagement elements. For this, the matrix of Popa et al. (2015) serves as a starting point; in Figure 2.6, an underlying matrix is added to describe the stakeholder engagement.

Using the synthesis of transdisciplinarity discourses in Figure 2.6, the scientific discourse on transdisciplinarity and sustainability can be visualized as moving from the left top corner more towards the bottom right corner, responding to the persistent nature of sustainability issues and the growing need for urgent transformative change. Common elements in the current approaches to transdisciplinarity can be identified, based on what transdisciplinary authors in the right and bottom part of the figure have presented as overall 'architecture' of transdisciplinary research processes. One of the main points of consensus is that no standard set of methods can be described. The key nature of joint knowledge creation for problem solving of sustainability challenges does, according to various scholars, explicitly require flexibility and context adaptiveness in the choice and application of research methods. These schools of researchers proposed methods and tools for the four mains steps in a 'diabolic' process: stakeholders first jointly engage in problem structuring, then proceed in joint systems analysis; this continues with a search for solutions and results in preparing for the application

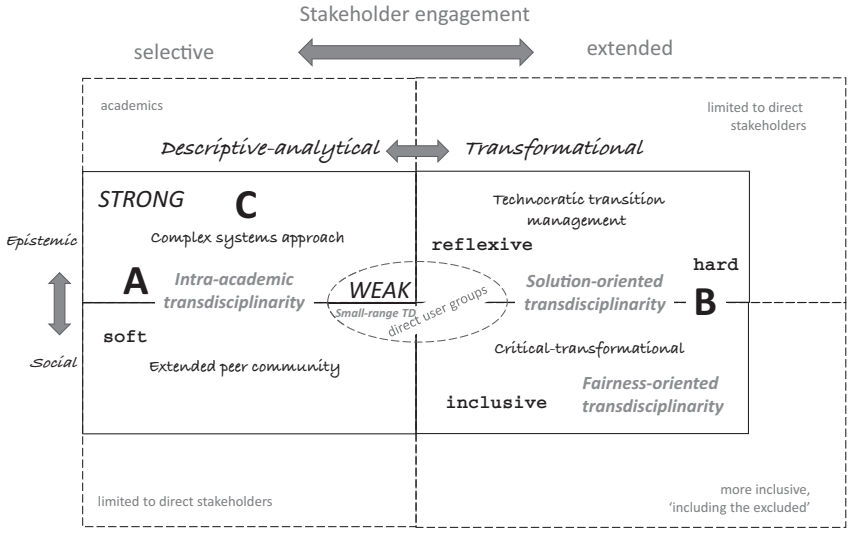


Figure 2.6 Playing field of transdisciplinary research in sustainability sciences: synthesizing typologies of transdisciplinarity (concepts described in text)

of jointly agreed solutions. During these steps, one moves backwards and forwards whenever needed for better understanding or better outcomes (Chapter 3 will further reflect on this). It is essential that the right side of the playing field, as mapped in Figure 2.6, stresses more inclusive and diverse forms of collaboration with non-academic stakeholders.

The next chapter will look more closely at the methods for transdisciplinarity, identifying the main principles (such as multi-actor involvement; iterative design; focus on wicked problems; using abductive reasoning; multi-level learning) and suggesting methods that can be applied for stakeholder engagement to deal with multiple perceptions, worldviews, value systems, collective ideation, selection and choice making.

Note

1 Others also use 'supra-disciplinarity' for all forms of scientific collaboration where the field of a single discipline is transgressed (Balsiger, 2004), or 'super-disciplinarity' while in fact referring to what elsewhere is labelled as interdisciplinarity (examples are Jones, 2009; Anatolevich and Vasilyevna, 2018; Li et al., 2020).

References

Abelson, J. et al. (2003) 'Deliberations about deliberative methods: Issues in the design and evaluation of public participation processes', *Social Science and Medicine*, 57(2), pp. 239–251. doi: 10.1016/S0277-9536(02)00343-X.

Ackoff, R. L. and Vergara, E. (1981) 'Creativity in problem solving and planning: A review', *European Journal of Operational Research*, 7(1), pp. 1–13. doi: 10.1016/0377-2217(81)90044-8.

Acland, A. F. (1995) *Resolving Disputes without Going to Court: A Consumer Guide to Alternative Dispute Resolution*. 2nd revised edition. London, UK: Century.

Alvaredo, F. et al. (2017) *World inequality report*. Berlin: World Inequality Lab.

Anatolevich, M. A. and Vasilyevna, K. N. (2018) 'Methods of teaching interdisciplinary module of physics and Informatics', *Perspektivy Nauki i Obrazovania*, 33(3), pp. 148–156.

Armour, A. (1995) 'The citizens' jury model of public participation: A critical evaluation', in Renn, O., Webler, T., and Wiedemann, P. (eds.) *Fairness and Competence in Citizen Participation: Evaluating Models for Environmental Discourse*. Dordrecht/Boston/London: Kluwer.

Balsiger, J. (2015) 'Transdisciplinarity in the class room? Simulating the co-production of sustainability knowledge', *Futures*, 65(June), pp. 185–194. doi: 10.1016/j.futures.2014.08.005.

Balsiger, P. W. (2004) 'Supradisciplinary research practices: History, objectives and rationale', *Futures*, 36(4), pp. 407–421. doi: 10.1016/j.futures.2003.10.002.

Bingham, L. B., Nabatchi, T. et al. (2005) 'The new governance: Practices and processes for stakeholder and citizen participation in the work of government', *Public Administration Review*, 65(5), pp. 547–558.

Bouma, J. (2015) 'Engaging soil science in transdisciplinary research facing "wicked" problems in the information society', *Soil Science Society of America Journal*, 79(2), p. 454. doi: 10.2136/sssaj2014.11.0470.

Brandt, P. et al. (2013) 'A review of transdisciplinary research in sustainability science', *Ecological Economics*. Elsevier B.V., 92, pp. 1–15. doi: 10.1016/j.ecolecon.2013.04.008.

Brundiers, K., Wiek, A., and Redman, C. L. (2010) 'Real-world learning opportunities in sustainability: From classroom into the real world', *International Journal of Sustainability in Higher Education*, 11(4), pp. 308–324. doi: 10.1108/14676371011077540.

Bulkeley, H. and Mol, A. P. J. (2003) 'Participation and environmental governance', *Environmental Values*, 12(2), pp. 143–154.

Busenberg, G. J. (2000) 'Resources, political support, and citizen participation in environmental policy: A reexamination of conventional wisdom', *Society & Natural Resources*, 13(6), pp. 579–587.

Carew, A. L. and Mitchell, C. A. (2008) 'Teaching sustainability as a contested concept: Capitalizing on variation in engineering educators' conceptions of environmental, social and economic sustainability', *Journal of Cleaner Production*, 16(1), pp. 105–115. doi: 10.1016/j.jclepro.2006.11.004.

Checkland, P. and Scholes, J. (1999) *Soft Systems Methodology in Action*. Chichester: John Wiley & Sons.

Coenen, F. H. J. M., Huitema, D. et al. (1998) *Participation and the Quality of Environmental Decision Making*. Dordrecht/Boston: Kluwer Academic Publishers.

Cuhls, K. (2003) 'From forecasting to foresight processes: New participative foresight activities in Germany', *Journal of Forecasting*, 22(2–3), pp. 93–111.

Daschkeit, A. (2006) 'From scientific environmental research to sustainability science? | [Von der naturwissenschaftlichen umweltforschung zur nachhaltigkeitswissenschaft?]', *GAIA: Ecological Perspectives for Science and Society*, 15(1), pp. 37–43.

De Jong, S. P. L., Wardenaar, T., and Horlings, E. (2016) 'Exploring the promises of transdisciplinary research: A quantitative study of two climate research programmes', *Research Policy*. Elsevier B.V., 45(7), pp. 1397–1409. doi: 10.1016/j.respol.2016.04.008.

Dreborg, K. H. (1996) 'Essence of backcasting', *Futures*, 28(9), pp. 813–828. doi: 10.1016/S0016-3287(96)00044-4.

Driessen, P. P. J. et al. (2001) 'Interactive policy-making: A model of management for public works', *European Journal of Operational Research*, 128, pp. 322–337.

Etzkowitz, H. and Leydesdorff, L. (2000) 'The dynamics of innovation: From national systems and "Mode 2" to a triple helix of university-industry-government relations', *Research Policy*, 29, pp. 109–123. doi: 10.1088/1751-8113/44/8/085201.

Fam, D. M. and Mitchell, C. A. (2013) 'Sustainable innovation in wastewater management: Lessons for nutrient recovery and reuse', *Local Environment*, 18(7), pp. 769–780. doi: 10.1080/13549839.2012.716408.

Faucheux, S. and Hue, C. (2001) 'From irreversibility to participation: Towards a participatory foresight for the governance of collective environmental risks', *Journal of Hazardous Materials*, 86(1–3), pp. 223–243.

Feola, G. (2015) 'Societal transformation in response to global environmental change: A review of emerging concepts', *Ambio*. doi: 10.1007/s13280-014-0582-z.

Fixdal, J. (1997) 'Consensus conferences as extended peer groups', *Science and Public Policy*, 24(6), pp. 366–376.

Freire, P. (1970) *Pedagogy of the Oppressed*. New York, NY: Continuum International Publishing Group Inc.

Friend, J. and Hickling, A. (2005) *Planning under Pressure*. Oxford, England: Elsevier Ltd.

Funtowicz, S. O. and Ravetz, J. R. (1994a) 'The worth of a songbird: Ecological economics as a post-normal science', *Ecological Economics*, 10(3), pp. 197–207. doi: 10.1016/0921-8009(94)90108-2.

Funtowicz, S. O. and Ravetz, J. R. (1994b) 'Uncertainty, complexity and post-normal science', *Environmental Toxicology and Chemistry*, 13(12), pp. 1881–1885.

Gaziulusoy, A. I. et al. (2016) 'Identifying and addressing challenges faced by transdisciplinary research teams in climate change research', *Journal of Cleaner Production*. Elsevier Ltd, 123, pp. 55–64. doi: 10.1016/j.jclepro.2015.08.049.

Geels, F. W. (2012) 'A socio-technical analysis of low-carbon transitions: Introducing the multi-level perspective into transport studies', *Journal of Transport Geography*, 24, pp. 471–482. doi: 10.1016/j.jtrangeo.2012.01.021.

Gibbons, M. (1999) 'Science's new social contract with society', *Nature*, 402(6761supp), pp. C81–C84. doi: 10.1038/35011576.

Gibbons, M. and Nowotny, H. (2001) 'The potential of transdisciplinarity', in *Transdisciplinarity: Joint Problem Solving among Science, Technology, and Society*. Basel: T. Birkhauser, pp. 67–80.

Gibbons, M. et al. (1994) *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: Sage.

Groß, M. and Stauffacher, M. (2014) 'Transdisciplinary environmental science: Problem-oriented projects and strategic research programs', *Interdisciplinary Science Reviews*, 39(4), pp. 299–306. doi: 10.1179/0308018814Z.00000000093.

Hall, B. L. (1992) 'From margins to center? The development and purpose of participatory research', *The American Sociologist*, 23(4), pp. 15–28. doi: 10.1007/BF02691928.

Hall, B. L. (2005) 'In from the cold? Reflections on participatory research from 1970–2005', *Convergence*, 38(1), pp. 5–24.

Hansmann, R. et al. (2009) 'Improving group processes in transdisciplinary case studies for sustainability learning', *International Journal of Sustainability in Higher Education*, 10(1), pp. 33–42. doi: 10.1108/14676370910925235.

Healey, P. (1997) *Collaborative Planning: Shaping Places in Fragmented Societies*. Hampshire, USA: MacMillan Press.

Hirsch Hadorn, G. et al. (2006) 'Implications of transdisciplinarity for sustainable research', *Ecological Economics*, 60, pp. 119–128. doi: 10.1016/j.ecolecon.2005.12.002.

Hirsch Hadorn, G. et al. (2008) 'Handbook of transdisciplinary research', in Hirsch Hadorn, G. et al. (eds.) *Handbook of Transdisciplinary Research*. Dordrecht: Springer Netherlands, p. 506. http://link.springer.com/10.1007/978-1-4020-6699-3_5.

IPCC (2014) *Ocean Systems: Impacts, Adaptation, and Vulnerability: Part A: Global and Sectoral Aspects, Climate Change 2014: Impacts, Adaptation, and Vulnerability: Part A: Global and Sectoral Aspects*. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Edited by Field, C. B. *et al*. Cambridge, UK/New York, NY, USA: Cambridge University Press.

Jahn, T., Bergmann, M., and Keil, F. (2012) 'Transdisciplinarity: Between mainstreaming and marginalization', *Ecological Economics*. Elsevier B.V., 79, pp. 1–10. doi: 10.1016/j.ecolecon.2012.04.017.

Jantsch, E. (1970) 'Inter- and transdisciplinary university: A systems approach to education and innovation', *Policy Sciences*, 1(1), pp. 403–428. doi: 10.1007/BF00145222.

Jantsch, E. (1972) 'Inter- and transdisciplinary university: A systems approach to education and innovation', *Higher Education Quarterly*, 1(1), pp. 7–37. doi: 10.1111/j.1468-2273.1947.tb02067.x.

Jerneck, A. et al. (2010) 'Structuring sustainability science', *Sustainability Science*, 6(1), pp. 69–82. doi: 10.1007/s11625-010-0117-x.

Jones, A. (2009) 'Redisciplining generic attributes: The disciplinary context in focus', *Studies in Higher Education*, 34(1), pp. 85–100. doi: 10.1080/03075070802602018.

Kaner, S. et al. (2014) *Facilitator's Guide to Participatory Decision-Making*. 3rd edition. San Francisco, CA: Jossey-Bass.

Kasemir, B. (2003) *Public Participation in Sustainability Science: A Handbook*. Cambridge, UK: Cambridge University Press.

Kates, R. W. (2002) 'Humboldt's dream, beyond disciplines, and sustainability science: Contested identities in a restructuring academy', *Annals of the Association of American Geographers*, 92(1), pp. 79–81.

Kates, R. W. et al. (2001) 'Sustainability science', *Science*, 292(5517, April 27, 2011), pp. 641–642.

Kemp, R., Loorbach, D., and Rotmans, J. (2007) 'Transition management as a model for managing processes of co-evolution towards sustainable development', *International Journal of Sustainable Development and World Ecology*, 14(1), pp. 78–91. doi: 10.1080/13504500709469709.

Klein, J. T. et al. (2001) *Transdisciplinarity: Joint Problem Solving among Science, Technology, and Society*. Basel: T. Birkhauser.

Lang, D. J. et al. (2012) 'Transdisciplinary research in sustainability science: Practice, principles, and challenges', *Sustainability Science*, 7(S1), pp. 25–43. doi: 10.1007/s11625-011-0149-x.

Lawrence, R. L. and Deagen, D. A. (2001) 'Choosing public participation methods for natural resources: A context-specific guide', *Society & Natural Resources*, 14(10), pp. 857–872.

Laws, D. et al. (2004) 'Expert view on sustainability and technology implementation', *International Journal of Sustainable Development and World Ecology*, 11, pp. 247–261.

Lazarus, R. J. (2013) 'Super wicked problems and climate change', *Cornell Law Review*, 94(July), pp. 1–60.

Levin, K. et al. (2012) 'Overcoming the tragedy of super wicked problems: Constraining our future selves to ameliorate global climate change', *Policy Sciences*, 45(2), pp. 123–152. doi: 10.1007/s11077-012-9151-0.

Lopes, A. M., Fam, D., and Williams, J. (2012) 'Designing sustainable sanitation: Involving design in innovative, transdisciplinary research', *Design Studies*. Elsevier Ltd, 33(3), pp. 298–317. doi: 10.1016/j.destud.2011.08.005.

Lotz-Sisitka, H. et al. (2015) 'Transformative, transgressive social learning: Rethinking higher education pedagogy in times of systemic global dysfunction', *Current Opinion in Environmental Sustainability*. Elsevier B.V., 16, pp. 73–80. doi: 10.1016/j.cosust.2015.07.018.

MacDonald, C. (2012) 'Understanding PAR: A qualitative research methodology.pdf', *Canadian Journal of Action Research*, 13(2), pp. 34–50. file:///C:/Users/Christelle/Downloads/37-ArticleText-89-1-10-20120913.pdf%0Ahttps://pdfs.semanticscholar.org/3b78/ecfe0b4a0a7591d2ea068c71e8ea320ff451.pdf.

Mauser, W. et al. (2013) 'Transdisciplinary global change research: The co-creation of knowledge for sustainability', *Current Opinion in Environmental Sustainability*. Elsevier B.V., 5(3–4), pp. 420–431. doi: 10.1016/j.cosust.2013.07.001.

Max-Neef, M. A. (2005) 'Foundations of transdisciplinarity', *Ecological Economics*, 53(1), pp. 5–16. doi: 10.1016/j.ecolecon.2005.01.014.

Miller, T. R. et al. (2008) 'Epistemological pluralism: Reorganizing interdisciplinary research', *Ecology and Society*, 13(2).

Mitchell, R. C., Cordell, D., and Fam, D. (2015) 'Beginning at the end: The outcome spaces framework to guide purposive transdisciplinary research', *Futures*. Elsevier Ltd, 65, pp. 86–96. doi: 10.1016/j.futures.2014.10.007.

Mitchell, R. C. and Moore, S. A. (2015) *Planetary Praxis & Pedagogy Transdisciplinary Approaches to Environmental Sustainability*. Rotterdam: Sense Publishers.

Mittelstrass, J. (2011) 'On transdisciplinarity', *Trames*, 15(4), pp. 329–338. doi: 10.3176/tr.2011.4.01.

Nicolescu, B. (2012) *Transdisciplinarity and Sustainability*. Lubbock, TX: The ATLAS Publishing.

Nowotny, H., Scott, P., and Gibbons, M. (2003) '"Mode 2" revisited: The new production of knowledge', https://link-springer-com.proxy.library.uu.nl/content/pdf/10.1023%2FA%3A1025505528250.pdf (Accessed February 13, 2019).

OECD (2001) *Citizens as Partners: Information, Consultation and Public Participation in Policy-Making*. doi: 10.1787/9789730063226-ro.

Pacanowsky, M. (1995) 'Team tools for wicked problems', *Organizational Dynamics*, 23(3), pp. 36–51. doi: 10.1016/0090-2616(95)90024-1.

Parris, T. M. and Kates, R. W. (2003) 'Characterizing and measuring sustainable development', *Annual Review of Environment and Resources*, 28(1), pp. 559–586. doi: 10.1146/annurev.energy.28.050302.105551.

Pohl, C. (2005) 'Transdisciplinary collaboration in environmental research', *Futures*, 37(10), pp. 1159–1178. doi: 10.1016/j.futures.2005.02.009.

Pohl, C. (2008) 'From science to policy through transdisciplinary research', *Environmental Science & Policy*, 11(1), pp. 46–53. doi: 10.1016/j.envsci.2007.06.001.

Pohl, C. (2011) 'What is progress in transdisciplinary research?', *Futures*, 43(6), pp. 618–626. doi: 10.1016/j.futures.2011.03.001.

Pohl, C. and Hirsch Hadorn, G. (2007) *Principles for Designing Transdisciplinary Research*. www.transdisciplinarity.ch/Berichte_Publ/principles_in_brief.pdf.

Pohl, C. and Hirsch Hadorn, G. (2008a) 'Core terms in transdisciplinary research', in Hirsh Hadorn, G. et al. (eds.) *Handbook of Transdisciplinary Research*. Dordrecht, Netherlands: Springer, pp. 427–432. doi: 10.1007/978-1-4020-6699-3.

Pohl, C. and Hirsch Hadorn, G. (2008b) 'Methodological challenges of transdisciplinary research', *Natures Sciences Sociétés*, 16(2), pp. 111–121. doi: 10.1051/nss:2008035.

Pohl, C. et al. (2010) 'Researchers' roles in knowledge co-production: Experience from sustainability research in Kenya, Switzerland, Bolivia and Nepal', *Science and Public Policy*, 37(4), pp. 267–281. doi: 10.3152/030234210X496628.

Popa, F., Guillermin, M., and Dedeurwaerdere, T. (2015) 'A pragmatist approach to transdisciplinarity in sustainability research: From complex systems theory to reflexive science', *Futures*. Elsevier Ltd, 65, pp. 45–56. doi: 10.1016/j.futures.2014.02.002.

Posch, A. and Scholz, R. W. (2006) 'Transdisciplinary case studies for sustainability learning', *International Journal of Sustainability in Higher Education*, 7(3). doi: 10.1108/ijshe.2006.24907caa.001.

Potschin, M. and Haines-Young, R. (2006) '"Rio+10", sustainability science and landscape ecology', *Landscape and Urban Planning*, 75(3–4), pp. 162–174. doi: 10.1016/j.landurbplan.2005.03.005.

Quist, J. and Vergragt, P. (2006) 'Past and future of backcasting: The shift to stakeholder participation and a proposal for a methodological framework', *Futures*, 38(9), pp. 1027–1045.

Rittel, H. W. J. and Webber, M. M. (1973) 'Dilemmas in a general theory of planning', *Policy Sciences*, 4(December 1969), pp. 155–169. doi: 10.1007/BF01405730.

Robinson, J. (2003) 'Future subjunctive: Backcasting as social learning', *Futures*, 35(8), pp. 839–856. doi: 10.1016/S0016-3287(03)00039-9.

Rotmans, J. (1998) 'Methods for IA: The challenges and opportunities ahead', *Environmental Modeling and Assessment*, 3, pp. 155–179. doi: 10.1023/A:1019019024003.

Schäpke, N. et al. (2018) 'Labs in the real world: Advancing transdisciplinary research and sustainability transformation: Mapping the field and emerging lines of inquiry', *Gaia*, 27, pp. 8–11. doi: 10.14512/gaia.27.S1.4.

Scholz, R. W. et al. (2006) 'Transdisciplinary case studies as a means of sustainability learning: Historical framework and theory', *International Journal of Sustainability in Higher Education*, 7(3), pp. 226–251. doi: 10.1108/14676370610677829.

Scholz, R. W. et al. (2013) 'Sustainable use of phosphorus: A finite resource', *Science of the Total Environment*, 461–462, pp. 799–803. doi: 10.1016/j.scitotenv.2013.05.043.

Schwarz, R. M. (2005) *The Skilled Facilitator Field Book: Tips, Tools and Tested Methods for Consultants, Managers, Trainers and Coaches*. San Francisco, CA, USA: Jossey-Bass.

Schwarz, R. M. and Thompson, M. (1990) *Divided We Stand: Redefining Politics, Technology and Social Choice*. London/Philadelphia: Harvester Wheatsheaf and University of Pennsylvania Press.

Secretariat of the Convention on Biological Diversity (2014) *Global biodiversity outlook 4*. Montréal.

Sell, J. et al. (2006) 'Decision criteria of European and Latin American market actors for tropical forestry projects providing environmental services', *Ecological Economics*, 58, pp. 17–36. doi: 10.1016/j.ecolecon.2005.05.020.

Shiroyama, H. et al. (2012) 'Governance for sustainability: Knowledge integration and multiactor dimensions in risk management', *Sustainability Science*, 7(suppl. 1), pp. 45–55. doi: 10.1007/s11625-011-0155-z.

Singleton, S. (2002) 'Collaborative environmental planning in the American West: The good, the bad and the ugly', *Environmental Politics*, 11(3), pp. 54–75. doi: 10.1080/714000626.

Smith, A., Stirling, A., and Berkhout, F. (2005) 'The governance of sustainable socio-technical transitions', *Research Policy*, 34(10), pp. 1491–1510. doi: 10.1016/j.respol.2005.07.005.

Steelman, T. A. and Ascher, W. (1997) 'Public involvement methods in natural resource policy making: Advantages, disadvantages and trade-offs', *Policy Sciences*, 30(2), pp. 71–90. doi: 10.1023/a.1004246421974.

Stock, P. and Burton, R. J. F. (2011) 'Defining terms for integrated (multi-inter-trans-disciplinary) sustainability research', *Sustainability*, 3(8), pp. 1090–1113. doi: 10.3390/su3081090.

Susskind, L., McKearnan, S., and Thomas-Larmer, J. (1999) *Consensus Building Handbook: A Comprehensive Guide to Reaching Agreement*. Thousand Oaks, CA: Sage Publications.

Thompson Klein, J. (2004) 'Prospects for transdisciplinarity', *Futures*, 36(4), pp. 515–526. doi: 10.1016/j.futures.2003.10.007.

United Nations (2015) *Transforming our world: The 2030 agenda for sustainable development*. United Nations. doi: 10.1007/s13398-014-0173-7.2.

van Breda, J. and Swilling, M. (2018) 'The guiding logics and principles for designing emergent transdisciplinary research processes: Learning experiences and reflections from a transdisciplinary urban case study in Enkanini informal settlement, South Africa', *Sustainability Science*. Springer, Japan. doi: 10.1007/s11625-018-0606-x.

van de Ven, A. and Johnson, P. E. (2006) 'Knowledge for theory and practice', *Academy of Management Review*, 31(4), pp. 802–821. doi: 10.5465/AMR.2006.22527385.

Vermeulen, W. J. V. (2002) 'Greening production as co-responsibility', in Driessen, P. P. J. and Glasbergen, P. (eds.) *Greening Society: The Paradigm Shift in Dutch Environmental Politics*. Dordrecht: Kluwer Academic Publishers, pp. 67–90. http://link.springer.com/chapter/10.1007/978-94-015-9958-0_4.

Vermeulen, W. J. V. (2018) 'Substantiating the rough consensus on concept of sustainable development as point of departure for indicator development (restricted version)', in Bell, S. and Morse, S. (eds.) *Routledge Handbook of Sustainability Indicators*. London: Routledge, pp. 59–90.

Vermeulen, W. J. V. et al. (1997) *Sustainability as a Challenge*. V101. Den Haag.

Waddock, S. A. (1998) 'Educating holistic professionals in a world of wicked problems', *Sandra A. Waddock To*, 2(1), pp. 40–47. doi: 10.1207/s1532480xads0201.

Walter, A. I. et al. (2007) 'Measuring societal effects of transdisciplinary research projects: Design and application of an evaluation method', *Evaluation and Program Planning*, 30(4), pp. 325–338. doi: 10.1016/j.evalprogplan.2007.08.002.

Wiek, A. and Iwaniec, D. (2014) 'Quality criteria for visions and visioning in sustainability science', *Sustainability Science*, 9(4), pp. 497–512. doi: 10.1007/s11625-013-0208-6.

Wiek, A., Withycombe, L., and Redman, C. L. (2011) 'Key competencies in sustainability: A reference framework for academic program development', *Sustainability Science*, 6(2), pp. 203–218. doi: 10.1007/s11625-011-0132-6.

Wiek, A. et al. (2006) 'Learning to research environmental problems from a functional socio-cultural constructivism perspective', *International Journal of Sustainability in Higher Education*, 7(3), pp. 252–275. doi: 10.1108/14676370610677838.

Withycombe Keeler, L. et al. (2016) 'Utilizing international networks for accelerating research and learning in transformational sustainability science', *Sustainability Science*, 11(5), pp. 749–762. doi: 10.1007/s11625-016-0364-6.

Wittmayer, J. M. and Schäpke, N. (2014) 'Action, research and participation: Roles of researchers in sustainability transitions', *Sustainability Science*, 9(4), pp. 483–496. doi: 10.1007/s11625-014-0258-4.

Wuelser, G., Pohl, C., and Hadorn, G. H. (2012) 'Structuring complexity for tailoring research contributions to sustainable development: A framework', *Sustainability Science*, 7(1), pp. 81–93. doi: 10.1007/s11625-011-0143-3.

Yarime, M. et al. (2012) 'Establishing sustainability science in higher education institutions: Towards an integration of academic development, institutionalization, and stakeholder collaborations', *Sustainability Science*, 7(suppl. 1), pp. 101–113. doi: 10.1007/s11625-012-0157-5.

Zscheischler, J., Rogga, S., and Busse, M. (2017) 'The adoption and implementation of transdisciplinary research in the field of land-use science-A comparative case study', *Sustainability (Switzerland)*, 9(11). doi: 10.3390/su9111926.

3 Transdisciplinary research

Approaches and methodological principles

Sjors Witjes and Walter J.V. Vermeulen

3.1 Introduction

Transdisciplinary research is grounded in a pluralist epistemology (Söderbaum, 2009; Vildåsen et al., 2017) that asserts the role of multiple values and ideologies in knowledge creation (Hessels and van Lente, 2008). By the co-production of knowledge between academics and non-academics (Pohl et al., 2010), transdisciplinary research aims at meaningful outcomes for both science and society. In Chapter 2, we described various 'tastes' in transdisciplinary research, which balance three distinct ambitions in different ways: complex system knowledge integration; addressing the persistency of wicked societal problems; and empowerment in the light of urgent transformational challenges. These ambitions each share the need to connect academic and non-academic actors in the process of producing applicable knowledge in the context of urgent sustainability challenges. Transdisciplinary research, therefore, pushes scientific research to leave the academic arena with an exclusive academic research culture and aims to search for direct contributions to societal transitions by applying co-production of knowledge with non-academic stakeholders. The contribution of scientific research to societal challenges raises expectations on, among others, the role of scientific work (Carayannis et al., 2016; Gibbons et al., 1994; Hessels and van Lente, 2008; see also the discussion on 'mode 1' knowledge production in Chapter 2). In this third chapter, we address the methodological implications of transdisciplinary research. For this, we first need to reflect on the contextual practice of transdisciplinary research.

Traditional scientific research approaches leading to 'mode 1' knowledge creation, as explained in Chapter 2, entail experimental research or validation of theory describing isolated phenomena, based on quantitative measurements providing merely statistical evidence. Also required is qualitative research, where researchers position themselves as external spectators of social phenomena (see opening quote in Chapter 1), while assuring the need for internal or external validity. Standard academic trajectories (i.e. funded research projects executed by professors, post-docs or PhDs) aiming at 'mode 1' knowledge creation merely operate in prearranged teams, working on a predefined scope and to a strict time plan, due to predetermined financial budgets and the empirical cycle (Hessels and

van Lente, 2008). In contrast to this, transdisciplinary research, while contributing to societal transitions, looks for answers to societal problems or challenges using knowledge of non-academic actors in addition to academic actors' knowledge. Transdisciplinary research, therefore, aims for both construct and field validity, thus going beyond traditional formal scientific evidence (Cash et al., 2003; Jahn et al., 2012; Pohl and Hirsch Hadorn, 2008). Merging knowledge from different actors creates enhanced understanding of the societal problems and challenges necessary for making strategic decisions to start a process of change that contributes to the societal transition at hand.

Exposure to different sources of knowledge requires researchers to be receptive to alternative mono-, inter- and/or multidisciplinary perspectives, and able to coordinate the change process that transdisciplinarity entails. This brings them into dual positions: they are both *experts* and *knowledge brokers*. Consequently, transdisciplinary researchers collect, value and integrate the knowledge needed to lead the transdisciplinary research to contribute to societal changes (Lopes and Videira, 2019; Zscheischler et al., 2017). In practice, transdisciplinary researchers also work with external funding or combine research with education, matching demands from a diverse group of stakeholders (e.g. scientific funding bodies, private funding bodies, educational bodies; Campbell et al., 2015; Wiek and Lang, 2016). Thus, transdisciplinary research projects are confronted by complex and sometimes even strict time planning in order to comply with the demands of the different stakeholders.

To enable contribution to societal challenges, transdisciplinary research entails a research approach that is broader than the individual research projects themselves: it is about the (portfolio of) research projects that generate knowledge on the societal challenge at hand, the roles that different actors play and the research strategy that is applied. For some examples of academic institutions that aim to contribute to societal issues through their transdisciplinary research portfolios and projects, see Sue McGregor's work on transversities (McGregor and Volckmann, 2013). For discussing methods, as seen from this context of the research practice of transdisciplinary scholars, we need to zoom out from individual research projects with their particular goals and aims to the wider research strategy of transdisciplinary researchers and their institutes, aiming at contribution to challenges in society at large. Transdisciplinary research, especially when going from selective to extended stakeholder engagement, is multi-levelled (see Figure 3.1): a single transdisciplinary project research even of limited scope can contribute to broad societal challenges when the single project outcomes are reflected in a broader portfolio of transdisciplinary projects or even a transdisciplinary research institute strategy. A consistent and/or coherent linking of goal and scope of transdisciplinary research between these levels enables a successful contribution to societal challenges and multidisciplinary knowledge creation as well as to methodological knowledge and experience built up on how to execute transdisciplinary research scientifically. Moreover, a clear vision and strategy on transdisciplinary research from the institute can help to generate synergy between the projects within the portfolio and, therefore, further the success of the contribution to societal issues.

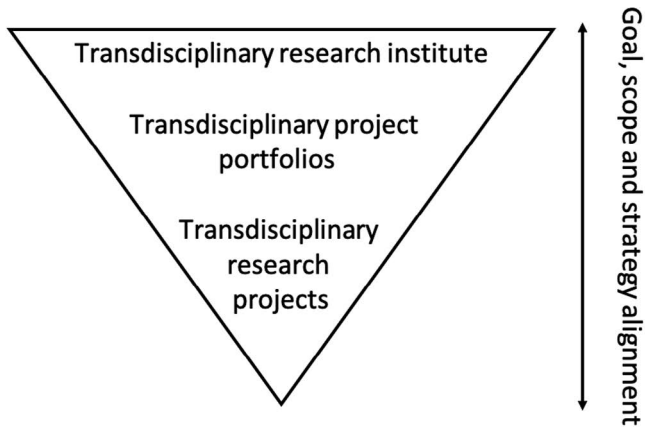


Figure 3.1 The multi-level perspective on transdisciplinary research

The methods applied for transdisciplinary research entail more than the process of data collection, data analysis, etc. It is also the process of organizing the network of necessary knowledge carriers – the academic and non-academic actors – and the strategic choices that lead to a contribution to societal developments of the transdisciplinary research project, the transdisciplinary project portfolio or the transdisciplinary research institute. This has implications for the research tools applied in transdisciplinary research while aiming for a contribution to meaningful outcomes for practice and science. In the next section, we will first discuss the commonly shared ideas on the architecture of such open and flexible transdisciplinary research processes, and then in section 3.3 we will discuss the main methodological principles applied in transdisciplinary research. In section 3.4, we will give an overview of available transdisciplinary tools. The chapter will conclude with some considerations.

3.2 A flexible and open process organization

Transdisciplinary research consists of tools and methods that integrate a thorough process of knowledge production and a connected creative process of developing interventions in a given system. Consequently, transdisciplinary research consists of two supporting cycles (see Figure 3.2): the scientific cycle of the production of knowledge based on curiosity (i.e. leading to meaningful outcomes for science), and the practical cycle of the development of interventions for societal problems (i.e. leading to meaningful outcomes for practice).

3.2.1 The scientific cycle of transdisciplinarity

A tension between creativity and verification lies at the heart of most theories of scientific inquiry. Creativity and verification play complementary roles in different

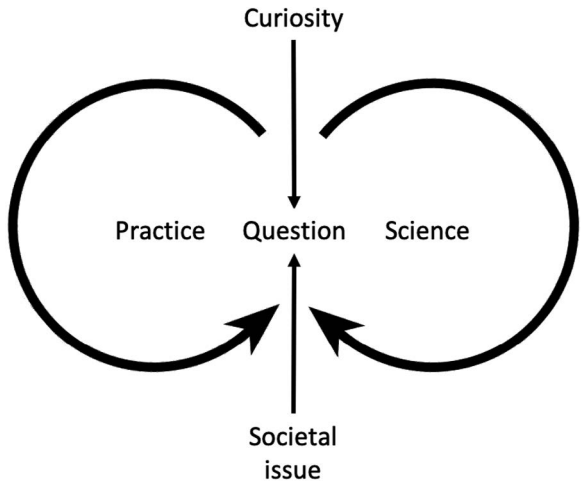


Figure 3.2 The intertwined cycle of transdisciplinary research: the practical and the scientific cycle

stages of the scientific process. Creative processes benefit from having a reliable knowledge base, which is something that the verification process in the scientific cycle helps to establish. The 'empirical cycle of growth of knowledge' developed by (Groot, 1994; Groot and Spiekerman, 1969) defines empirical research as mainly based on a cycle which starts with a *question* originating from curiosity (for example, from the need for enhanced understanding) and then follows the steps of theory, hypotheses, method, data, analysis, discussion and conclusion (see Figure 3.3). The quest for new knowledge is first reflected upon by reviewing the literature for *theory* at hand, resulting in *hypotheses* that could give direction for finding an answer to the research question (Knight and Cross, 2012).

> The construction of hypotheses about possible associations in reality is principally considered a 'free' activity. . . . Only when this freedom is respected will room remain for the brilliant insight, for the imagination of the researcher.
>
> (de Groot and Spiekerman (1969) as cited by Wagenmakers et al., 2018)

The *method* that will guide the collection, *analysis* and synthesis of the research *data* ensures the quality of the data and enables the critical representation of the research data. The *discussion* explains the contribution to science of the research, which is supported by reflecting on the synthesis of the research data in light of debates in literature related to the research. The *conclusion* of the research on content as well as method gives responses to the research question. Consequently, the inductive assessment of the outcome results in an updated knowledge base, after which the empirical cycle starts anew (Wagenmakers et al., 2018). The knowledge

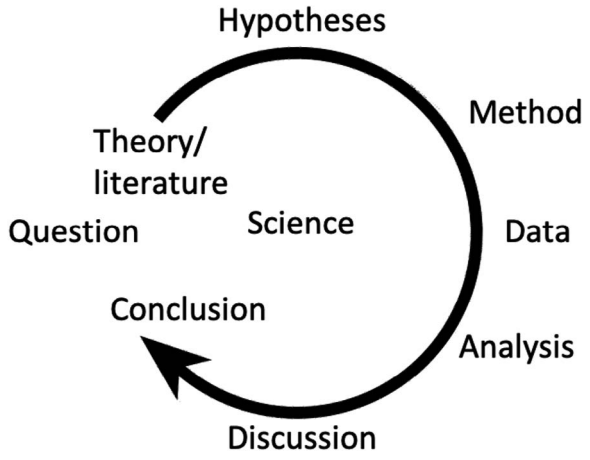


Figure 3.3 The empirical cycle based on de Groot (Groot, 1994; Groot and Spiekerman, 1969)

produced by this empirical research cycle contributes to 'mode 1' knowledge production and is useful for validating or to some extent even generalizing knowledge (e.g. theories, models).

Collaborative transdisciplinarity aiming at co-production of practical and scientific knowledge is becoming more common in the philosophy of science and the management discipline (Balsiger, 2015). With ongoing societal challenges, there is a demand for continuous development of multidisciplinary theories (Lang et al., 2012; Pohl et al., 2010). Efforts to understand ongoing societal developments, with their very high levels of uncertainty, have disclosed the limitations of conventional scientific mono-, inter- and even multidisciplinary approaches to theory testing. Already available research from mono-, inter- and multidisciplinary research based on the collaboration between academic actors reflecting on societal developments from different perspectives also creates an applicable knowledge base for transdisciplinary research. Consequently, transdisciplinary research is still in the 'mode 1' production of knowledge, as discussed in Chapter 2, and therefore the collaboration between academic actors from different disciplinary backgrounds is key for the success of transdisciplinarity.

As transdisciplinary research starts from a societal challenge, the curiosity and research question are directly linked to a question of societal actors. Transdisciplinary research is driven by the empirical cycle of knowledge creation in academia and a practical cycle of developing new options for societal problems. It is the combination or linking of these two cycles of science and practice that enables transdisciplinarity to produce new knowledge and develop interventions to contribute to societal challenges. These joint cycles correspond to what Lang et al. (2012) call the societal practice pathways and the scientific practice of transdisciplinary research: the practice cycle is pledged to the exploration of new options

for solving societal challenges and questions; the scientific cycle is pledged to the production of knowledge by developing multi- and interdisciplinary approaches, transdisciplinary research methods and general insights related to the field of the societal challenge. Linking both cycles is crucial for transdisciplinary research (Bergmann et al., 2010) to contribute to meaningful outcomes for the practical and scientific question at stake but, most importantly, to contribute to the societal challenge.

3.2.2 The practical cycle of transdisciplinarity

The practical cycle starts with the identification and description of the real-world problem, formulating agreed upon, societally relevant questions and building a team or consortium (Lang et al., 2012) for identifying and developing possible interventions. After the application of these interventions, the evaluation phase shows whether the practical question at hand has been answered. Depending on the choice for the transdisciplinary taste (see Figure 2.6), the evaluation of the interventions is on a project, portfolio or institute level. As such, the meaningful outcomes for practice and science are evaluated based on their contribution, using societally relevant questions (i.e. project or portfolio) or societal challenges (i.e. portfolio or institute).

In this way, doing transdisciplinary research links closely to design thinking, the theory of inventive problem or systematic innovation. This link is supported by sustainability scholars from other social science backgrounds (for example, Escobar, 2011, 2018 – anthropology; Welsh and Dehler, 2012 – management education; Kuijer, 2014 – social practice theory), presenting design theory and practice with the aim of channelling design's world-making capacity towards a more sustainable society. Design theory aims to put knowledge to work to get the right solution to the problem. Or, as Von Oech (1983, p. 38) puts it:

> Knowledge is the stuff from which new ideas are made. Nonetheless, knowledge alone won't make a person creative. I think that we've all known people who knew lots of facts and nothing creative happened. Their knowledge just sat in their crania because they didn't think about what they knew in any new ways. Thus, the real key to being creative lies in what we do with our knowledge.

Design thinking, as an activity of solving complex problems (Buchanan, 1992), can be understood through the search skills of information, creation and organization of knowledge, decision-making, learning and problem solving. Design thinking is a set of mental processes aimed at interventions to solve complex problems, in particular social sciences (Buchanan, 1992). Design thinking challenges the traditional line of analytical thinking that fragments the processes and examines them by specificity. Design thinking involves dynamic processes characterized by collaborative and systemic views, integrating interdisciplinary elements and knowledge, and is, therefore, apt to be applied in a transdisciplinary

research approach to support the process of transforming the knowledge produced in the scientific cycle into interventions. The usefulness of these contributions to practice serve as feedback of the usefulness of scientific knowledge (Boland and Collopy, 2004; Nobre and Biscaia, 2015).

One of the common ways of describing the design thinking process is as consisting of four steps with iteration loops (Cross, 2011; Mueller-Roterberg, 2018; see Figure 3.4):

1 *Exploration*

In this first step, a collaboration between stakeholders (i.e. problem owners as well as actors engaged in solving the issue at hand) aims at understanding the question and the underlying societal issue. In transdisciplinary research, the knowledge from the scientific cycle contributes to this understanding;

2 *Idea/concept generation*

In this second step, the collaboration between different stakeholders starts with generating ideas on potential interventions. The concepts developed are at a draft stage, detailed enough to be assessed in the next step;

3 *Evaluation*

In this third step, a reflection between the actors leads to an assessment and selection of the draft intervention possibilities, leading to a limited number of concepts that will be developed and selected for possible application. The collective understanding of the question and underlying issue coming from the scientific cycle and the first step, exploration, is used for setting the assessment criteria;

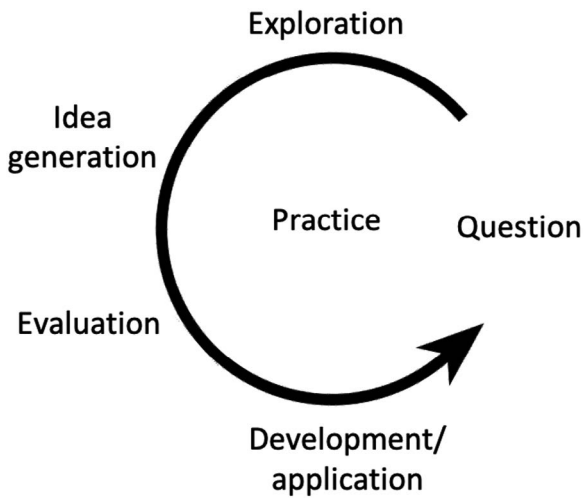


Figure 3.4 The practice cycle

4 *Definite development and application*

In this final step, the selected intervention will be made final through detailed drawings, prototypes, plans, details, specifications, etc., and the interventions will be applied.

3.2.3 The integrated cycle of transdisciplinary research

By combining the practical and scientific cycle, transdisciplinary research is not just about advancing scientific understanding or theory; it launches the assumption that scientific knowledge created by academic actors, together with knowledge of non-academic actors, is by itself a powerful agent of change, placing science at the centre of transformative changes (Moser, 2016). Thus, transdisciplinary research often requires coping with different interpretations of the core concept of 'transformation' across disciplines, groups of actors with their sectorial, regional or even cultural specificities, as well as with the very understanding of science and its role in society.

When combining the practical and scientific cycles (see Figure 3.5) from a multi-actor and collaboration view, the real-world problem should be translated into a boundary object (see e.g. Clark et al., 2016) that is both researchable and allows for the re-integration of the insights into the scientific body of knowledge as well as interventions in practice (Lang et al., 2012). Curiosity and the societal issue at hand drive the question as a centre focus. The combination of both cycles implies that academic and non-academic actors together have to go through both cycles in order to reach meaningful outcomes for practice and science.

Multi-actor collaboration during transdisciplinary research has consequences for the scientific cycle of knowledge development as well as for the practical

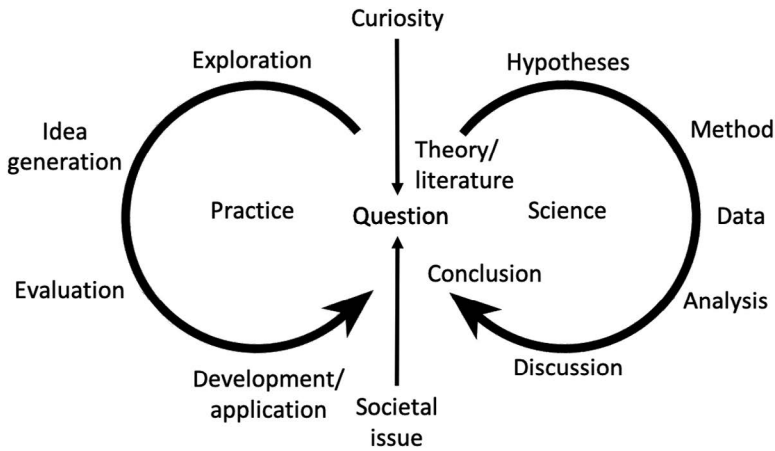


Figure 3.5 The cycle of transdisciplinary research

cycle of intervention development: for example, theory development in transdisciplinary research values knowledge from science, as well as practice creating a broader basis for hypothesis development. The consequences for methods and transdisciplinary research tools can be found in the next sections. The analysis and discussion of the research data consist of a collaborative reflective process aimed at field validity: the fact that the research outcomes can be used by the academic actors facing the societal issue. The enhanced understanding by the academic and non-academic actors of the societal issue coming from the scientific cycle is used to explore and generate intervention ideas or concepts collectively. Consequently, the evaluation of these intervention options is performed from both a scientific and a practical perspective, confirming the practical usefulness of the knowledge created in the scientific cycle. Finally, the continuous collaboration between academic and non-academic actors (see Figure 3.6) in the application of the interventions ensures the input for the scientific cycle as to whether field validity has effectively worked; this makes the transdisciplinary cycle a continuous process of learning of the creation of knowledge and interventions to contribute to societal challenges.

In the continuous collaboration throughout the transdisciplinary research process, it is essential that key decision-makers are continuously attached to this double cyclical process so that implementation of the developed interventions in society is ensured. For the transdisciplinary researchers themselves, being one of the principal actors requires them to deal with the paradox between focusing on the content and focusing on the coordination of the project and its actors: while

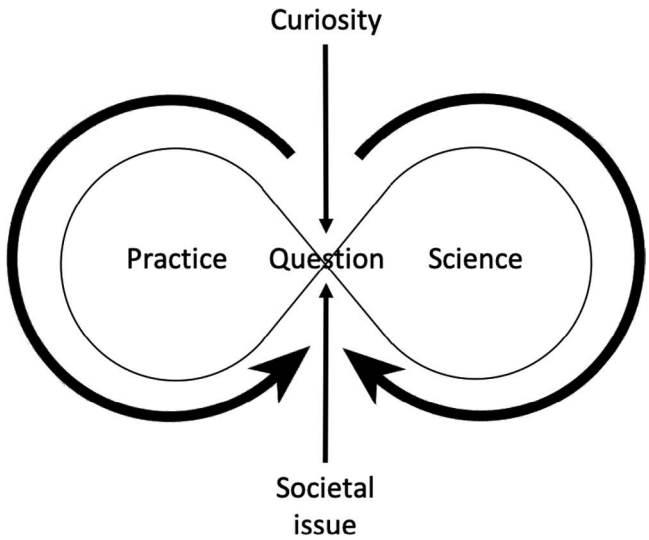


Figure 3.6 The continuous collaboration between academic and non-academic actors to ensure the transdisciplinary research process

contributing to the development of knowledge and/or interventions, the transdisciplinary researcher is the main actor responsible for coordinating the overall process, including project and time management, to ensure the collaboration between the different actors.

This also depends on the type of transdisciplinary research: for example, small range transdisciplinarity (see section 2.3) involves a limited group of actors. The coupling of both cycles enables the enrichment of scientific theory based on 'mode 1' knowledge production with field theory coming from stakeholders' experiences in practice. Theory development in transdisciplinary research is based on validated and non-validated (experience) knowledge. Consequently, the validation of knowledge is based on the successful usage of the outcomes of the transdisciplinary research in practice instead of internal/external validity as is the case with 'mode 1' knowledge creation. Due to the multi-level character of transdisciplinary research, there should be a multi-level validation check: what is meaningful within a project should be checked on a research portfolio and institutional level as well. Transdisciplinary research of both the practical and scientific cycle implies a synchronization of the scientific method and practical experiment/idea generation for the intervention to be successful.

3.3 The process steps of transdisciplinary research

As the integration of both cycles from Figure 3.6 is necessary for transdisciplinary research to reach its aim, we present a six-step model for transdisciplinary research, enabling the co-creation and designing of meaningful outcomes for practice and science contributing to societal challenges:

1 *Research vision and strategy*

   Considering the research portfolio of and the contribution to the societal challenge, the researcher or research institute aims to define the goal and scope of the project at hand. The development of the research vision and strategy includes aligning demands from academic and non-academic actors;

2 *Problem exploration and structuring*

   The goal and scope of the transdisciplinary research project is explored and detailed by collaborating with direct actors facing the societal challenge. The hunch (i.e. abduction) of academic and non-academic actors related to this step of the transdisciplinary research is crucial;

3 *System understanding*

   Based on the problem addressed by the project team, the application of grounded theory leads to an exploration in practice and theory. An enhanced understanding of the system as a whole clarifies challenges considering the scope and goal of the project;

4 *Search and compare solutions*

A creative process with different actors, based on the understanding of the full system, leads to the design and comparison of solutions for the problem or challenge at hand;

5 *Choose, decide and prepare for application*

After the selection of the direction of the solution, the strategic, tactic and operational activities are set up to apply and implement the solution;

6 *Synthesis and feedback with overall vision and strategy*

In this final step, the meaningfulness of the outcomes of the project and the contribution to society and science is discussed at the content, process and strategy levels: did the project contribute to meeting the specific societal problem? Did the project outcomes advance debates in literature on the topic and/or the methodological approach? And did the project support the strategy of the transdisciplinary researcher and/or transdisciplinary research institute to directly contribute to the sustainable development of society? See here the link back to step 1.

Following these six steps, a transdisciplinary research architecture includes strategic questioning at multiple levels (project, portfolio and institute; see Figure 3.1), connecting the vision of the academic institution regarding its contribution to societal challenges to the specific projects. To offer guidance on the generation of meaningful outcomes for science and practice in the collaborative process between academic and non-academic actors, the overall transdisciplinary architecture discussed in Chapter 2 enables us to identify a common approach, at least for *intra-academic transdisciplinarity* and *fairness-driven transdisciplinarity*, with their stakeholder engagement aiming for commitment, creation and/or empowerment. The six steps described allow us to synthesize various suggested approaches in literature. A widely known Swiss–Austrian group of scholars described the generation of meaningful outcomes for science and practice as a combination of 'forward operating' and 'backward planning', applying five steps in both directions (Scholz et al., 2006), rooting it in literature about 'backcasting' (Dreborg, 1996; Holmberg and Robert, 2011). In their 2008 handbook and some connected publications, Hirsch Hadorn et al. (2008) describe the process as consisting of three phases: 'problem identification and problem structuring'; 'problem analysis'; and 'bringing results to fruition', with the phases treated in an iterative manner rather than a sequential manner, responding to the specific context emerging (Hirsch Hadorn et al., 2008; Hirsch Hadorn et al., 2006; Pohl and Hirsch Hadorn, 2008). A few years later, three German scholars also described transdisciplinarity as a research '*approach*' (rather than a method), working in three phases: 'formation of a common research object'; 'production of new knowledge (interdisciplinary)'; and 'transdisciplinary integration: contributing to societal and scientific

progress'. In the graphic presentation of their approach, they stress the double ambition of creating both societal results and scientific results (Jahn et al., 2012). In the same year, a larger international team of authors (including one author of the Jahn et al., 2012 article) describes transdisciplinarity in almost the same manner, with basically the same graphic, but replacing the names of the three phases with: 'A: problem framing & team building'; 'B: Co-creation of solution-oriented and transferable knowledge'; and 'C: (Re-) integrating and applying the co-created knowledge' (Lang et al., 2012). See all four transdisciplinary process descriptions in Table 3.1.

The common transdisciplinary approach coming from all four proposals in Table 3.1 can be seen as a flexible iterative approach to elementary steps, which is required to allow for the unexpected. This is essential when alternative knowledge sources and the perspectives of multiple stakeholder groups, with their own specific needs and experiences, are intended to be equally represented in the process of knowledge creation. What is missing in all four proposals in Table 3.1 is a phase for the generation of a collective and shared questioning of the situation at hand and development of the research approach, including the iterative nature of research: an initial step to define the strategic research focus of a transdisciplinary research project based on a research portfolio and vision of transdisciplinary researcher or a transdisciplinary institute, and a final step to provide feedback on the outcomes of the transdisciplinary research project in light of the research portfolio of the transdisciplinary researcher or transdisciplinary institute. Both are defined in Table 3.1 as step 1 and 6.

The multidisciplinary perspective of transdisciplinary research has resulted in several methodological considerations and tools being lent from different social sciences approaches. The approaches described in the transdisciplinary literature have in this sense a very strong resemblance to other related fields that search for contributions to societal challenges by applying comparable transdisciplinary principles. For example, the methodological considerations in the field of participatory policy making are similar to transdisciplinary research: see Table 3.2. Friend and Hickling (2005) described their consensus building process as a 'twin track' or U-loop process, engaging in both a political work process and a technical–scientific work process, describing main steps as 'shaping', designing', 'comparing' and 'choosing'. Susskind et al. (1999), in their *Consensus Building Handbook*, described it comparably with three 'zones': a 'divergent zone'; a 'groaning zone'; and a 'convergent zone'. Comparable approaches can be found in the field of collaborative policy making (Chambers, 2002; Kaner, 2011), with a large availability of evaluations, critical reviews and discourse on effectiveness, legitimacy, implications for education and the capacity to catalyse transformations (Elle et al., 2002; Vermeulen et al., 1997; van der Waals and Vermeulen, 2002).

Seemingly comparable approaches that contribute to sustainable development related research, in various disciplines, developed similar procedural approaches as what we have described for sustainability science, but they are not always labelled with the same concepts. Nevertheless, there has been cross-pollination between these disciplines.

Table 3.1 Chronological synthesis of transdisciplinary research project planning in the field of sustainability sciences

Transdisciplinary research process steps	*Scholz et al. (2006) Transdisciplinary case study methodology*		*Hirsch Hadorn et al. (2008) Transdisciplinary approach*	*Jahn et al. (2012) Transdisciplinary conceptual model*	*Lang et al. (2012) Ideal–typical transdisciplinary research process*
6 steps *Within broader research portfolio; linked to research vision; strategic focus; iterative process*	*5 steps* *Two directions of working*		*3 phases* *Iterative rather than sequential*	*3 phases* *Parallel*	*3 phases* *Continuous evaluation; strengthen participation; mitigate conflict*
	Forward operating	*Backward planning*			
1) Research vision and strategy					
2) Problem exploration and structuring	1) Goal specification	10) Case faceting	Problem identification and structuring	Formation of a common research object	A) Problem framing & team building
3) System understanding	2) System analysis	9) Characteristics of systems model		Production of new knowledge (interdisciplinary)	B) Co-creation of solution-oriented and transferable knowledge
4) Search and compare solutions	3) Scenario construction	8) Characteristics of scenarios	Problem analysis		
	4) Multi-criteria assessment	7) Assessment criteria and procedure		TD integration: contributing to societal and scientific progress	C) Re-integrating and applying the co-created knowledge
5) Choose, decide and prepare for application	5) Generation of action orientations	6) Goal formulation	Bringing results to fruition		
6) Synthesize and feedback with overall vision and strategy					

Table 3.2 Transdisciplinary research project planning in the field of participatory policy making according to the transdisciplinary research process steps in the field of sustainability sciences

Transdisciplinary research process steps	*Friend and Hickling (2005) Process of strategic choice*	*Susskind et al. (1999) Consensus building*	*Vermeulen et al. (1997), van der Waals and Vermeulen (2002)*	
1) Research vision and strategy		Start up Convening	Political formalizing	
		Go/no-go	Choosing internal or dialogue	
2) Problem exploration and structuring		Clarifying responsibilities, process design	Problem structuring	
			Process management	
3) System understanding	Shaping	Consensus building	Weighing in dialogue and confrontation	Perceptions exchange
	Designing			Generating solutions
4) Search and compare solutions	Comparing	Deliberating		Analyze options
				Collaborate weighing
	Choosing	Deciding		Consensus creation
5) Choose, decide and prepare for application			Feedback	
			External communication	
6) Synthesis and feedback with overall vision and strategy		Implementing		
	Organizing learning and development			

All the schools of research highlighted in Tables 3.1 and 3.2 are developing methods and tools for the six main steps in the transdisciplinary process. This opens the floor for various challenges when executing transdisciplinary research – the challenges of:

- Dealing with how various disciplines perceive the joint problem-solving research: the diversity of methods applied; and the mutual exchangeability of these methods;
- Dealing with challenges in connecting the various forms of knowledge and information and best ways for working towards a shared perception of problems and suitable solutions;
- Dealing with the requirements of scientific quality (validity, reliability, generalizability, traceability and more);
- Dealing with the best ways of enabling communication between a wide variety of stakeholders;
- Dealing with uncertainty about the key success factors for application of the results of such a research process;
- And, last but not least, how, for the academic researchers in their various disciplines, they can create new roles, while still being awarded in the (traditional) academic system.

Apart from these challenges, in the research process itself various disciplines are dealing with some of the same crosscutting challenges, which need to be addressed at the institutional level and within the respective disciplines. Researchers need to deal with ethical issues about stakeholder engagement, fairly dealing with competing interests and conflict of interests as well as with promises made. Transdisciplinary research institutes need to consider how their application of the transdisciplinary research results can be ensured, what forms of involvement on the part of policy makers or other decision-makers can be applied and how the intended changes can be achieved. Transdisciplinary research also has implications for academic teaching, in terms of teaching curriculum, aiming at skills development. It needs to have a strategy in order for (PhD) student projects to be integrated into transdisciplinary research projects, simultaneously ensuring applicable outcomes and fruitful student experience and graduation. Transdisciplinary research institutes need to be prepared to respond to research funding agencies as these are in various ways demanding transdisciplinary research, but not always in line with the expectations of the proponents of the three 'tastes' of transdisciplinarity described in Chapter 2. Such challenges, and many more, will have to be addressed when working with the diverse communities of practice in various disciplines while contributing to the field of sustainable development.

In the next section, we will have a closer look at a transdisciplinarity toolbox, identifying the main principles of transdisciplinary research and suggested types of tools and methods that can be applied for stakeholder engagement, dealing with multiple perceptions, worldviews and value systems, collective ideation, selection and choice making.

3.4 The basic methodological principles of transdisciplinary research

Transdisciplinary research varies from one-person projects (e.g. PhD projects; small research projects) to very complex projects, implying challenges in how to develop and design these projects. As can be seen from Tables 3.1 and 3.2, transdisciplinary research projects are projects with many stakeholders, making them very different from individual research projects that cover the proposed six transdisciplinary research project steps. This has methodological implications for the overall research design and addressing the many actors in different project designs, as well as for the art and type of activities contributing to the transdisciplinary research – especially activities for the collaboration between academic and non-academic actors that contribute to the exchange, collection, joint analysis and synthesis of knowledge.

These activities should enable more flexible and open work, instead of strict protocols and objective validity-based research, as is the case with 'mode 1' knowledge creation. At least eight essential principles of transdisciplinary research can be identified: 1) abductive reasoning; 2) open-minded multi-actor reflection; 3) iterativeness; 4) triple focus; 5) understanding the bigger picture; 6) multi-level learning; 7) long-term and full system perspective; and 8) an orchestrated approach. The combination of these principles illustrates transdisciplinary research's different approach to scientific inference compared to traditional 'mode 1' knowledge production.

3.4.1 Abductive reasoning

Scientific inference within transdisciplinary research is based on abductive reasoning, as the process of reinterpretation and recontextualization throughout the research process (Eastwood et al., 2016). Modell (2009) clarifies that

> abduction does not move directly from empirical observations to theoretical inferences, as is the case in purely inductive research, but relies heavily on theories as mediators for deriving explanations . . . while preserving researchers' sensitivity to variations in situated meanings.
>
> (Modell, 2009, p. 209)

Theories are therefore used in a continuous process of enhancing the understanding of the situation at hand by moving from empirical observations to theoretical inferences, guided by the hunch of the researcher or actors involved in the transdisciplinary research process. The transdisciplinary research process, therefore, uses prior knowledge from academics as well as non-academics: knowledge of how societies work through the thorough process of scientific research as well as through the learning processes of individuals or groups of individuals by being exposed to and embedded in practice. While emergent knowledge creation forms the basis for hypothetic-deductive theory testing (Eastwood et al., 2016),

transdisciplinary research – in order to create collective knowledge of and actively contribute to urgent societal challenges – is constituted by a process of intuitive pre-knowledge on the situation (i.e. the hunch). This knowledge is available in the social practice itself and is shared by different stakeholders in a knowledge creation process by feed-backing between practice and theory, called abductive reasoning (Witjes, 2017). In social sciences, especially in critical realism, the abductive research strategy is explicitly linked to the grounded theory approach (Reichertz, 2009) and is used in order to construct theories that are grounded in everyday activities, in the language and meanings of social actors in the field of study (Ong, 2012). This makes it especially useful for transdisciplinary practices.

3.4.2 Open-minded, multi-actor reflection

Abductive reasoning for an enhanced system understanding of the societal challenge at hand is needed for academic and non-academic actors to share and enhance understanding by collective reflection. The outcomes of these collective reflections lead to adjusted behavioural actions and solutions to societal challenges. In order to get academic and non-academic actors involved in this multi-actor reflection process, they have to be taken out of their comfort zone and routines: logical inference for all actors means critically reflecting on day-to-day situations that contribute to the societal challenge as object of study of the transdisciplinary research process. This also counts for the academic actors involved: they have to be willing and able to see through disciplinary and methodological boundaries while aiming for meaningful outcomes for practice and science alike.

3.4.3 Iterativeness

For all actors, being involved in critically reflecting on the societal challenge requires letting go of inert concepts, observations or social roles. The latter could mean that different actors will be involved in the process of contributing to the understanding of the challenge by giving a different perspective. The iterativeness and pragmatic stance of a transdisciplinary research process and the continuous search for the unknown also mean the social roles or even the actors themselves may not be seen as stable throughout the entire process. It is, therefore, a shared responsibility for all actors involved to critically reflect on the transdisciplinary research process as well as on the outcomes, making higher order learning a key feature of transdisciplinary research. Sharing individual critical reflections on the research outcomes as well as on the process itself in a multi-actor setting, enhances the transformative capacity of a transdisciplinary research project. As a consequence, a strict linear research project, as common in ‘mode 1’, is not possible; during the project, one needs to enable return to earlier steps as a result of reinterpretations and new insights, as suggested by many scholars (see also Table 3.1).

3.4.4 The triple focus

The importance of the collective reflection process with academic and non-academic actors is based on their pluriversal knowledge (i.e. 'a world of [knowledge] where many worlds fit'; Escobar, 2018), meaning an acknowledgement that each world of knowledge is represented by the knowledge of a specific actor on the challenge at hand. The process of reflection on this pluriversal knowledge, while at the same time acknowledging each actor, forces a transdisciplinary researcher into the double role of facilitating and coordinating the transdisciplinary research process as well as creating successful situations in which the academic and non-academic actors can exchange their knowledge and experience. This underlines that a dual focus on the methods applied to ensure transdisciplinary research (as addressed in this chapter) and on the type of theoretical and practical knowledge needed to address the challenge at hand is needed for the quality of a transdisciplinary research. Moreover, the contribution to societal challenges also implies the development of new ideas for possible interventions that can be implemented by having the right strategic decisions makers among the academic and non-academic actors on the team. Consequently, research aiming at contributing to societal challenges requires academics and their institutions to take active part in enabling such societal contribution by 1) leading the process (i.e. methodologically); 2) bringing together the right actors with the right knowledge (i.e. theoretically); and 3) ensuring the meaningfulness of the research outcomes (i.e. the implementation of the interventions). An overall transdisciplinary research strategy has therefore a *triple focus* on content, process and implementation: the contribution to meaningful outcomes for practice (i.e. an active contribution to the societal challenge) and for science (i.e. a contribution to debates in literature on the content of the research) and a well-developed, resilient research plan, including methodological and tool considerations to get to the meaningful outcomes.

3.4.5 Understanding the bigger picture

Academics leading a transdisciplinary research project should be able to face the complexity and wickedness of societal challenges: they have to be used to stepping out to practice and getting their boots dirty in seeking to achieve a higher understanding of practice. The three main ambitions of complex system knowledge integration, addressing the persistency of wicked societal problems and empowerment in light of urgent transformational challenges (see Figure 2.4.) in the playing field of transdisciplinary research can therefore be seen as basic principles to ensure successful coordination of a transdisciplinary research process and, moreover, meaningful outcomes of the research for practice and science (as addressed by Lang et al., 2012). Transdisciplinary research methodology should be able to understand the bigger picture by applying systems thinking to ferret out the challenge at hand, while ensuring multi-actor collaboration in reflecting on pluriversal knowledge. The dirty-boots mentality helps transdisciplinary researchers with maintaining the bigger picture while ensuring project details, but will also ensure close contact with the different actors involved in the project.

3.4.6 Multi-level learning

As already explained in Figure 3.1, the feedback between the different transdisciplinary research levels also counts outside of the transdisciplinary research project, at the transdisciplinary project portfolio and transdisciplinary research institute level. Multi-level learning as part of a transdisciplinary research project (i.e. individual actor, collective reflection, overall reflection on content and process) forces transdisciplinary research to use knowledge sources from multiple actors to feed their knowledge of the system, of which the challenge is part of leading to an implementable outcome. It is in the process of multi-level learning that a higher understanding of the challenge and related solutions are able to ensure the meaningfulness of the outcomes of a transdisciplinary research process for both practice and science.

3.4.7 The long-term and full system perspective

Outcome-oriented ambitions should be accompanied by a continuous reflection on whether the transdisciplinary research process contributes to the understanding of a complex and wicked problem or just leads to practical, or sometimes consultancy, advice, to single actors that form part of the system of the challenge. This means that transdisciplinary research always has a long-term and full system perspective and that the outcomes should be pointed at long-term visions that contribute to a more sustainable society (see also Figure 2.4).

3.4.8 The orchestrated approach

Depending on the complexity and wickedness, but also on the urgency or development of the challenge at hand throughout the project, the transdisciplinary researcher should choose between orchestrated and pragmatic approaches to ensure collective reflectivity on the pluriversal knowledge of the challenge (Popa et al., 2015). The pragmatic approach is mainly for smaller projects, in scope, complexity and time, and therefore has questionable contribution to the development of a more sustainable society. The orchestrated approach is for projects of greater scope but can also be in need of smaller pragmatic process elements.

3.5 Transdisciplinary research tools

Serving the high expectations and challenges for transdisciplinary research methods, many tools have been developed and applied in transdisciplinary research to ensure meaningful outcomes for practice and science. Recently, several transdisciplinary scholars have critically analyzed their research with a methodological focus and shared their experiences with the application of several methods and tools. In Table 3.3, the experiences of four renowned transdisciplinary scholars are grouped according the transdisciplinary process steps, as presented in section 3.2.

Table 3.3 Transdisciplinary methods and tools in different literature

Transdisciplinary research process steps	*Bammer (2015)*	*Fahy and Rau (2013)*	*Franklin and Blyton (2013)*	*Byrne et al. (2017)*
1) Research vision and strategy	*Toolkit #6* Research integration and implementation	*Chapter 5* Sustainable development of what? *Chapter 6* Indicators of society-nature interaction	*Chapter 2* Developing and delivering social science research for sustainability	*Chapter 3* Sustainability as contingent balance between opposing though interdependent tendencies: a process approach to progress and evolution
2) Problem exploration and structuring	*Toolkit #2* Engaging and influencing policy *Toolkit #1* Co-producing knowledge *Toolkit #4* collaboration *Toolkit #3* Dialogue methods for knowledge synthesis	*Chapter 3* Social groups and collective decision-making: focus group approaches *Chapter 2* Disciplinary methods challenge	*Part II* Approaches to sustainability research	*Part 2* Transdisciplinary conversations and conceptions
3) System understanding	*Toolkit #7* (Dynamic) systems thinking *Toolkit #8* Integration methods	*Chapter 4* Local lives and conflict: towards a methodology of dialogic research	*Part III* Disseminating sustainability research	
4) Search and compare solutions	*Toolkit #5* Change	*Chapter 7* Mapping for sustainability		
5) Choose, decide and prepare for application		*Chapter 6* Indicators of society–nature interaction	*Chapter 2* Developing and delivering social science research for sustainability	
6) Synthesis and feedback with overall vision and strategy	*Toolkit #2* Engaging and Influencing policy *Toolkit #6* Research integration and implementation	*Chapter 5* Sustainable Development of what?		

Bammer, from Australia National University, summarized her methodological reflections in the *Toolkits for Transdisciplinarity* series (Bammer, 2015). Published between 2015 and 2017 in *Gaia*, she highlights existing compilations of methods useful for transdisciplinary research. The toolkits unite several existing tools from other methodological research fields and range from full range transdisciplinarity, via a collaborative focus, to tools to synthesize disciplinary knowledge, apply systems thinking and support change.

Fahy and Rau from the National University of Ireland share experiences with different transdisciplinary research projects in a critical review of methodological approaches, as well as tools for the integrated investigation of sustainability questions (Fahy and Rau, 2013). They discuss methodologies based on their experiences with transdisciplinary research on attitudes and behaviour observable at the local level – from families and households to individual organizations within communities – and focus on comparative sustainability research across different levels of socio-political organization, from cities and regions to nation-states.

Franklin and Blyton from Coventry University recollected their transdisciplinary experiences specifically related to the BRASS project (Franklin and Blyton, 2013): a large-scale, ESRC-funded project on community sustainability. Their book contains the illustrated methods and approaches applied in this transdisciplinary research project to disseminate findings, influence policy, and communicate with non-academic actors as well as work with the media.

Byrne, Mullally and Sage from the University College of Cork summarize their reflections on transdisciplinary methodology and tools based on their research (i.e. Sustainability in Society Initiative) and related to the Transdisciplinary Conversations conference they organized in 2013. Their book (Byrne et al., 2017) demonstrates how they were able to make progress in contributing to a more sustainable world by applying transdisciplinary research methods. The book includes several examples.

Focusing on the transdisciplinary process steps, we can conclude that steps 2–5 are covered in the reflections of all the mentioned transdisciplinary scholars. Some even handle methods and tools for steps 1 and 6, but these methods and tools are not included in the empirical examples given: experiences on separate transdisciplinary research projects are shared, but not on a transdisciplinary researcher or transdisciplinary institute level, emphasizing the attention for strategy and vision development for transdisciplinary research.

3.6 Considerations for the application of transdisciplinary approaches, methodological principles and tools

Sustainability research requires not only natural sciences knowledge of the environmental system, but also expertise in technical and social sciences, in order to contribute to societal changes. As a result, research projects require not only development and integration of academic and non-academic expert knowledge in a collaborative way; public outreach and societal engagement also need to be undertaken to enable a direct contribution to societal developments. Consequently,

transdisciplinary research entails the challenge of engaging with different actors, each with their own stake in the research process and its outcomes, and having to deal with multiple perceptions, worldviews and value systems, collective ideation, selection and choice making. These challenges need to be considered and overcome through strategies throughout the transdisciplinary research process. Gaziulusoy et al. (2016) summarize the challenges transdisciplinary researchers face in three types:

1 *Inherent challenges*: challenges that arise directly from the characteristics inherent to transdisciplinary research, like abductive reasoning, iterativeness and dual focus, as mentioned in section 3.3;
2 *Institutional challenges*: challenges that arise from the current structures and procedures of knowledge generation and performance evaluation in academic institution. Challenges come from institutions that are more used to 'mode 1' knowledge creation and have to get used to other modes as well;
3 *Teamwork challenges*: challenges that stem from the requirement of collaboration between researchers from backgrounds with different expertise and who are often from different academic institutions as well as reflection with non-academic actors in ways to enable mode 2 and 3 knowledge generation.

Whereas inherent and teamwork challenges have been addressed in this chapter, institutional challenges depend on the characteristics of the different institutions. To start the process of transdisciplinary research and at the end ensure that the developed interventions are applied, working from traditional institutions, as universities mostly are, is not easy. Transdisciplinary researchers have to learn to be smart in working with the available resources, for example, linking several smaller projects with a similar and comparable way of working towards an overall research programme (Bootsma et al., 2014; Gaziulusoy et al., 2016). By building up transdisciplinary research step-by-step transdisciplinary researchers aim for a transdisciplinary research portfolio or even smaller or bigger institutes that have an enhanced impact in society. This model of transdisciplinary research growth is inherent to the growth of the knowledge generated and interventions developed and, therefore, is inherent to the learning process transdisciplinary research implies. The collaboration and co-designing process between academic and non-academic actors is crucial to ensuring constant growth, leading to enhanced contribution to societal transitions (Moser, 2016).

The combination of the inherent, institutional and teamwork challenges puts high demands on transdisciplinary researchers and their capacities, for example to be constantly able to get key decision-makers linked to the research process, while addressing conflicting interests between actors can even demand the transdisciplinary researcher take a mediating role (Susskind et al., 1999). In all cases, the transdisciplinary researcher has to ensure that the different principles (as discussed in section 3.3) and concurrent transdisciplinary research activities are consistently reflected by the basic philosophy of collaborative understanding and intervention. The transdisciplinary researcher needs to bring along a sense of the legitimacy,

relevance and representativeness (see step 4 of the transdisciplinary research project) of the transdisciplinary research project outcomes as it develops. This makes the salience of transdisciplinary research that aims at the development of knowledge and interventions linked to the problem or societal challenge at hand more important than the curiosity for developing this knowledge or intervention. Consequently, the playing field of transdisciplinary research in sustainability sciences comes with the three main ambitions, as mentioned in Figure 2.4: challenges of pluralistic scientific knowledge creation, features of societal problems and the urgency of major persistent challenges.

The multi-level characteristic of transdisciplinary research (i.e. project, portfolio and institution) also brings along considerations on different levels of learning from transdisciplinary research outcomes: individual project learnings, multiple project learnings and learnings on the contribution of the institute to societal challenges. The academic institute is therefore also confronted with the implementation of these learnings in their teaching activities. Integrating educational activities in transdisciplinary research opens up the possibility of developing future capacities for transdisciplinary research and making young researchers aware of societal challenges and their implications.

The six-step model presented in this chapter supports transdisciplinary research in working from an overall transdisciplinary research architecture, including strategic questioning at multiple levels (i.e. project, portfolio and institute) that connects the vision of the academic institution regarding its contribution to societal challenges to the specific projects and creates a flexible iterative approach to elementary steps, which is required to allow for the unexpected. Consequently, the responsibility for transdisciplinary research goes beyond the capacity of a single transdisciplinary research(er) and should be covered by a group of transdisciplinary researchers working within a transdisciplinary research institute that collectively contributes to meet societal sustainability challenges.

References

Balsiger, J. 2015. Transdisciplinarity in the class room? Simulating the co-production of sustainability knowledge. *Futures*, 65, 185–194.

Bammer, G. 2015. Toolkits for transdisciplinarity. *GAIA: Ecological Perspectives for Science and Society*, 24, 149–149.

Bergmann, M., Jahn, T., Knobloch, T., Krohn, W., Pohl, C. & Schramm, E. 2010. *Methoden transdisziplinärer Forschung: Ein Überblick mit Anwendungsbeispielen*, Frankfurt am Main, Germany, Campus Verlag.

Boland, R. J. & Collopy, F. 2004. *Managing as Designing*, Stanford, Stanford University Press.

Bootsma, M. C., Vermeulen, W. J. V., Van Dijk, J. & Schot, P. P. 2014. Added value and constraints of transdisciplinary case studies in environmental science curricula. *Corporate Social Responsibility and Environmental Management*, 21, 155–166.

Buchanan, R. 1992. Wicked problems in design thinking. *Design Issues*, 8, 5–21.

Byrne, E., Mullally, G. & Sage, C. 2017. *Transdisciplinary Perspectives on Transitions to Sustainability*, London, UK, Routledge.

Campbell, C. A., Lefroy, E. C., Caddy-Retalic, S., Bax, N., Doherty, P. J., Douglas, M. M., . . . West, J. 2015. Designing environmental research for impact. *Science of the Total Environment,* 534, 4–13.

Carayannis, E. G., Campbell, D. F. J. & Rehman, S. S. 2016. Mode 3 knowledge production: Systems and systems theory, clusters and networks. *Journal of Innovation and Entrepreneurship*, 5.

Cash, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Guston, D. H., . . . Mitchell, R. B. 2003. Knowledge systems for sustainable development. *Proceedings of the National Academy of Sciences,* 100(14), 8086–8091.

Chambers, R. 2002. *Participatory Workshops: A Sourcebook of 21 Sets of Ideas and Activities*, London, UK, Earthscan Publications.

Clark, W. C., Tomich, T. P., van Noordwijk, M., Guston, D., Catacutan, D., Dickson, N. M., & McNie, E. 2016. Boundary work for sustainable development: Natural resource management at the Consultative Group on International Agricultural Research (CGIAR). *Proceedings of the National Academy of Sciences,* 113(17), 4615–4622.

Cross, N. 2011. *Design Thinking: Understanding How Designers Think and Work*, London, UK, Bloomsbury Publishing.

Dreborg, K. H. 1996. Essence of backcasting. *Futures*, 28, 813–828.

Eastwood, J. G., Kemp, L. A. & Jalaludin, B. B. 2016. Realist theory construction for a mixed method multilevel study of neighbourhood context and postnatal depression. *Springerplus*, 5, 1081.

Elle, M., Van Hoorn, T., Moss, T., Slob, A., Vermeulen, W. & Van Der Waals, J. 2002. Rethinking local housing policies and energy planning: The importance of contextual dynamics. *Built Environment (1978)*, 28, 46–56.

Escobar, A. 2011. Sustainability: Design for the pluriverse. *Development*, 54, 137–140.

Escobar, A. 2018. *Designs for the Pluriverse: Radical Interdependence, Autonomy, and the Making of Worlds*, Durham, NC, Duke University Press.

Fahy, F. & Rau, H. 2013. *Methods of Sustainability Research in the Social Sciences*, London, UK, SAGE Publications.

Franklin, A. & Blyton, P. 2013. *Researching Sustainability: A Guide to Social Science Methods, Practice and Engagement*, Milton Park, UK, Taylor & Francis.

Friend, J. & Hickling, A. U. 2005. *Planning under Pressure*, Milton Park, UK, Taylor & Francis.

Gaziulusoy, A. I., Ryan, C., Mcgrail, S., Chandler, P. & Twomey, P. 2016. Identifying and addressing challenges faced by transdisciplinary research teams in climate change research. *Journal of Cleaner Production*, 123, 55–64.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., Trow, M., Schwarzman, H. & Scott, S. 1994. *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*, London, UK, SAGE Publications.

Groot, A. D. D. 1994. *Methodologie: grondslagen van onderzoek en denken in de gedragswetenschappen*, Assen, Van Gorcum.

Groot, A. D. D. & Spiekerman, J. A. A. 1969. *Methodology: Foundations of Inference and Research in the Behavioral Sciences*, The Hague, The Netherlands, Mouton.

Hessels, L. K. & Van Lente, H. 2008. Re-thinking new knowledge production: A literature review and a research agenda. *Research Policy*, 37, 740–760.

Hirsch Hadorn, G., Bradley, D., Pohl, C., Rist, S. & Wiesmann, U. 2006. Implications of transdisciplinarity for sustainability research. *Ecological Economics*, 60, 119–128.

Hirsch Hadorn, G., Hoffmann-Riem, H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Wiesmann, U. & Zemp, E. 2008. *Handbook of Transdisciplinary Research*, Dordrecht, Netherlands, Springer.

Holmberg, J. & Robert, K. H. 2011. Backcasting: A framework for strategic planning. *International Journal of Sustainable Development & World Ecology*, 7, 291–308.

Jahn, T., Bergmann, M. & Keil, F. 2012. Transdisciplinarity: Between mainstreaming and marginalization. *Ecological Economics*, 79, 1–10.

Kaner, S. 2011. *Facilitator's Guide to Participatory Decision-Making*. Toronto, Canada, John Wiley & Sons.

Knight, S.-A. A. & Cross, D. 2012. Using contextual constructs model to frame doctoral research methodology. *International Journal of Doctoral Studies*, 7, 39–62.

Kuijer, L. 2014. Implications of social practice theory for sustainable design. PhD thesis, Technical University Delft, Delft, The Netherlands.

Lang, D. J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M. & Thomas, C. J. 2012. Transdisciplinary research in sustainability science: Practice, principles, and challenges. *Sustainability Science*, 7, 25–43.

Lopes, R. & Videira, N. 2019. How to articulate the multiple value dimensions of ecosystem services? Insights from implementing the PArticulatES framework in a coastal social-ecological system in Portugal. *Ecosystem Services*, 38.

Mcgregor, S. L. T. & Volckmann, R. 2013. Transiversity: Transdisciplinarity in higher education. *Leading Transformative Higher Education*. Olomouc, Czech Republic, Palacky University Press.

Modell, S. 2009. In defence of triangulation: A critical realist approach to mixed methods research in management accounting. *Management Accounting Research*, 20, 208–221.

Moser, S. C. 2016. Can science on transformation transform science? Lessons from co-design. *Current Opinion in Environmental Sustainability*, 20, 106–115.

Mueller-Roterberg, C. 2018. *Handbook of Design Thinking: Tips & Tools for How to Design Thinking*, Eugene, OR, Amazon Digital Services LLC.

Nobre, F. S., & Biscaia, H. G. 2015. *Design Thinking for Sustainability: Fighting Against Hunger and Poverty*. Paper presented at the The XXVI ISPIM Conference – Shaping the Frontiers of Innovation Management, Budapest, Hungary.

Ong, B. K. 2012. Grounded Theory Method (GTM) and the Abductive Research Strategy (ARS): A critical analysis of their differences. *International Journal of Social Research Methodology*, 15, 417–432.

Pohl, C. & Hirsch Hadorn, G. 2008. Methodological challenges of transdisciplinary research. *Natures Sciences Sociétés*, 16, 111–121.

Pohl, C., Rist, S., Zimmermann, A., Fry, P., Gurung, G. S., Schneider, F., Speranza, C. I., Kiteme, B., Boillat, S., Serrano, E., Hadorn, G. H. & Wiesmann, U. 2010. Researchers' roles in knowledge co-production: Experience from sustainability research in Kenya, Switzerland, Bolivia and Nepal. *Science and Public Policy*, 37, 267–281.

Popa, F., Guillermin, M., & Dedeurvvaerdere, T. 2015. A pragmatist approach to transdisciplinarity in sustainability research: From complex systems theory to reflexive science. *Futures,* 65, 45–56.

Reichertz, J. 2010. Abduction: The logic of discovery of grounded theory—Forum Qualitative Sozialforschung. *Qualitative Sozialforschung; Forum: Qualitative Social Research,* 11(1), 11.

Scholz, R. W., Posch, A., Lang, D. J., Wiek, A., Walter, A. I. & Stauffacher, M. 2006. Transdisciplinary case studies as a means of sustainability learning. *International Journal of Sustainability in Higher Education*, 7, 226–251.

Söderbaum, P. 2009. Making actors, paradigms and ideologies visible in governance for sustainability. *Sustainable Development*, 17, 70–81.

Susskind, L., Mckearnan, S. & Thomas-larmer, J. 1999. *The Consensus Building Handbook: A Comprehensive Guide to Reaching Agreement*, Thousand Oaks, CA, SAGE Publications.

Van Der Waals, J. F. M. & Vermeulen, W. J. V. 2002. The carbon dioxide reduction workshop: Dutch experiences with a participatory approach. *Journal of Environmental Planning and Management*, 45, 549–569.

Vermeulen, W., Van Der Waals, J., Ernste, H. & Glasbergen, P. 1997. *Duurzaamheid als uitdaging: de afweging van ecologische en maatschappelijke risico's in confrontatie en dialoog*, Den Haag, SDU Uitgevers.

Vildåsen, S. S., Keitsch, M. & Fet, A. M. 2017. Clarifying the epistemology of corporate sustainability. *Ecological Economics*, 138, 40–46.

Von Oech, R. 1983. *A Whack on the Side of the Head: How to Unlock Your Mind for Innovation,* New York, Warner Books.

Wagenmakers, E.-J., Dutilh, G. & Sarafoglou, A. 2018. The creativity-verification cycle in psychological science: New methods to combat old idols. *Perspectives on Psychological Science*, 13, 418–427.

Welsh, M. A., & Dehler, G. E. (2012). Combining critical reflection and design thinking to develop integrative learners. *Journal of Management Education,* 37(6), 771–802.

Wiek, A. & Lang, D. J. 2016. Transformational sustainability research methodology. In: Heinrichs, H., Martens, P., Michelsen, G. & Wiek, A. (eds.) *Sustainability Science: An Introduction*, Dordrecht, Netherlands, Springer.

Witjes, S. 2017. *Leapfrogging through Retrospection*. PhD, Utrecht University.

Zscheischler, J., Rogga, S. & Busse, M. 2017. The adoption and implementation of transdisciplinary research in the field of land-use science: A comparative case study. *Sustainability*, 9.

4 Transdisciplinary collaboration and ethics

Martina M. Keitsch

4.1 Introduction

Transdisciplinarity (TD) and transdisciplinary collaboration (TDC) are receiving increased attention in both academia and society. While TD epistemology is comparatively broadly discussed, this is not the case for ethics. The ethical landscape in TD is multi-faceted, touching upon various subjects such as research ethics, empathy, inclusion, diversity and responsibility towards stakeholders. Many TD and TDC concepts also rely on normative claims rather than arguments, which impedes analysis of their ethical foundations.

According to the Etymology Dictionary (2019), 'trans' and 'discipline' both come from Latin (trans- 'across, over, beyond', 'disciplina – instruction given, teaching, learning, knowledge'). The terms transdisciplinarity and transdisciplinary collaboration are not strictly separated in this chapter since their use overlaps in the literature. It is, however, possible to distinguish them analytically: 'transdisciplinarity' (TD) as 'theory- and knowledge generation focused', and 'transdisciplinary collaboration' (TDC) as 'practice and application focused'. Within this distinction, the following chapter discusses mainly TDC from a perspective of solution-driven transdisciplinarity, although parts may be also relevant for intra-academic transdisciplinarity.

The chapter presents a structure for TDC ethics with a special focus on sustainability by discussing ideas from classic and newer literature within two categories: ontological ethics and social ethics. The chapter further views TDC ethics with a specific focus on sustainability issues, more specifically, questions and challenges related to sustainable planning and design within the limits of ecosystems.

The aim of the chapter is to make ethics accessible to transdisciplinarity practice and theory. Following the introduction, section 4.2 presents a systematic overview of ethical ideas in TD/TDC based on a systematic literature search. Section 4.3 illustrates and analyzes how some ideas can be applied in a TDC process related to sustainability, with help of an example from practice. Section 4.4 summarizes conditions to integrate ethics in TDC. Insights from this chapter should provide sustainability researchers, professional practitioners and societal stakeholders with the ethical contents of the transdisciplinarity debate.

4.2 Ontological and social ethics within transdisciplinarity

Ethics (moral philosophy) is a theory of human ways of life (descriptive) that discusses what is right and just and develops standards for this (normative). Ethics also examines differences between moral and non-moral phenomena according to their epistemological, linguistic philosophical and ontological form of moral judgments (metaethics). Finally, ethics analyzes concrete moral societal actions in relation to the aforementioned, such as climate change, animal welfare, death penalty etc. (practical or applied ethics). Moral ascribes the righteousness of actions in relation to what is considered correct or duly accepted.

Ontological ethics assumes an identity of humans and nature, implying that realization of being human means right ethical decision-making and action in a form of '*become who you are*' Ultimately, wrong ethical behaviour has as its reason the lack of insight into the interdependency of all beings (Krebs, A. 1999).

Relational ethics interprets morally acceptable actions regarding human–human or human–nature relationships, the latter e.g. in Apel's *Macroethics* (Apel in: Øfsti 1992, 249): 'We treat natural beings here as something similar or analogous to human co-subjects of communication.'

If ethics generally asks the question of how to live a moral life, relational ethics asks, how to live a moral live together (Austin 2008). Social ethics is part of relational ethics and comprises interpretations of morally acceptable actions regarding commonly shared values such as justice, fairness, responsibility, solidarity, tolerance, inclusion, access etc. Humans are seen as both zoon politicon (social being) and autonomous moral agents. The degree and quality of realizing common shared values determines the quality of a society. Distinguishing relational ethics and social ethics, however, is mostly an analytical endeavour. As the next section will show, arguments and values often overlap in both ethical concepts.

Relating ethics to human and natural environment relationships means, not least since the start of the environmental crisis in the 1970s, asking for the causes, dimensions and tendencies of what makes this relationship problematic. Even if TD and TDC are increasingly acknowledged today as addressing this question, the transdisciplinarity concept has existed for over 40 years as human–nature discourse (e.g. Bernstein 2015). Transdisciplinarity was introduced in 1970 by, among others, the psychologist Piaget, the astrophysicist Jantsch and the theoretical physicist Nicolescu (Bernstein 2015). Nicolescu draws on the study of natural systems to proceed to explain transdisciplinarity. 'In so far as Nature *participates* in the being of the world one must ascribe an ontological dimension to the concept of Reality' (Nicolescu 2000; emphasis M.K.).[1] Max-Neef (2005, 13, 15) expands Nicolescu's reality idea to transdisciplinarity:

> The action of the logic of the included middle upon different levels of reality, induces an open structure of the unity of levels of reality. The different levels of reality *are accessible to human knowledge through the existence of different levels of perception*, which stand in a one-to-one correspondence with the levels of reality. . . . The disciplinary investigations concern only one level

> of reality. Transdiscipline, instead, extends its action through several levels of reality.

Nicolescu has defined three TD axioms:

> 1. The ontological axiom: There are, in nature and society and in our knowledge of nature and society, *different levels of reality of the object and, correspondingly, different levels of reality of the subject*. 2. The logical axiom: The passage from one level of reality to another is ensured by the *logic of the included middle*.[2] 3. The complexity axiom: The structure of the totality of levels of reality or perception is a complex structure: *every level is what it is because all the levels exist at the same time*.
>
> (Nicolescu 2010, 22; emphasis M.K.)

Nicolescu's correlation of possibility and necessity in a system implies ethical assumptions (Keitsch 2012). Semantically, the prefix 'trans' gets here an ethically connoted value and a surpassing function as quasi-ethical corrective. This is done by attaching it to culture and religion:

> Transdisciplinarity can help with this important advancement of democracy, through its basic notions of '*trans*cultural' and '*trans*religious'. . . . The transcultural designates the opening of all cultures to that which cuts across them and transcends them, while the transreligious designates the opening of all religions to that which cuts across them and transcends them.
>
> (2010, 32; emphasis M.K)

Advancing to norms, Nicolescu (2002) states:

> The transdisciplinary ethic rejects any attitude that refuses dialogue and discussion, regardless of whether the origin of this attitude is ideological, scientistic, religious, economic, political or philosophical. Shared knowledge should lead to a shared understanding based on an absolute respect for the collective and individual Otherness united by our *common life on one and the same Earth*.
>
> (emphasis M.K.)

Nicolescu's argument includes both a self-referential assertion and an ontological ethics implication. Self-referential means that ethics is *per se* part of transdisciplinarity. Ontological ethics means among others attributing intrinsic values to systems or nature, a claim that comes with certain challenges. First, it has to deal with an 'appeal to nature fallacy';[3] second, it faces the problem that human emancipation from nature cannot be regarded as a phylogenetic 'natural' process. Since nature and human development appear at least dialectic, if not antinomic, the claim that different levels of reality of the object and different levels of reality

of the subject correspond is difficult to justify. This does not mean that nature and society are not connected – on the contrary. Historically, the exhaustion of natural ecosystems (as alienation from, rather than correspondence with nature) has often shown severe consequences for humans and society (e.g. Carson 2002) and changes in the natural environment have placed the social environment under pressure to change (Odum 1998). Logically, however, it is impossible to deduce ethical guidelines from nature or from any (ecological) system as presented earlier because ideas, explanations and ascriptions of nature (e.g. its intrinsic value), systems etc. relate *sui generis* (through one's kind) to humans.[4]

Seemingly, interpretations of nature as human habitat and (inter-)action space allow more plausible reasoning for a TDC ethics foundation.[5] Anthropocentrism comprises the maxim that humans should, as far as possible, care for and protect their natural environments, and transdisciplinary ethics is essentially anthropocentric ethics. Assuming a self-value of nature can be part of anthropocentrism as well, yet it does not belong to ecology or biology but to society. The inherent self-value of nature is also relevant for the TDC debate, especially when connected to sustainable development for at least three reasons. First, metaethically, the self-value of nature belongs to the 'noumenal world' (Kant 1781):

> We then realise that not only are the drops of rain mere appearances, but that even their round shape, nay even the space in which they fall, are nothing in themselves, but merely modifications or fundamental forms of our sensible intuition, and that the transcendental object remains unknown to us.

Nature and its beings embody here values such as 'autonomy', 'honesty' and 'non-instrumentality' (e.g. via the sublime in nature). Second, phenomenologically, nature sensitizes humans for their self-value as natural, physical beings (Keitsch 2018). Third, socially and pragmatically, nature provides space and possibilities for experiences and interactions that encourage (or prevent) well-being and life quality for humans.

Conclusively, it is difficult to justify ethical claims via systems or nature ontologies (Keitsch 2003), but values assigned to nature can support an integrative, emancipatory TDC approach. Nature experiences can transcend material aspects, for example via correspondence with other living beings, regulating an overly technical–empirical approach to the environment. Correspondence with living beings can evoke and cultivate empathy, which might be relevant in transdisciplinary collaboration when e.g. working with marginalized stakeholders. Further, appreciation of place and cultural identity can contribute to developing a common horizon and reference frame for a sustainability issue in a transdisciplinary team. This relates to narratives and concepts such as 'home' and 'belonging', and to love for and attachment to specific surroundings. In an emancipatory TDC discourse and interaction, acknowledging an individual experience of an appreciated surrounding is a supplement to facts and intersubjective, rational arguments (Giri 2002; McGregor 2015). Together with them, it can enhance the possibility of finding a desirable and practically applicable solution for a sustainability issue.

Habermas' discourse ethics provides a philosophical platform for TDC comprising values such as interdependency, equality, responsibility and care for nature, which recurrently appear in TDC concepts. Mercador (in: McGregor 2015) proposes e.g. respect, honesty, responsibility, unity, integrity and justice as values for TD ethics. Discourse ethics links to both social and relational ethics and presume both *real contexts* as empirical foundation for discourses *and* the decontextualization of discourses via *transcendental methods* towards a 'universal' moral point of view (Gimmler 2019). For example, Bergum and Dossetor (2005) propose embodied knowledge, context, processes and space as essential conditions to realize ethical values, which is part of the *real context* assumption. Bergum and Dossetor describe this as 'ethical space' or 'relational space' and suggest that this space must be recognized and nurtured in order to be available for communication and interaction. The concept of 'relational space' enlightens discourse ethics, which has a rather intellectual space interpretation, with a real-world approach (ibid.).

Austin (2008) and Palaiologou (2012) present other concepts on relational ethics as dialogue-based and requiring values such as attentiveness, responsiveness and commitment to listening to others, while taking the complexity of the situation and the relationships among diverse actors into account. While Austin's ethics build on virtues (see also Giri 2002), Habermas' discourse ethics are deontological.[6] Yet, it is the common denominator of both authors that seems most relevant for TDC ethics: communicative action.

In the Habermasian concept, moral problems can be solved in a rational and cognitive manner, and ethical decision-making takes place within an egalitarian and hierarchy-free discourse structure as societal decision-making (Habermas 1990). Democracy, perceived as intrinsic value, is the civil basis for this decision-making, and actors have to give good reasons for their claims and/or actions in order to enable different agents to make autonomous choices on that basis. A good reason is one that is capable of gaining confirmation from others as rational evaluators.

Habermas has pointed out three validity claims in discourses as fundaments for decision-making: claims for truth, rightness and truthfulness.

1 A claim for truth provable via empirical facts, concerning the sum of existing state of affairs;
2 A claim for rightness is discussible via pro and contra arguments, concerning situations and interactions within the social world;
3 A claim for truthfulness is explainable via subjective decision making, concerning individual experiences and attitudes.

(Habermas 1984)

In order to vote for an argument, one might give 'good reasons' like certified facts or argumentative skills in case 1 (theoretical discourses) and 2 (practical discourses). In case 3, one cannot confirm a statement just through corresponding arguments but has to demonstrate it via consistent behaviour. If one asserts

for instance to be vegetarian, eating beefsteak contradicts this assertion. Each of the three validity claims is related to one basic function of language, one domain of reality and one speech act. In a discourse, all categories below can be addressed.

Habermas' discourse ethics carries a hermeneutic principle: only norms which outcomes would be acknowledged and tolerated by *all* participants can gain general acceptance and hence social validity. He refers to discourses, where all actors are treated equally, and the question of power is not of importance. Yet, real stakeholder discourses must tackle different roles of participants and power relations. Realizing the dialectics of power relations and hierarchy-free discourses, Habermas' (1984) validity claims allow stakeholders to accept different methods of communication as possibilities for overcoming obstacles in order to achieve a common goal. This happens e.g. when at least two heterogeneous participants coordinate their perspectives and actions to succeed as described in section 4.3. Communication equals here coordination, and communicative acts focus on goal-adjusted actions to integrate single performances in an action plan.

Conclusively, Habermas' discourse ethics allow a variety of views to be expressed and discussed. It also presumes ethical values and virtues such as tolerance, respect for diversity of positions and willingness to find compromises for the sake of common action. Realizing and supplementing these values in collaborative interactions, e.g. through patience and listening to different kinds of validity claims, develops an understanding in the stakeholders' team that TDC happens in a lifeworld. Ethics relates here to general maxims as well as to different contextual experiences and perceptions of what is valuable and right. A practitioner or professional who attempts to facilitate TDC can aim to adopt generic ethical values in actual situations and explore common denominators to express them with the team involved. Regarding e.g. 'care for nature', universal claims for nature protection can be linked to subjectivity and experiences with local natural surroundings, respect for immediate nature and necessities to interact in a harmonious manner. Integrative ethics in this sense aims at finding shared views and common values towards the maintenance of natural and cultural environments.

Relating to transdisciplinarity and transdisciplinary collaboration (TDC), integrative ethics considers the field of intra-academic transdisciplinarity (see Chapter 2, Figure 2.6) in terms of credibility, transferability and dependability of research to establish trustworthiness (Høiseth et al. 2014). Solution-driven transdisciplinarity, on the other hand (see Chapter 2, Figure 2.6), is looking for common paths to establish planning and design concepts that are ultimately feasible in everyday life. Normatively, this requires TDC to pay attention to values such as solidarity, equality and tolerance and to strive towards a common good. Meta-ethically, co-produced knowledge in transdisciplinary teams must be feasible, transferable and understandable for all involved stakeholders, at least in its main parts. Finally, solution-driven transdisciplinarity in terms of transcendental-pragmatics,[7] e.g. in Bracken et al.'s (2015) somewhat uniliteral approach of 'understanding the stakeholder perspective', points towards the acceptance of different worldviews:

> transdisciplinary work is also increasingly seen as a *means through which to create usable research*; that is, research that can be readily taken up in a range of public and policy contexts. . . . Stakeholder involvement in the research process, either as the target for communication or as active participants . . . will shape the decisions, actions and capacities of these individuals and organisations. This is partly because the *contingent societal judgements and values* of more than just academic researchers and policy makers *become an integral part of the process*.
>
> (p. 1294, all emphasis M.K.)

4.3 TDC ethics in practice

Illustrating integrative ethics in TDC, the following section describes a common effort of academic and non-academic stakeholders to meet environmental challenges (Huutoniemi & Tapio 2014) and co-produce knowledge and solutions in a rural community in a Himalayan region in Nepal. The goal was to 'join forces' with the community to become a sustainable settlement. The concrete task was to introduce renewable energy solutions within a transdisciplinary collaboration project on planning and designing a Solar Street Light (SSL) in the village of Jhong Ward, former Jhong VDC (Village Development Committee), Mustang.

Ethical implications of theories and concepts here are analyzed in the following section regarding three project phases: 1) gather and process information; 2) identify conditions for collaboration; and 3) assess practical relevance of TDC for all stakeholders. The ethics analysis in section 4.3.3 has been conducted by the author of this chapter. It has been further discussed with a stakeholder of the project and a colleague from Nepal who investigates stakeholder collaboration in Jhong VDC in his PhD research on eco-villages local and regional contexts.

Findings of the project indicate that ethical intentions of academics were not always realistic and/or applicable and misunderstandings between stakeholders were common in all phases. Nevertheless, transdisciplinary collaboration contributed in this project to enlarged understanding of each other's position, values and skills, and to increased respect for different positions. Also, the (self-)learning progression was appreciated by both local and academic stakeholders (students and researchers). This might also be the case because a tangible and useful solution was commonly designed, which emphasizes the pragmatic relevance of objects and/or products and services in a TDC that manifests shared goals, values, knowledge and skills.

4.3.1 Introduction to the case and the local stakeholders

Jhong Ward lies in the north part of the Himalaya region of Nepal at an altitude of 3540 metres. It is located in Lower Mustang, next to the Muktinath Pilgrimage temple. Administratively, Jhong Ward comprises three villages – Jhong, Chhoekhor and Putak – with a total of 95 households. The major ethnic group is Gurung,

with 84.19% of the total population. Jhong Ward has 253 residents, 112 men and 141 women (Government of Nepal, National Population and Housing Census 2011). The Jhong people follow their own cultural, historical and religious traditions from six to seven centuries ago, when their ancestors immigrated from today's Southern Tibet. They have their traditional festivals, language and food habits. People in Jhong follow Shakya Buddhism,[8] and sacred practices such as puja (offerings) and praying are part of their daily life. There are many prayers and strong beliefs in gods and goddesses for peace and prosperity to prevail in the household or village. Generally, nature and humans are seen as dependent on each other. Jhong people mostly honour nature by law and respect, despite the use of modern technology. Mountains are the greatest wealth of Mustang; they are regarded as ornaments and representations of the divine.[9] Mountains are also the greatest water resources for household and irrigation purposes (Keitsch & Gurung 2018).

The land topography of Jhong village is slope. Most of the land area is barren and covered with low vegetation. Jhong village has a motorable road. Although near the Muktinath holy temple and spectacular mountain scenes, few pilgrims and tourists visit the village. The lack of facilities like hotels, lighting and internet are the reasons it has not developed as a tourist hub. The main occupation of the Mustangi remains agriculture as subsistence farming, whereas wheat, barley, grains and buckwheat are mostly cultivated products. Apples and potatoes are the main source of income from agriculture, and recently motivated apple farming and plantation generates local income. Some local people also engage in tourism business, like hotels, restaurants and trekking agencies in recent years. People keep different animals for food and farming. They use horses for transportation and trade and other animals for meat and compost for fertilizer. Rare and costly herbs like Yarchagumba are another source of income for the locals (Keitsch & Gurung 2018).

The active involvement of local stakeholders in Mustang (Stokol 2006)[10] has gained increasing importance for many project activities in recent years, for example under the Local Government and Community Development Programme (LGCDP). The Community Development Programme (CDP) is connected to the LGCDP and implemented by the Ministry of Federal Affairs and Local Development (MoFALD) and local municipalities. From 2015 to 2017, the CDP supported governance for better local service delivery in 18 districts. It strengthens development of local governance institutions such as Citizen Awareness Centres (CACs), Ward Citizen Forums (WCFs) and Integrated Plan Formulation Committees (IPFCs). The CDP support is based on the 14-step planning process (Keitsch & Gurung 2019). Besides national and regional government stakeholders, several community-based stakeholders like an agriculture development office, an animal service office, a district coordinating committee etc. and non-governmental organizations are involved in local development in Mustang.

Since 2015, several sustainability and local enhancement projects have been initiated by the government, which are today self-sustained and maintained by the local people in the Jhong Ward, the former Jhong VDC. The public mill and the

public toilets in Putak, community plantations in Jhong and irrigation in Chhoekhor village are small, partly governmental funded projects that were mentioned as for the locals. They are successful because local stakeholders know their needs and challenges and share the responsibility of taking care of the public property.

Some projects failed because of unresolvable conflicts between external and internal stakeholders, or/and internal local disagreements;[11] others failed because of poor time management, e.g. phases of too short duration between planning, design and implementation, lack of strategy and/or unfavourable weather conditions. Besides political conditions and regulations, overall project goals and expected results in a transdisciplinary project should be approved by all relevant stakeholders locally to achieve and implement successful solutions (Hirsch Hadorn et al. 2008). Ideally, these goals should correspond with regional and national objectives, or at least not obstruct them.

4.3.2 Project setting and design process

The initial initiative for the project 'Renewable Energy Design of a Solar Street Lamp' came from academic stakeholders (researchers, PhD and master's students) from the Institute of Engineering (IOE), Tribhuvan University Kathmandu, and the Department of Design, Norwegian University of Science and Technology, Trondheim. The entire project period was about two years from gathering information to assessing outcomes for all stakeholders. It began in autumn 2014 with spontaneous dialogues with Jhong residents on needs for sustainability improvement. Early discussions revolved around village issues in major public areas such as the Gumpa (monastery), the Health Post, the Youth Club and Ama-Samuha (mothers' group) building, and topics of concern included e.g. water, energy or waste management. In spring 2015, a community meeting (mass meeting)[12] with about 60 local stakeholders was arranged. Their views, opinions and ideas in terms of renewable energy use were discussed.[13] In this meeting, the locals agreed to build a solar street light project for three reasons: 1) Jhong village has access to the national grid but, due to extreme weather conditions, the grid fails frequently; 2) there is enough solar energy to produce electricity. Once a solar power solution is established, power cuts can be met without difficulties; 3) an SSL not only benefits the local people but also encourages other villages and promotes sustainability.

The mass meeting was followed up by a planning workshop for the project and interviews conducted by researchers and students with local stakeholders, individually and in groups, in 2015 and in beginning 2016.

For the design phase, four MSESSD master's students and one PhD student went to Jhong in autumn 2015 for additional observations and interviews. The master's students arranged a second workshop for project specifications with 19 participants, including village leaders and political party representatives. They applied a funnelling approach to specify technical, functional and operational requirements, where general questions were asked before specific questions. This allows responses to specific questions will not bias answers to general questions.

The students then suggested a concept for a solution, of which a slightly simplified version was manufactured.

A prototype of Solar Street Light was installed in Jhong on February 8, 2016. It was financially supported by the MSESSD programme and coordinated by Jhong Youth Club. The SSL is seen as very useful and beneficial by local people. The prototype parts were designed by a renewable energy entrepreneur company with costs of approximately 30,000 NPR. The battery and panel were set on a private house rooftop. Functionally, the SSL has worked up to the present day (2019) for the whole night, or approximately 12 hours. After three months of evaluation, local people reported that technically, an integrated solution of panel, battery and lamp instead of three different items would be more feasible. Operationally, the house owner and the members of the Jhong Youth Club take care of maintaining the SSL. However, due to lack of interest from local governance, community-based organizations and NGOs, and comparatively high initial costs for solar lighting products, a larger number of SSLs could not be established. Consequently, the Jhong community still must rely on the national grid, which is intermittent due to frequent power cuts, load shedding and high cost in the long run. An integrated, portable SSL was described as the most desirable alternative to the stationary type for rural SSL in 2018.

The installation of several SSLs would have been desirable but failed. In July 2016, the Jhong village secretary applied to the Alternative Energy Promotion Centre for support to establish SSLs but got no financial support due to many local applications and prioritizing. So, even if the prototype were successful and manageable, SSLs were not established in Jhong due to the lack of financial means.

However, a great spin-off of the project was that the Jhong Youth Club manufactured conventional street lights themselves and contacted Nepal Electric Authority (NEA) to connect the street lights to the national grid. NEA agreed to install the street lights on wooden poles. In this way, electric street lights are provided to the village when the grid works.

Shifting to the ethical analysis in section 4.3.3, the Jhong project comprised two main values to be realized: 1) ensuring that communication and trust were established and maintained among stakeholders; and 2) creating opportunities for realizing the selected solution. Trust was established practically, through repeated meetings and collaboration activities which stretched over several months and repeated visits. Besides interviews with the local people, activities such as conversations with various residents without directly going into the topic were made by the author of the chapter and her research team, and partaking in festivals and community activities took place. Trust was mutually built here by each side letting go of the script, engaging in authentic dialogues and letting the others take charge. Together with the goodwill of the local stakeholders to go for the project, the activities here also generated mutual openness and in-depth information. Trust, long term, is a value that takes time to be established; it can increase as well as drop over a project period. Patience with each other and mutual respect for diverse views and cultural attitudes (Dinca 2011) are as important conditions for trust building as acknowledging each other's expertise and professionalism.

Additionally, expertise and skills from both sides must be made accessible e.g. with help of narratives, visualization and/or new media. Clark & Button (2011) see creative imagination in thinking and making as an essential part of transdisciplinarity and suggest connecting art, science and local communities to facilitate mutual learning (Shrivastava & Ivanaj 2011).

Regarding opportunities such as promoting solar street lights on a higher decision-making level in the VDC to get the fiscal year budget, internal and external stakeholders played a major role while academics turned out to be less important. This implies a need to let go in the right phase and not overload a project with scientific expertise. Generally, realizing a project on a bigger political and technical scale is a tedious process. Having different expectations on how big a project and its outcomes should be, all stakeholder parties should formulate concrete scale expectations in the planning phase, relating to time frame, expenses, own contributions and results. These can be adjusted in the design process but will form a baseline that contributes to reducing mismatching assumptions about what a project is able to deliver. The collaborators should also agree that the project is part of an overall (sustainability) learning context. For example, contributing to sustainable settlements and/or eco-village development in Jhong: both concepts have to be made accessible to stakeholders in a feasible in a step-by-step manner and based on their own decision-making practices (Keitsch & Gurung 2019).

4.3.3 Ethics analysis

4.3.3.1 Gather and process information

In the first stakeholder meeting, it became evident that both local and academic stakeholders needed updating on each other's background knowledge. Common ground was based on three assumptions: 1) the energy situation in Mustang is critical at present; 2) solar energy is widely and extensively available in Mustang; and 3) it can be utilized as a clean energy resource for local sustainable development. The assumptions are presented linearly; in the discussions, they were not followed in a back and forth discussion in each phase.

The following section exemplifies how information was presented and processed in the planning phase; technical and organizational aspects in the design and maintenance phase were treated similarly. Regarding Habermas' first validity claim, for 1) and 2) local stakeholders accepted facts from the District Development Committee (DDC) Resource Mapping Report (2015) and from a World Bank Report (2017). Both the DDC and the World Bank are credible and prominent actors, known to governmental stakeholders in the village, whose information stabilized the assumptions. According to these reports, Mustang energy demand is growing; however, the district also has the maximum of solar and wind energy resources in Nepal

The map was explained and discussed in the stakeholder team e.g. how much solar energy/electricity could be produced and, especially, with what means. Discussing the relation between the source and the technology possibilities is a

difficult part. Scientific 'truths' have to be presented in an understandable way, comparing solar energy generation e.g. to an existing solar cooker in the village and explaining the difference between photovoltaic and thermal energy. The academic stakeholders presented illustrations on how four renewable energy technologies (biogas, solar, hydro and wind energy) function. Ethically, 'claims of truth' request the academics to present facts as explanatorily and plainly as possible, i.e. without academic rhetoric, and ask the local stakeholders to be honest about real conditions without exaggerating conditions to achieve collaboration.

With regard to 3), it is very important to achieve a common understanding on how renewable energy solutions, in this case the solar street light, should be designed. Even if there are many SSL designs available, the challenge was to develop a product that met the local circumstances. This means, among other things, a need to clarify local skills and knowledge. Mustang is relatively isolated in terms of technical support, and while the residents in Jhong are skilled in repairing mechanical products, they are not trained to repair solar panels, oxidized wires etc. The SSL design further requires estimations of the local contribution for manufacturing and maintenance. The per capita income of Mustang as of 2014 was approximately 1,922 USD annually, and economically, the SSL was a burden with comparatively high investments and low financial return (Keitsch & Gurung 2019).

The selection of a solution also implied significant differences in decision-making, of which one turned out to be most relevant. The main livelihood of 90% of the residents in Jhong is farming. Decisions on farming contrast to those on technology projects. The ethical choice here was to respect entirely different ways of planning regarding solution preferences. For example, academic stakeholders would do a cost–benefit analysis, which is a nonsensical method to most local stakeholders. Restraining from another explanatory approach that could result in an imbalance of power relations between the stakeholders, the team adopted a local approach for decision-making, called 'dropping pot analysis' (Keitsch & Gurung 2019, 27 ff). Dropping pot analysis has been used in Jhong to identify sources of income and assist on reduction of expenditures in projects. It facilitates discussion in the community.

Conducting a complete dropping pot analysis for the SSL was not possible in this project, but adopting the method for discussion generated understanding on expenses and facilitated the decision to produce SSL prototype parts in Kathmandu and assemble them in Jhong, rather than relying on support from government or donors for a ready-made model.

Conclusively, Habermas' claims for truth are a valuable onset for discussions and can be deliberately used by stakeholders. First, as reminder to be as clear, transparent and understandable as possible within a team. Second, they can contribute to creating awareness that facts vary and explanations have to be adapted to specific situations. Ethically, the possibility of reaching a common solution should determine how facts are presented and what methods are chosen, rather than the academic grandiosity to present them as sophisticated as possible.

4.3.3.2 Identify conditions for collaboration

Initiating collaboration stakeholders implies profound respect for the practicalities in their life world and everyday business. This means, in our case, that meetings with rural residents were scheduled when and where it was most appropriate for them, e.g. early in the morning before or in the evening after field work, in their homes, in the community hall, the mothers' club (Ama-Samuha) etc. The inclusion of female stakeholders in meetings was especially complicated in this project, and they seldom participated in discussions because they were constantly occupied with field or household work. This problem was partly mitigated by conducting individual interviews and joining Ama-Samuha's group meetings.

Habermas' claim for rightness, where pro and contra arguments are given and discussed on a rational and equal basis, depended in this project greatly on the participants. If residents had the same gender and a similar social status in the community, and the hierarchy between them was clear, the discussion was open and frank. However, the community is becoming increasingly heterogenous with low-caste people from other districts moving in as paid workers. This corresponds with Lengwiler's (2006) observation that TDC stakeholders are likely to come from diverse backgrounds with varying worldviews and perspectives. In the Jhong case, worker migrants do not have a say in village decisions, and they are not entitled to join the village council, the Ama-Samuha or the Youth Club. However, they are needed to sustain the community, which is threatening to shrink population-wise due to Jhongeli migration abroad, and many worker migrants have the skills to contribute to realize village improvements. A TDC approach to the exclusion dilemma involved single consultations with these stakeholders, comparing their views with the 'majority'.

Implementing the solution, it turned out that worker migrants were involved in setting up the SSL while instructions came from the (male) villagers. Another inclusion challenge in collaboration activities are government representatives, such as the village secretary. These are not Mustangi and thus not allowed to take part in decision-making, yet they have an 'official' role and the residents must include them e.g. in the mass meeting. If possible, they are circumvented. The project could not deal with this challenge without losing their credibility to the residents. The academic stakeholders tried to emphasize, however, that an increase of the SSLs beyond the prototype needed political support and that official representatives can help to achieve this.

Overall, Habermas' ideal of an emancipatory discourse seems difficult to realize in this kind of setting. Engrained ideas of hierarchies, roles and castes, religiously and socially stabilized, were prevalent and omnipresent in all discussions. This does not mean, however, that there is no mutual ethical understanding. Respect, empathy, doing no harm to living beings and the duty to *act* altruistically towards less fortunate fellow humans is morally mandatory in Buddhism. However, misunderstandings and disputes concerning values in Sankya Buddhism, with its tacit paternalist implications, and values in secularized Western emancipatory ethics can emerge easily, especially when the team members additionally must grapple

with prejudices and stereotypes of each other. The main ethical condition for this project was thus to build mutual tolerance of diverse views. TDC can comprise a variety of values, conceptions and beliefs, and team members must also accept that these values overlap only to a certain degree (see also Wickson et al. 2006; Augsburg 2014). Evident values, such as learning from each other, should be emphasized since they provide a common ethical platform. Also, in the SSL project, pragmatic involvement of marginalized residents or groups increased respect and altered rigid hierarchy perceptions of some stakeholder to a certain extent (Singh & Keitsch 2014).

Habermas' claim for truthfulness concerning individual experiences and attitudes plays a significant role in the context of identifying conditions for collaboration. Ethics is here seen as universal human behaviour and connected with contextual experiences and realization. The claim for truthfulness refers to most significant human qualities such as sincerity, authenticity and honesty. These qualities are universally valuable, and realizing them through stakeholders' attitudes, behaviour and interactions evokes respect in a community, despite one's gender, role or status.

4.3.3.3 Assess project relevance for all stakeholders

Developing mutual understanding based on different interpretations, agendas and needs is a huge challenge in TDC projects. Interpretations concern here worldviews and values as well as recognition of facts and ways of how things are or should be done. For example, in Jhong there is no voting rule of majority in decision-making, but the discussion lasts until everyone in the group agrees. Agendas come with different societal structures (subsystems) where stakeholders are embedded; the purpose for academy is gaining new knowledge, for local stakeholders getting practical support with everyday life, for politicians developing laws and regulations etc.

According to Luhmann (1989), understanding each other within these subsystems is impossible, while for Habermas (1987) it is probable. Darsø (2001, 176) enlarges Habermas' view by specifying that a common ground is dynamic and must be established early in a project: 'Communication consists of sharing between members in such a way that each member listens, participates in and contributes to sharing, but the contributions and experiences of individual members are not identical'. Interest in meeting specific problems is also part of this common ground, and research products and objects in the widest sense also serve as boundary objects (Keitsch 2015), facilitate communication between design areas and provide a *practical* relevance for all stakeholders.

For the Jhong residents, the research product/prototype was convenient, and they were content with the SSL and experiencing its potential and benefits (Keitsch & Gurung 2018). After three months of evaluation, however, residents reported that technically, an integrated solution of panel, battery and lamp instead of three different items would be more feasible. After one year, they reported that an integrated portable SSL would be most desirable as an alternative to the

stationary type for rural SSL. In 2016, the local stakeholders applied for subsidies to different governmental stakeholders and organized SSL maintenance by the Jhong Youth Club. Yet, due to lack of interest from local governance, community-based organizations and NGOs, and the still comparatively high initial costs for solar lighting products, a larger number of SSLs could not be established. A successful, if unexpected, spin-off of the project that has probably a long-term impact is knowledge generation. When the local stakeholders learned that there was no funding, the Jhong Youth Club manufactured 30 conventional streets lights themselves. Then they contacted Nepal Electric Authority, which agreed to install them on poles. In this way, electric street lights are provided to the village, at least when the grid works.

The Jhong residents confirmed that the SSL project had motivated the community to not only adapt parts of the SSL planning process but had also to initiate change for better electricity conditions in the village. This was partly due to the persistence of the team to overcome difficulties and the fact that most stakeholders in the project felt trusted and respected. The trust aspect was confirmed in conversations with stakeholders from both academia and the community, after the end of the project, and also attains credibility through the fact that collaboration with the community on other sustainable projects has continued to today.

The academic stakeholders found relevant insights on how to plan, organize and conduct transdisciplinary collaboration. An assessment of if and how TDC insights will change the way disciplines at universities work, when actively including civil society and societal stakeholders (McGregor 2015), was in this generic form not part of our project. Yet, the following possibilities for transdisciplinary SDG augmentation were noticed. Chronologically, the willingness of all stakeholders in the project to proceed with sustainability challenges allows a *prolongation* of the SDG agenda. Spatially, the project facilitated expansion to a nearby region, thereby *broadening the range* of SDG implementations. Academically, the project gave input for TD inclusion in master's and PhD curricula in sustainable design and planning.

For academic actors, TDC comprises many benefits and challenges. Ethically, reflections by academic stakeholders on their role and responsibilities within a dynamic and contextual setting can contribute to mitigating academic almightiness. If the timeframe permits it, it is advantageous e.g. to co-design learning processes to create common understanding. This can be done with visualization and creative methods that include and illustrate different knowledge and experience settings. The results of the TDC project and process should also be transparent and disseminated to *several* relevant audiences. Stakeholders in the TDC have responsibility to promote them within different channels, while dissemination may vary in form and type (Defila et al. 2014). Dissemination can also occur when the former partners start working on different problems in the same context, reapplying practices that worked before and learning from former experiences and challenges (Keitsch & Gurung 2018). In this way, the generated transdisciplinary knowledge can be kept alive and dynamic, because those co-creating it are active and alert in dealing with new and comprehensive local sustainability opportunities. In case of

Jhong, this means e.g. how to adapt and adjust eco-village strategies and embed, for example, solar and renewable energy use, waste and water management and income generation into the overall picture of a resilient, sustainable village.

Conclusively, integrative ethics (IE) seems theoretically relevant for TDC. An IE maxim could be to recognize shared values instead of moral motives as an onset for describing moral actions (McGregor 2015). An IE attitude for TDC projects can be described with the term 'postconventional moral conscience',[14] i.e. seeing oneself *as part of not apart from* the context with its own individual values and norms that influence a TDC team. Further, postconventional moral conscience requires a valuation of different types of knowledge to be of relevance as well as acting respectful and fair towards other stakeholders and showing care for human relationships. Overall, the IE concept must be elaborated further, among others things with regard to antinomies of universalism and relativism and the relation between theoretical and applied ethics. Finally, nature as living space and possibility for experience is an ethical asset that can work as a regulative in TDC, which is currently dominated by fact fetishism and instrumental rationality. As a regulative, nature experiences can support TDC decisions because they often transcend material aspects. They are linked to emotions and bodily states such as growing health problems due to environmental impacts, feelings of unhappiness with the design of natural surroundings, and doubts of whether there is enough space and food for the people. Additionally, allowing for contextualized and subjective interpretations, values and norms recognize partners not only as stakeholders but as individual beings (Seghezzo 2009). Overall, this incorporation may generate a comprehensive TDC ethics integrating claims for truthfulness, purposive rational arguments and concrete necessities.

4.4 Conclusion

As illustrated earlier, working with TDC and sustainability in local contexts requires all partners to discuss, appreciate and manifest different relations to natural and social–cultural contexts. These requirements comprise two essential ethical conditions for success: diversity and openness. Diversity means, metaphysically, the acceptance of e.g. the polyvalent character of nature interpretations expressed through multiple perspectives from stakeholders. Practically, it means that a TDC project comprises various roles, goals and responsibilities, partly assigned through structural circumstances, e.g. academics provide theory knowledge and methods, residents contribute information and material resources, policy makers strategies etc. TDC partners should be aware that tensions related to conflicting goals and ambitions can appear in a team. Respecting diversity guarantees that goals and responsibilities are met in a fair manner. Equality of position provides that reasons are given in a discourse, without being judgemental of the beliefs, cultural habits or personal attitudes of stakeholders. This includes that all actors are treated alike, regardless of their role, religion, gender, personal beliefs etc. and that the question of power is (heuristically) not of importance or, as Habermas puts it, that 'the unforced force of the better argument prevails' (in:

Allen 2012). Diversity and openness are connected because TDC includes per se diverse partners, while achieving solutions requires openness to other stakeholders' opinions. TDC openness endorses, among others, the following regulatives:

- Goal adjustments to overcome individual prejudices;
- Understanding of common lifeworld as onset for actions, which provides by the same way resources for actions;
- Communication between experts and non-experts through non-domination of groups to steer TDC on their own terms using e.g. professionally coded language.

Openness is needed to be logically fascinated by the variety of opinions in a discourse, to ethically admire the willingness to find compromises and to take up the designerly challenge to find feasible solutions. Practically, openness allows a systemic onset, asking first after common goals and how single participants or groups may contribute to achieve them, instead of arguing for interests as an onset for discussions. Openness thereby signifies potential for expanding ways of seeing a certain problem (Mylonakou-Keke 2015). Gadamer (1975) sets a hermeneutic, transcendental–pragmatic agenda for this openness in TDC, referring to the aim for a state of mind that is the condition for interpretive and liberating reasoning. He explains as follows:

> When we try to understand . . . we try to understand *how what the other is saying could be right*. If we want to understand, we will try to make his arguments even stronger. This . . . is *a fortiori true* of understanding . . . the miracle of understanding, which is not a mysterious communion of souls, but sharing in a common meaning.
>
> (emphasis M.K.)

In TDC practice, cultural contexts are intrinsically tied to the aforementioned ethical conditions in realizing diversity and openness. The lifeworld of stakeholders may vary greatly considering e.g. urban, peri-urban and rural contexts (Marshall & Dolley 2019). In urban Nepal, for example, multiple and varying roles of participants and diffuse power relations are mor easily acceptable in urban contexts, which facilitates openness e.g. towards the acceptance of new stakeholders (Singh & Keitsch 2016). In rural settings, power structures are often formally defined, and even if respect is given, appreciation must be earned. Initially, openness towards newcomers is limited. Further, defined power structures can make relations and collaborative tasks clearer, but they can also lead to deep-rooted power struggles and conflicts that impede decision-making. An exception, regarding openness as a necessity in rural contexts, is when environmental changes forge innovation. In this case, stakeholder constellations and power relations can change quickly (Keitsch & Gurung 2019). Ethnic diversity is part of everyday lifestyles in Nepalese cities and engenders public lenience. Urban stakeholders in Nepal may, however, be less open and relate strongly to traditions, when they fear

losing their cultural identity, while rural people seem to have deep traditional and religious roots and cultural habits (Singh & Keitsch 2016). Referring to national settings, when diversity and openness are part of a common socio-political value canon, as for example in Western and in some industrialized countries, they are easier to mediate with stakeholders than in conservative, developing countries, where securing basic needs has priority over experimenting and possibly failing in the social and sustainable fabric.

To conclude, further research and analyzes on the relations between ethical conditions, contextual values and successful TDC are needed. Besides developing an integrative ethics for TDC on a metalevel, this comprises concrete studies on how e.g. openness and diversity are understood and realized in distinctive geographic surroundings. The author's overall impression is that the pursuit of ethics would, together with a steadier epistemology, contribute significantly to the future development of just, pragmatic transdisciplinary collaboration on a global scale.

Acknowledgements

This research was supported by NORAD's Energy and Petroleum Programme (EnPe). I would also like to express my gratitude to Mr. Nyima Tsering Gurung for his tireless efforts to convey Mustangi culture to the researchers and students of MSESSD and to Mr. Helmut Herzberg and Mr. Bijay Singh for their valuable insights and support during this research.

Notes

1 However, assuming an immediate identity between a subject's knowledge of an object and the object itself its questionable. According to Kant, one can never truly know reality in itself (the noumenal world) since human understanding is based on bounded perceptions (phenomenal world) and processed and represented in time and space. (www.britannica.com/topic/noumenon).

2 In contrast to Aristotle's logic of the Excluded Middle ($a = b$, or $a \neq b$), the Included Middle is a theory proposing that logic has a three-part structure. The three parts comprise $a = b$, their negation $a \neq b$ and a third position, which is neither ($a \vee b$) or both ($a \veebar b$). Axion 1 claims that different 'reality levels' for objects (nature) and subjects (society) are alike and of equal value ($a = b$); axiom 2 introduces the Included Middle ($a \vee b$ and $a \veebar b$). A logical conclusion in axiom 3 would be that it is possible to transgress from reality levels for objects to reality levels for subjects ($a = b$). Yet, axiom 3 describes something else (Included Middle. www.edge.org/response-detail/27155, last visited 26-03-2019).

3 Appeal to nature fallacy: because something is natural, it is morally acceptable. Fallacy Files, www.fallacyfiles.org/adnature.html, last visited April 20, 2019.

4 If Nicolescu's reality concept comprises an ontological fallacy (assuming that something exists because there is a term for something), it remains controversial but is not relevant for this chapter.

5 In anthropocentrism, nature has no *intrinsic* value or right on its own. Muir (in: Sessions, George. 1995. *Deep Ecology for the 21st Century*. Shambhala Publications, Inc, Boston, Massachusetts, p. XII) expresses this in a classic dispute with Pinchot, a defender of eco-centrism: 'Even wilderness and other species had no value for their own sake; they were just human "resources" to be either exploited through resource

extraction or enjoyed for their recreational or aesthetic values or to be saved for the enjoyment of future generations of humans'.

6 Virtue ethics emphasize the development of moral abilities (virtues), while deontic ethics refer to duty as cause for moral actions.

7 Roughly explained, transcendental pragmatics allows normative validity claims based on the assumption that values are speech-act inherent preconditions. For example, in a discussion of if the right to live is valid only for humans or for every natural being, the partners presume that the right to live exists, otherwise a discussion would be impossible.

8 Sakya is a tantric tradition which developed during the second period of translation of Buddhist scripture from Sanskrit into Tibetan in the late 11th century (Sakya Buddhism. https://en.wikipedia.org/wiki/Sakya, last visited 26-11-2019).

9 E.g. Annapurna, the name of a mountain range bordering Mustang, is also the name of the goddess of nourishment.

10 Stokols (2006) describes three categories of TDC: 1) among scholars from different fields; 2) among researchers and community practitioners; and 3) among local, regional, national and global organizations. The phases in the Jhong project required interactions in all categories with emphasis on category 2.

11 The project defined 'internal stakeholders' as locals in specific areas or villages who are directly affected by the project's planning and outcomes. 'External stakeholders' are actors whose decisions and strategies have affected or are affecting the locals. Governmental and non-governmental organizations are sometimes present as external stakeholders, involved in community development activities in Mustang. These external stakeholders play a vital role in local development, but their contributions and efforts may result in both positive and negative effects on the local atmosphere. Most of the government projects largely relate to the infrastructure development in villages, like community buildings, toilets, irrigation systems, drinking water projects etc., whereas community-based governmental or non-governmental activities are largely engaged in social, animal health and agricultural development. Usually small grant projects are handed to the locals for implementation. Governmental projects are more effective, but they often have a short-term vision and must meet certain criteria to be fulfilled within a limited period.

12 'Mass meeting' is a commonly used term in Nepal for an officially announced gathering on a certain topic. The term does not indicate numbers of participants; even in a village such as Jhong, with 253 inhabitants, 'mass meeting' is used as an official form of assembly.

13 The decision on renewable energy use was twofold: it was a relevant improvement issue for the local residents and within the framework of the MSESSD programme.

14 Kohlberg defined three levels of moral development: preconventional, conventional and postconventional. The postconventional level of moral development is characterized by a sense of morality that refers to generic ethical principles and values. Kohlberg describes it as: 'Orientation not only toward existing social rules, but also toward the conscience as a directing agent, mutual trust and respect, and principles of moral choice involving logical universalities and consistency' (ww3.haverford.edu/psychology/ddavis/p109g/kohlberg.stages.html).

References

Allen, A. (2012) 'The Unforced Force of the Better Argument: Reason and Power in Habermas' Political Theory', *Constellations*, Vol. 19, No. 3.

Apel, K.O. (1992) 'The Ecological Crisis as a Problem for Discourse Ethics', in Øfsti, A. (ed.), *Ecology and Ethics*, Trondheim, Tapir Forlag.

Augsburg, T. (2014) 'Becoming Transdisciplinary: The Emergence of the Transdisciplinary Individual', *World Futures*, Vol. 70, No. 3–4, 233–247.

Austin (2008) 'Relational Ethics', in Given, L.M. (ed.), *SAGE Encyclopaedia of Qualitative Research Methods*, Thousand Oaks, CA: SAGE Publications. www.yanchukvladimir.com/docs/Library/Sage%20Encyclopedia%20of%20Qualitative%20Research%20Methods-%202008.pdf, last visited 12-12-2019.

Bergum, V. and Dossetor, J.B. (2005) *Relational Ethics: The Full Meaning of Respect*, Hagerstown, MD: University Pub. Group.

Bernstein, J.H. (2015) 'Transdisciplinarity: A Review of Its Origins, Development, and Current Issues', *Journal of Research Practice*, Vol. 11, No. 1, Article R1.

Bracken, L.J. and Bulkeley, H.A. and Whitman, G. (2015) 'Transdisciplinary Research: Understanding the Stakeholder Perspective', *Journal of Environmental Planning and Management*, Vol. 58, No. 7, 1291–1308.

Carson, R. (2002) *The Silent Spring*, Boston, MA, USA: Mariner Books.

Clark, B. and Button, C. (2011) 'Sustainability Transdisciplinary Education Model: Interface of Arts, Science, and Community', *International Journal of Sustainability in Higher Education*, Vol. 12, No. 1, 41–54.

Darsø, L. (2001) *Innovation in the Making*, Samfundslitteratur, Danmark: Fredriksberg.

Defila, R. and Di Giulio, A. (2014, January) 'Integrating Knowledge: Challenges Raised by the "Inventory of Synthesis"', *Futures*, Vol. 65.

Dinca., I. (2011) 'Stages in the Configuration of the Transdisciplinary Project of Basarab Nicolescu', in Nicolescu, B (ed.), *Transdisciplinary Studies: Science, Spirituality and Society*, (No. 2, pp. 119–136), Bucharest, Romania: Curtea Veche Publishing House http://basarab-nicolescu.fr/Docs_Notice/Irina_Dinca.pdf, last visited 20-11-2019.

District Development Committee Mustang (2015) *Regional Government Report Mustang*. http://ddcmustang.gov.np/wp-content/uploads/2015/07/Full-Report-of-Resource-Mapping-Work.pdf, last visited 26-03-2019.

Etymology Dictionary. www.etymonline.com/word/discipline#etymonline_v_11385, last visited 26-03-2019.

Fallacy Files. www.fallacyfiles.org/adnature.html, last visited 20-04-2019.

Gadamer, H.G. (1975) *Truth and Method*. https://mvlindsey.files.wordpress.com/2015/08/truth-and-method-gadamer-2004.pdf, last visited 20-11-2019.

Gimmler, A. (2019) *The Discourse Ethics of Jürgen Habermas*. http://caae.phil.cmu.edu/Cavalier/Forum/meta/background/agimmler.html accessed, last visited 26-03-2019.

Giri, A.K. (2002) 'The Calling of a Creative Transdisciplinarity', *Futures*, Vol. 34, No. 1, 103–115.

Government of Nepal, National Population and Housing Census (2011). https://unstats.un.org/unsd/demographic-social/census/documents/Nepal/Nepal-Census-2011-Vol1.pdf, last visited 28-07-2020.

Habermas, J. (1984) *The Theory of Communicative Action 1*. Reason and the Rationalization of Society, Cambridge, UK, Polity Press.

Habermas, J. (1987) *The Theory of Communicative Action* (Vol. 2). Lifeworlds and System: A Critique of Functionalist Reason (TCA II). McCarthy, T. (trans.). Paperback edition from 2006, Cambridge, UK, Polity Press.

Habermas, J. (1990) *Discourse Ethics: Notes on a Program of Philosophical Justification*, Cambridge, MIT Press.

Hirsch Hadorn, G., Hoffmann-Riem, H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Wiesmann, U., and Zemp, E. (Eds.) (2008) *Handbook of Transdisciplinary Research*, Netherlands, Springer.

Høiseth, M., Keitsch, M. and Hopperstad, M. (2014) 'Interactions between Caregivers and Young Children: Exploring Pedagogical Tact in Nebulizer Treatment', *Qualitative Health Research*, Vol. 24, No. 12.

Huutoniemi, K. and Tapio, P. (eds.) (2014) *Transdisciplinary Sustainability Studies: A Heuristic Approach*, Routledge Studies in Sustainability, London, Routledge Publisher.

Included Middle. www.edge.org/response-detail/27155, last visited 26-03-2019.

Kant, I. (1781) *Critique of Pure Reason* (German, 1781, Kritik der reinen Vernunft), Transcendental Aesthetic 85. https://archive.org/stream/immanuelkantscri032379mbp/immanuelkantscri032379mbp_djvu.txt, last visited 26-03-2019.

Keitsch, M. (2003) 'Naturästhetik und ökologische Ethik, Eine Einführung', *Bioethiana, Forschungsergebnisse zur Philosophie*, Hamburg, ISBN 3-8300-0962-3.

Keitsch, M. (2012) 'Ethical Implications of Systems Methodology Applied to Industrial Ecology', *Sociology Study*, Vol. 2, No. 1.

Keitsch, M. (2015) 'Boundary Objects as Means for Knowledge Generation in Design Education', *International Conference on Engineering and Product Design Education*, Lough-borough University, Design School, Loughborough, UK, 3–4 September.

Keitsch, M. (2018) 'Structuring Ethical Interpretations of the Sustainable Development Goals: Concepts, Implications and Progress', *Sustainability*, Vol. 10, No. 3, 829.

Keitsch, M. and Gurung, N. (2018) 'Transdisciplinary Collaboration in Renewable Energy Projects: A Case Study from Mustang, Nepal', *The 4th International Conference on Renewable Energy Technology for Rural and Urban Development (RETRUD-18)*, Kathmandu, Nepal, 29–31 October.

Keitsch, M. and Gurung, N. (2019) *Stakeholder Collaboration in Rural Settings: Part 1: Manual for Local Project Planning*, Trondheim, Eigenwert Verlag, ISBN 978-82-691749-2-2.

Krebs, A. (1999) *Ethics of Nature: A Map*, Berlin, de Gruyter.

Lengwiler, M. (2006) 'Between Charisma and Heuristics: Four Styles of Interdisciplinarity', *Science and Public Policy*, Vol. 33. http://dx.doi.org/10.3152/147154306781778821, last visited 26-03-2019.

Luhmann, N. (1989) *Ecological Communication*, Cambridge, UK: Polity Press.

Marshall, F. and Dolley, J. (2019) 'Transformative Innovation in Peri-Urban Asia', *Research Policy,* Vol. 48, No. 4, 983–992.

Max-Neef, M.A. (2005) 'Foundations of Transdisciplinarity', *Ecological Economics*, Vol. 53, No. 5–16, 13, 15

McGregor, S.L.T. (2015) 'Transdisciplinary Knowledge Creation', in Gibbs, P.T. (ed.), *Transdisciplinary Professional Learning and Practice*, New York, NY: Springer.

Muir, J. (1995) in Sessions, G. (ed.), *Deep Ecology for the Twenty-First Century*, Shambala, UK: Oxford University Press.

Mylonakou-Keke, I. (2015) 'The Emergence of "Syn-Epistemic Wholeness" from Dialectic Synergy of Disciplines: A Transdisciplinary Social Pedagogic Model', *Creative Education*, Vol. 6, 1890–1907.

Nicolescu, B. (2000) *Transdisciplinarity and Complexity*. Bulletin Interactif du CIRET, Paris. http://ciret-transdisciplinarity.org/bulletin/b15c4.php, last visited 26-03-2019.

Nicolescu, B. (2002) *Manifesto of Transdisciplinarity*. Charter of Transdisciplinarity. http://inters.org/Freitas-Morin-Nicolescu-Transdisciplinarity, last visited 26-03-2019.

Nicolescu, B. (2010) 'Methodology of Transdisciplinarity: Levels of Reality, Logic of the Included Middle and Complexity', *Transdisciplinary Journal of Engineering & Science*, Vol. 1.

Odum, E.P. (1998) *Ecology: A Bridge between Science and Society*, Sunderland, MA, USA, Sinauer Associates Publishers.

Øfsti, A. (1992) *Ecology and Ethics*, Trondheim, Tapir Forlag.

Palaiologou, I. (2012) 'Ethics in Multi-Agency Working', in Palaiologou, I. (ed.), *Ethical Practice in Early Childhood*, Thousand Oakes, CA, SAGE Publications.

Sakya Buddhism. https://en.wikipedia.org/wiki/Sakya, last visited 26-11-2019.

Seghezzo, L. (2009) 'The Five Dimensions of Sustainability', *Journal Environmental Politics*, Vol. 18, No. 4. https://doi.org/10.1080/09644010903063669 4, last visited 26-11-2019.

Shrivastava, P. and Ivanaj, S. (2011) 'Transdisciplinary Art, Technology, and Management for Sustainable Enterprise', *Transdisciplinary Journal of Engineering & Science*, Vol. 2, 81–92.

Singh, B. and Keitsch, M. (2014) 'Sustainability and Public Space: A Stakeholder Collaboration Approach', *Proceedings of the 20th International Sustainable Development Research Conference*, Trondheim, 18–20 June, ISBN 978-82-91917-34-4.

Singh, B. and Keitsch, M. (2016) 'Cultural Sustainability and Space: A Comparison of Two Cases in Kathmandu, Nepal', *Sustainable Development*, Vol. 24, No. 5, 307–318.

Stokols, D. (2006) 'Toward a Science of Transdisciplinary Action Research', *American Journal of Community Psychology*, Vol. 38, 63–77.

Wickson, F., Carew, A.L. and Russell, A.W. (2006) 'Transdisciplinary Research: Characteristics, Quandaries, and Quality', *Futures*, Vol. 38, No. 9, 1046–1059.

World Bank (2017) *Map on Solar Energy in Nepal*. http://documents.worldbank.org/curated/en/585921519658176633/pdf/123705-ESM-P150328-PUBLIC-NepalSolarMappingCountrySolarResourceReportMarch.pdf, last visited 20-11-2019.

5 Transdisciplinary research

Practitioners' lessons on key methodological challenges

Joachim H. Spangenberg

5.1 Introduction

A broad consensus is emerging that solution-oriented science is needed to inform decisions for addressing today's complex and interacting social, environmental and economic problems (Wiek et al., 2006; Siew et al., 2016), and that no individual discipline is capable of offering appropriate solutions (Pohl et al., 2017; Spangenberg, 2011; see also Chapter 2). Such solutions would have to be scientifically sound, socially robust and practical in application and, in particular, take ignorance, uncertainty and risk into account (Funtowicz & Ravetz, 1990; O'Connor, 1999; Rotmans et al., 2001; Walker et al., 2003).

While the history of TD is reaching back deeply into the last century (see Chapter 2), the conceptual work underpinning TD is not yet mature enough to provide sufficient and satisfactory guidance on methodological issues: how to conduct a TD project; how to deal with stakeholders; and how to coordinate the internal and external relations of research projects. It is time now to confront existing methodological concepts with accumulating hands-on local experience and, in a bottom-up approach, modify concepts and identify gaps, such as the qualifications required to successfully conduct TD research. Thus, this chapter starts with a look at the status quo of concepts and experiences, before describing methodological challenges and potential responses identified by practitioners in 25 years of TD research. The empirical basis is mainly projects in the field of sustainability science, with TD ranging from conceptual work to collaboration, exchange and joint reflection with civil society (NGOs, environmental justice movements, trade unions, religious associations and organizations, business, politicians and farmers) in Europe, Africa, Asia and Latin America.

The exchange with colleagues involved in different projects in the Land Management Research Programme of the German Ministry of Education and Research (BMBF, 2008) during formal and informal meetings helped consolidate individual experiences into the more generalized picture presented here. Discussions at the German Future Earth conference helped to refine and confirm the analysis (DNK Future Earth, 2018). Hence, the chapter combines literature sources with conclusions drawing on the oral exchange of mostly unpublished experiences.

5.2 Status quo: blueprints and reality check

Transdisciplinarity is mostly invoked to improve the social and scientific quality of knowledge, i.e. to support the generation of problem solving or transformative knowledge (Polk, 2014; Faucheux & Hue, 2001; Jahn et al., 2012). Three main conditions for real-world contributions to problem solving were identified in an in-depth evaluation of the EU INCO research programme (Nauen et al., 2006; European Commission, 2019). They are confidence, perceived competence and communication capability, which have to be secured in the respective research. *Confidence* and trust are fostered by transparency, openness of motives and actions, accountability and legitimacy enhanced by participation. Extended collaboration time – unusual as it is in research projects – supports confidence building (Gibbons et al., 1994). *Competence* attribution is best supported by credible results, addressing societies' needs, underpinned by mutual recognition among scientists. However, this is not enough – the quality of information and knowledge provided must be recognized by (dominant) social actors. Understanding local needs and the legal, social and political implications of recommendations, and being able to communicate in the prevailing cultural framework, are important conditions (Nauen et al., 2006). Crucial from the project outset is the *capability* for convincing communication based on knowledge which is not only factually but also politically relevant, addressing all target groups by adequate means. The more people believe in someone or something, the more the impact of actions or attitudes based on that confidence will increase to the point where it may become self-fulfilling prophecy.

A second condition, rarely met by research projects but more frequently in development cooperation, is a project's ability to support the problem-solving process (ibid.). To the dismay of many scholars, scientific quality is not one of the most prominent influence generating factors, as it is a quality often verbally supported but in essence alien to stakeholders, other than those with a scientific education (as a result, good science will not beat fake news alone based on its quality).

To meet the condition of confidence, competence and communication capabilities, combining disciplinary knowledge is not enough; the tacit, experience-based contextual knowledge of stakeholders offers additional relevant information which needs to be integrated on an equal footing, including indigenous and local knowledge (IPBES et al., 2019). It is the local stakeholders who have first-hand knowledge about the social structure of communities, including the power relations at local and national levels, and thus may correct naïve assumptions of (often foreign) researchers, but also of higher-level decision-makers. Consequently, TD has been conceptualized as a combination of interdisciplinarity and stakeholder integration for the co-production of knowledge, which supports solving sustainability problems (Max-Neef, 2005; Pohl & Hirsch Hadorn, 2007). However, already this rather vague description points to some of the epistemological and ontological challenges discussed below. They are decisive for the choice of methods (mostly developed by individual disciplines) and the conduct of transdisciplinary research projects (Angelstam et al., 2013; Bracken et al., 2014).

Several typologies of participation have been developed for TD research (Hadorn et al., 2008; Pohl & Hirsch Hadorn, 2008); for their emergence and definitions, see Chapter 2. Communication structures and the degree to which the power to determine the agenda and outcomes of a participatory process is shifted to those affected are the most frequently used classification criteria in these typologies, going back to the 'ladder of participation' suggested by Arnstein (1969). He argued that real participation only takes place when the public is given sufficient power to negotiate their interests and put this kind of interaction at the top of the ladder. Some authors argue that the selection of stakeholders and involvement methods as well as the intensity and form of stakeholder involvement should be adapted to the problem addressed, the research context and objective, the specific stakeholder group, the extent of agreement regarding values and knowledge and the project phase; they should consider aspects such as interests, availability of time, resources and capacities of stakeholders and researchers (Schmidt et al., 2018; Hurlbert & Gupta, 2015; Spangenberg et al., 2015, 2018; Görg et al., 2014; Neef & Neubert, 2011; Reed, 2008; Newig et al., 2008; Stauffacher et al., 2008). The 'ladder' is used here as a structuring approach, not to deny the need for adaptation to the local, temporal and social circumstances.

Least intensive and thus level 1 is one-way communication (information collection, for instance through expert interviews, and information dissemination, for example by information and training workshops, or through media); it is disputed whether this level of involvement already fulfils the definition and intention of transdisciplinarity (Pohl & Hirsch Hadorn, 2008; Spangenberg, 2011). The second level is two-way communication with mutual learning, e.g. in stakeholder dialogues of local, regional and national level policy makers (Durham et al., 2014), or citizen science approaches mobilizing knowledge and raising awareness, for instance regarding locally specific or unique biodiversity, or goal-oriented focus groups (Theobald et al., 2015; van Etten et al., 2019). On this level, stakeholders have influence through mutual learning processes, but it is not institutionalized. The next level is joint learning through socio-cultural experiments – e.g. in the Farmer Participatory Research approach, or through Participatory Rural Appraisal techniques elucidating the benefits of certain behavioural and management changes (Huan et al., 2005). The highest level of participation is reached when the public is given sufficient power to negotiate their interests or gain full managerial power. The resulting co-creation of knowledge has been suggested as a way to operationalize substantial transdisciplinarity. It has initially been defined as 'a common learning process between different social actors' required by 'unstructured problems' (Regeer & Bunders, 2009, p. 11). This is the case if the 'problem is one that acts on several system levels, with different societal actors, and where there is no consensus about the problem definition or the most suitable direction for a solution' (ibid., p. 18). Funtowicz and Ravetz (1993) call this 'post-normal' situations, emerging when 'facts [are] uncertain, values in dispute, stakes high and decisions urgent' (p. 744). For these situations, they suggest a 'transdisciplinary' approach to problem-solving research, innovations and solution implementation (see Chapter 2 for more information on the post-normal science approach).

However, while there is a growing literature on theories and concepts of TD (see e.g. Hadorn et al., 2008; Pohl & Hirsch Hadorn, 2008; Polk, 2014), discussions among practitioners reveal that they are often considered as overly abstract and too strict to accommodate the particularities of local social, cultural and economic settings (Fritz & Binder, 2018; Zscheischler et al., 2014). A growing number of researchers and stakeholders report that – partly as a result – expectations regarding the involvement of stakeholders in research and decision-making are often not met in practice (see e.g. Blackstock et al., 2007; Bracken et al., 2014). Such concerns were discussed at the roundtable 'Beyond Speaking Truth to Power? The Implications of Co-Creation for Research and Policy Advice' at the 3rd German Future Earth Summit – From Knowledge to Action, February 8 and 9, 2018, in Berlin (BMBF, 2018). Furthermore, comparative analyses of projects conducted under the Land Management Programme of the German Ministry for Research and Education BMBF have highlighted the diversity of situations projects have to adapt to, but also the commonalities of TD projects across different themes and four continents (Siew et al., 2016; Falk et al., 2018; Schmidt et al., 2018; 2020).

The shared experiences showed that the expectations of what TD co-creation can deliver are often unrealistic: TD as a collaborative and reflexive approach needs time before any results emerge. It is a trust-based collaborative effort which is at risk of collapse if temporal pressure is enacted. The quality of interactions and the respective outcomes depend on the whole range of different actors involved, on their mutual trust and on whether interactional and procedural justice is sufficiently addressed in the knowledge co-producing TD process (Hurlbert & Gupta, 2015; Nauen et al., 2006). Recurring challenges include significant requirements of time and resources, language barriers, conflicting interests, knowledge and institutions and hierarchically structured socio-cultural and political environments (Lang et al., 2012; Schmidt & Pröpper, 2017; van Kerkhoff & Lebel, 2006). For instance, when conducting a formative evaluation of four projects on sustainable land and water management in China, the Philippines and Vietnam based on guiding principles of TD, Siew et al. (2016) found that in all projects, local political conditions restricted the set of stakeholders that could be involved in the research processes, and stakeholders in most cases only participated if they belonged to the personal network of the project leaders. Spangenberg et al. (2018) found similar network effects in Vietnam and the Philippines. Thus, there is no one-size-fits-all approach to TD – to the contrary. All the more important is gaining more clarity about the challenges, and some basic steps to accommodate them.

5.3 Challenges

The main conceptual, epistemological, ontological but also practical challenges which impinge on the success of TD projects can be summarized in a few key points. As TD has been conceptualized as a combination of interdisciplinarity and stakeholder integration, we start with problems already inherent to interdisciplinarity, before addressing the challenges arising from the role of stakeholders as an 'extended peer community' (Funtowicz & Ravetz, 1993, p. 744).

5.3.1 Incoherent scientific base

First of all, TD requires a coherent interdisciplinary scientific basis, interdisciplinarity being more than the collaboration of disciplines. Disciplinary work results, if intended to contribute to interdisciplinary endeavours, should be 'interdisciplinarity-ready', i.e. ready to be combined with those of other disciplines without creating logical or epistemic contradictions which would devalue the joint result. To create such a new and comprehensive view, disciplinary scholars must make sure that they follow the 'basic law of interdisciplinarity', i.e. making no assumptions which are in flagrant contradiction to the insights of other disciplines in charge of the respective issue (Spangenberg, 2011). This corresponds to the demand for a 'generalised epistemology' (Jantsch, 1972) from the early transdisciplinarity discourse described in Chapter 2. It requires in-depth reflection within every discipline involved, but without it, instead of a more comprehensive picture, a cacophony of views arises.

Furthermore, sustainable development as such is a normative objective, and science for sustainability is necessarily both transformation science and transformative science (de Bremond et al., 2019; Schneidewind, 2013). While being actively involved in pushing a transformation and generating knowledge to serve that end flies directly in the face of the ideology of value-neutral, objective science (a positivist ideal which in reality does not exist; see Bromley, 2008; Funtowicz & Strand, 2007), it is a major challenge to the self-perception of scientists, in particular from the natural sciences. The frequent occurrence of both positivist and normative views among scholars contributes to the risk of incoherence.

5.3.2 Abstract versus contextual knowledge

Second, the knowledge integration process is different between academic disciplines and the knowledge held by stakeholders. Acknowledging that in a 'knowledge society' there is no place for an academic claim to a knowledge monopoly reduces the status of such knowledge to one among other relevant sources. Science is then no longer producing 'the truth', as many scholars in particular in natural sciences still see it, but scientists are offering one suitable description of the case under analysis – and it is not science alone determining what is suitable. Engaging the holders of tacit knowledge is not easy to achieve. It demands reconciling well-established scientific procedural standards with the implicit or explicit criteria of relevance that apply in civil society – a process that typically causes severe tensions and comes up against both habitual as well as institutional constraints (Görg et al., 2014).

Procedurally, many projects are characterized by a long and often laborious 'phase zero' with intensive personal exchange and the building of understanding and trust as a condition for the future collaboration, before any co-creation in the conventional sense can take place. While stakeholders provide contextual knowledge, methodologically based on participation in social structures and discourses, scientists tend to hold more abstract knowledge and a set of methods they

are qualified to apply. Consequently, projects will have different phases between which the kind of activity and with it the importance of different agents involved varies (Spangenberg et al., 2015). Funding organizations, methodologists and practitioners have to bear in mind that this early phase involves particularly sensitive negotiations and is a very time- and resource-intensive part of the project work which must be allowed for in work plans and funding.

5.3.3 Understanding motivations and interests

Understanding stakeholder motivation is crucial for sustained participation. Civil society representatives are usually not interested in publications, conference presentations and academic qualification, but have to allocate their limited resources to what is their raison d'être. Only if they see more progress for their case by participating will they dedicate personal capacities to a research project (Spangenberg, 2012). Furthermore, stakeholders are not a homogenous group, and thus usually no single 'stakeholder position/point of view/knowledge' exists. The diversity of positions has to be recognized and managed in the course of a TD research project. In the Vietnam example mentioned earlier, the authorities' development plans were at odds with farmers' interests in a hidden conflict; farmers did not dare articulate their dissatisfaction, neither in public nor in a project context (Spangenberg et al., 2018). Scholars have to ensure that research is not biased towards some (powerful) actors and their interests (Durham et al., 2014).

As TD is invoked for problem solving, there are usually competing interests in defining the problem, which knowledge is relevant and which solutions are suitable. This in turn implies that different groups of stakeholders, representing different interests, will often react differently, endorsing or rejecting project results depending on the perceived impact on the case they are advocating. Such stakeholder conflicts (between stakeholders and between scholars and stakeholder groups) become part of the research process whenever stakeholder participation takes place in reality. For instance, Falk et al. (2018) found that research pointing at the importance of more strongly supporting the provision of public goods and common pooling of resources in ecosystem management often comes under strong pressure to instead endorse concepts prioritising systems that mainly provide private goods.

5.3.4 Projects as agents

Another issue, scholars are often not prepared for, and at odds with an epistemology of value-free science and objective results, is that any project dealing with objects of decision relevance will inevitably be attributed the role of an agent by its social environment, like it or not. The reason is that project results, if relevant, constitute interventions in the prevailing socio-cultural, political and ecological systems. In situations of different expectations held by different stakeholders and of conflicting interests, even the most 'neutral' information can change the balance of power between competing parties. Thus, projects will necessarily be

interfering with existing (and potentially be sparking new) conflicts, and as this is exactly what agency is all about, they are perceived as agents.

Such interference might occur, for instance, by providing information supporting an intervention suggested by one group in a local conflict with another group of stakeholders rejecting the intervention. Protests tend to be particularly vitriolic if the group feeling disadvantaged, rightly or wrongly, is among those which have (for well-defined reasons) not been involved in the participatory process. Conflicts with projects as perceived agents might also be triggered if the project results interfere with the prevailing distributional mechanisms and ongoing open or hidden conflicts. Any such interference will have supporters and adversaries, making the project – regardless of its intentions – a controversial agent in local and regional conflicts.

5.3.5 The risks of participation

While stakeholder participation is often described as a means to generate socially robust applicable knowledge, there are also risks emerging from stakeholder participation. The kind of risk varies with the means and methods of participation, and their intensity can be influenced by good project coordination and management. The most frequent disturbances include the risk of short-term orientation of the research question, dominated by acute problems; taboos for proposed interventions and solutions not deemed adequate (culturally, politically, traditionally or in terms of provoking backlashes); and interventions into the research process, in particular in the choice of methods, to enforce desired results (Spangenberg et al., 2015).

These challenges have only rarely and sparsely been addressed in the theories and concepts of TD, and if so, often with no empirical basis, although they shape the way TD projects can be conducted. They imply a need for systemic reflexivity (Beck, 1996) and to rethink everyday practices deeply enshrined in disciplinary routines (Hargreaves, 2011; Shove et al., 2012) – TD is no business-as-usual for the scientific profession.

5.4 Responses

The starting point for developing responses addressing these challenges is early reflection among the scholars involved. Even before a project starts, they should be questioning their own routines and habits, rethinking their potentially diverging worldviews and becoming open to new approaches and sensitized for their necessity, but also for their preconditions. Without this, the effectiveness of all other responses will be severely hampered (Schmidt et al., 2020).

5.4.1 Ex-ante and ongoing reflection

Given the different culturally shaped epistemologies and ontologies within and between different groups of scholars and stakeholders, knowledge integration is

a real challenge. It demands self-reflexive processes that consider one's own limited and situated knowledge (Rosendahl et al., 2015), addressing the challenges lined out. In particular, it demands a specific understanding of the role of science in society (Funtowicz & Ravetz, 1993), acknowledging that science is part of the social system holding one of many bodies of legitimate knowledge.

The need for reflection is manifest on several levels, in a process which has to start long before a project application is submitted. In TD research, reflection is necessary regarding the meaningfulness (with criteria not only from science but predominantly from the semiotic system of the respective society) of the problem description, the research question and the methods chosen.

Among TD project scholars it is helpful to reflect on the objective of stakeholder participation – be it normative (justice and democracy criteria), substantive (improving the quality and significance of research), a condition for social learning among scholars and stakeholders involved, or supporting the implementation of research results (creating ownership) (Schmidt et al., 2020).

Within the disciplines, reflection is required regarding which parts of their established body of knowledge and theories is indeed in line with the 'Law of Interdisciplinarity' and can be used in a TD collaboration – which obviously influences the choice of methods applicable. Unfortunately, this is the least addressed of the TD challenges.

Between disciplines reflection is needed regarding their respective roles as contributors to a multi-faceted understanding of the object of research, an understanding they no longer 'own' it as a discipline.

A joint reflection with selected stakeholders interested in the project is required, being aware of the potentially diverging reasons for that interest (see next section and Chapters 2 and 3). In the planning phase, it is important to be aware of the different character of knowledge and qualifications the partners hold, in particular the difference between natural and social sciences, between stakeholders and scholars and the risks for project success emerging from that.

5.4.2 Understanding stakeholder diversity

Any procedure chosen when selecting the necessarily limited number of participation process participants is at the same time excluding those who are not invited – the 'exclusion by inclusion' – creating challenges to guarantee a fair and representative range of stakeholders involved. From the outset, but also throughout a project, it is recommendable to have an open process, actively inviting and enabling participation of a representative diversity of stakeholders while being aware that the form, level and participants may change between different phases of a project (Spangenberg et al., 2015). However, such openness creates much uncertainty regarding how the interaction process will eventually evolve.

A representative diversity of stakeholders is necessary to avoid a willing but biased stakeholder panel (Bracken et al., 2014); how much efforts should be made to motivate relevant but uninterested stakeholders depends on their respective importance for the project success and on the resources available. In cases when

conflicts among stakeholders prevent the emergence of trust, making fruitful discussions impossible, research teams may be better off running several parallel participation processes, using different settings at different times and in different project phases, and then synthesizing the results to keep a balance (Valentin & Spangenberg, 2000). The continuous collaboration with strategic stakeholders through fair partnerships, combined with temporal tools for target-oriented involvement, can help balancing between building a sense of ownership and dealing with unexpected dynamics and tensions (Schmidt et al., 2018).

5.4.3 Exercise: turning the tables

The ontologies of different bodies of knowledge are culturally shaped, and the epistemologies of TD have been at odds with scholars considering themselves as value-neutral truth seekers while following implicit individual and discipline-inherent values. In particular, rethinking their everyday practices and thus their methods is a suggestion with few friends in natural sciences, but also in economics. Overcoming the lack of understanding civil society prevalent in large parts of the scientific community, mutual learning to understand and respect differing worldviews, but also finding commonalities and defining bridging concepts, is of crucial importance. One possible means of doing so is 'turning the tables', i.e. having stakeholders pin down what they expect from a project at least and at best, and confronting scholars with the question of how they plan to deliver on these demands (which represent the minimum conditions for continuous participation, and the ambitions of each stakeholder). It counteracts the prevailing dominant role of science in defining the problem and identifying those who are legitimate and/or beneficial contributors to a solution (Bracken et al., 2014; Rosendahl et al., 2015) and might prevent research fatigue. The resulting 'balance of understanding' is an important contribution to the 'balance of power' in participatory transdisciplinary projects, where the powerful position of science in determining the process has to be reduced to the one of a contributor to collaborative initiatives, with responsibility and power shared among all those involved (Meppem & Bourke, 1999; Scholz & Steiner, 2015). The crux is a discursive synthesis of different bodies of knowledge while at the same time ensuring the use of robust methodologies, possibly adapted to new circumstances and modified by new insights, but in any case, in compliance with scientific standards.

5.4.4 Ex-ante impact assessments

From the very outset, project planners should deliberately take into account the particular socio-cultural contexts to minimize unintended side effects and achieve what have been called 'socially robust' results (Nowotny, 2003). A condition for this is to systematically scrutinize the claimed justifications and benefits alongside the potential risks, to evaluate alternative options for meeting needs alongside the option under appraisal and to promote robust, diverse and adaptable solutions (EEA, 2001). This requires monitoring not only the project success factors, but also being on alert for potential unintended and unexpected negative effects.

5.4.5 Expectation management and exit strategy

As in local processes becoming an agent is unavoidable, for the project success it is better to shape the role deliberately than it being attributed by outsiders without the project influencing its perceived role and the resulting expectations. Thus, project teams should accept an agent role in order to understand their influence and be able to mitigate upcoming resistance from stakeholders who feel their interests violated. Therefore, explicitly defining the role of a project is necessary from the planning phase on, with adaptation to (changing) local circumstances throughout the project duration (defining their own role as a social actor also provides projects with an opportunity for scientific reflection). Such expectation management is crucial for project success – if neglected, it can easily lead to undermining whatever impact the project might have potentially had (Spangenberg et al., 2015). Stakeholder management is one of the essential means for it, requiring a permanent bidirectional flow of information (Durham et al., 2014).

A particular aspect of expectation management is creating awareness of the limitation a project is confronted with, in terms of not only resources, but also limited duration. While local stakeholders tend to be permanent agents, projects appear and disappear again, and expectations for a permanent role are necessarily frustrated. Hence, the expectation management should also include communicating a well-defined exit strategy, emphasizing the time-limited local presence and preparing partners for the project's exit from the ongoing social processes. Communicating the exit strategy early on is of utmost importance to avoid otherwise unwarranted disappointments leading to frustration and neglect or even rejection of project results.

In practice, the TD approach and its methods have to be adapted to respond to the specific cultural, social and political conditions in different research areas. However, the pace of policy and its demands to science can easily develop faster than TD. Nonetheless, the fact that the demands are often at odds with what TD can deliver is rarely discussed – the conceptual, institutional and temporal (mis) fit between policy and research is an issue that urgently requires more attention.

5.4.6 Methodological diversity

Letting stakeholders have an influence on method choices to enhance their confidence regarding the results is unusual, and for good reasons: while stakeholders hold expertise about local situations, practices and processes often invisible to visiting scholars, researchers are experts for methods, their application and the interpretation of the results. However, it should be permitted – of course within the limitations set by scientific quality – if and when stakeholders' information suggests changes in the formulation of research questions or, in particular for social sciences, if certain methods are culturally less acceptable than others which can generate comparable insights. A level of flexibility is warranted; past experience has shown that individual methods such as workshops, interviews, focus groups or media work can serve different objectives, and have been chosen for different purposes by research teams with and without stakeholder participation.

However, even with the same methods applied, the way results are analyzed may differ according to purpose.

It has proven effective to discuss the interpretation of results with the stakeholders involved, to grasp their meaning within the semiotic system of the respective society. Agreeing on such interpretations and basing communication strategies on them can create a feeling of ownership which turns stakeholders into project ambassadors.

5.4.7 Some implications

Projects have been suggested to start with reflection, including tasks, challenges, potential partners and their motivations, and the team composition (including social and cultural knowledge, management and communication experience) to improve the chance of successfully conducting TD research. On both the individual and the group level, this also requires reflection on and questioning of the own worldview and its appropriateness in the TD research context. It might strengthen this approach if instead of starting with disciplinary-based, often natural science analysis and measurement, e.g. of ecosystems and their services, as usual today, a TD project begins with understanding human demands, in particular the problems stakeholders want to be solved, and with livelihood analysis of those potentially affected by the project and its outcomes. This necessitates involving the stakeholder-partners already in formulating the research questions which should be valid from a researcher's point of view and relevant from a stakeholder perspective. In turn, this requires the integration of stakeholder identification and dialogic research question refinement already in the preparatory phase.

Given the different epistemologies and ontologies, anthropologies and axiologies constituting different worldviews, mutual learning is an indisputable condition of success for any TD project. As soon as possible, a formal or informal exercise in 'turning the tables' appears recommendable to generate mutual understanding of expectations and motivations. This would be an excellent condition for finding agreement on a research plan combining phases of opening up (joint mutual learning) and closing down (applying the tools of rigorous scientific analysis to the information and insights gained). Such a research plan can be inspired and informed by the helpful manuals and guidance books available (e.g. Durham et al., 2014; Pohl & Hirsch Hadorn, 2007), but as there is no 'one-size-fits-all' strategy for stakeholder engagement in TD research, such sources need to be and can be used adapting their recommendations to the reality on the ground (Spangenberg et al., 2018). Seeking agreement on the work plan is hence both a confidence building measure (creating ownership and trust) and a part of the expectation management, minimizing overblown expectations, avoiding misunderstandings and not least providing the first step to exit management. An archetypical structure of a work plan, taking the aforementioned considerations into account (which of course will be no blueprint but in need to be adapted to the circumstances, with modifications, bifurcations and iterations in practice) might consist of six phases of which only phases 2, 3 and 4 are part of the funded project

(for some obstacles to such an approach due to funding criteria see Chapter 2, and for similar ways of structuring a TD process see Chapter 3):

1 Preparation, identification of motivation, experimental sites and relevant issues jointly with local stakeholders, communication with them regarding the purpose, role and possible results of the project, planned activities and presence in the region, using this information for writing the final application for funding;
2 Once the project is accepted – and thus the material basis for continued collaboration guaranteed – stakeholder consultation and participation agreements, formal or informal depending on local cultures, intensive communication with them regarding the data gathering planned when and where, maybe the need for support;
3 Once the project has started, a series of activities following the research plan is unfolding. They include observations and measurements, but also interaction with the local population beyond the selected stakeholders, incidentally (meeting people e.g. in the market), as a side effect (talking to land owners to get permission for research on their land) or systematically (interviews, focus groups, workshops, joint media work). Lessons learnt that way should be integrated into the disciplinary-based and interdisciplinary information distillation, processing and evaluation (in the phase the methodological skills of scholars dominate the process); for most scholars this requires learning what could be valuable information for disciplines other than their own;
4 Communication of results with stakeholders to evaluate if the findings are meaningful in the respective context, if the information base has been comprehensive, if the interpretation of results is adequate to the socio-cultural context, etc. (although the communication is conducted by scholars, in this phase stakeholders and scholar are partners on eye level). If necessary, steps 3 and 4 are reiterated until agreement has been achieved;
5 Application of results, often in experimental or demonstrator scale, dissemination of results and insights, offering the applications as visual illustration, planning for a larger scale implementation (in this phase stakeholders take over the ownership and responsibility – the project results become part of the local fabric – or the project fails to have lasting impact);
6 Post-funding phase – if the appropriation of the project results by stakeholders has been successful, this phase will develop a dynamic of its own which might be supported by scholars available as resource persons, at best local scientists with the appropriate language skills. If the project has not been appropriated, this will be a very short phase ending with the collapse of all intervention results which may have emerged from it.

5.4.8 A final challenge

The former sections are based on the assumption that a shared solution is possible. What about those cases where it turns out in the course of the project that either the interests are too divergent to agree which findings are relevant and

which are not, or the stakeholders operate from worldviews so different that no common language and thus no joint problem definition, let alone a common solution, emerges? Epistemologically, this is not implausible, given that the Cartesian worldview underlying Western science is but one of many different worldviews (IPBES et al., 2019). If, for instance, the harvest in Ifugao, Philippines, depends on the blessing of the rice gods, climate change impacts are best addressed by prayers and donations. If a river basin including all organisms and the surrounding sea is seen as one entity which cannot be put apart by Maoris in New Zealand, fishery management concepts make no sense. At least the latter case is one modern science could see as a challenge to its own performance.

Thus, while producing several incommensurable project results is an anathema to standard science, it must be accepted as one possible result of participation. Of course, different quality criteria apply to information from different cultures. One criterion might be that each result must be rigorously tested *by the experts and according to the criteria of its own worldview*. In the Ifugao example, it would be the elders and the Mumbai, the animist priest. Then the results of biological and sociological research would be presented alongside mythical narratives considered as explanations by locals, all rigorously validated by best available experts, be they scientists or village authorities and traditional priests. However, due to a lack of examples of projects and studies presenting incomparable and incommensurable answers to a problem or research question as equally valid results, this is still only a thought-provoking scenario which needs further investigation to become operational.

5.5 Conclusions

The challenges presented in this chapter are not new and are rather well known to TD practitioners. Nonetheless, both the policy debate and the conceptual work fall short of sufficiently addressing them (see Chapter 2 for the history and the state of these discussions). The concerns articulated are derived from TD project experience over the last 25 years; with the increasing role of TD in funders' rules and regulations, they have been confirmed by an increasing number of scholars. However, what has grown as well is the insight that there are no silver bullets – different cases, different stakeholders demand different ways of proceeding with TD. Understanding situations, communicating intentions and results (i.e. expectation management and exit strategies) and collaborating with stakeholders on eye level are social qualifications which are probably required in any TD research project.

Thus, one key measure to address the challenges would be to integrate the skills necessary for successful TD research into the curricula of all disciplines. Unfortunately, the skills for dealing with these kinds of challenges are not among those academic professionals have learnt and young scientists are taught and trained in during their academic education. Thus, there is a need for attractive advanced training for professional scientists, from early career to senior scientist positions, maybe in high level summer schools, including interaction with non-scholars.

Grants and awards for TD research may also provide effective incentives. Adding push to pull, donors might make it clear from the outset that TD must not only shape the application (for this behalf there should be options to finance phase 1), but project results will only be accepted if TD was also the dominating research *practice*. TD courses might even become mandatory when applying for a lead role in TD projects; they would have to include a critical reflection on worldviews and science philosophies held dear but not shared by others, as a condition to adapt assumptions and methods to the joint frame necessary to integrate disciplinary results into a more comprehensive picture.

Offering training to stakeholders is a less urgent issue – scientists 'designing' suitable stakeholders is not TD. However, a basic understanding of how to deal with complexity, escaping the seduction of simplistic solutions, would be helpful for society at large not only to understand the need for and co-manage the process of a Great Transformation, but also to resist the siren songs of science denying populists and conspiracy theorists. As people in power have little time to read scientific studies, however relevant they may be, having trained staff members would be an achievement (and they would long for scientists able to communicate their insights and results in plain language).

As stakeholders may not be the best agents to set up stakeholder involvement trainings, societies of academic professionals might play a role here, as far as they have taken TD on board within their own ranks already. Transparent evaluation procedures for TD projects would help all those involved to guarantee both effective participation and scientific robustness. They might also serve as platforms for exchanging experiences regarding the challenges and how they dealt with them; such a bottom-up collection might stimulate conceptual discussions and developments which are closer to the research practices and challenges on the ground and in the field.

References

Angelstam, P., Andersson, K., Annerstedt, M., Axelsson, R., Elbakidze, M., Garrido, P., Grahn, P., Jönsson, K.I., Pedersen, S., Schlyter, P., Skärbäck, E., Smith, M., Stjernquist, I. (2013). Solving problems in social-ecological systems: Definition, practice and barriers of transdisciplinary research. *AMBIO* 42(2): 254–265.

Arnstein, S.R. (1969). A ladder of citizen participation. *Journal of the American Institute of Planners* 35: 216–224. https://doi.org/10.1080/01944366908977225.

Beck, U. (1996). Wissen oder Nicht-Wissen? Zwei Perspektiven reflexiver Modernisierung. U. Beck, A. Giddens, S. Lash (Eds.) *Reflexive Modernisierung – Eine Kontroverse*. Frankfurt/Main, Germany, Suhrkamp: 289–315.

Blackstock, K.L., Kelly, G.J., Horsey, B.L. (2007). Developing and applying a framework to evaluate participatory research for sustainability. *Ecological Economics* 60(4): 726–742.

BMBF Bundesministerium für Bildung und Forschung. (2008). Bekanntmachung des Bundesministeriums für Bildung und Forschung von Richtlinien über die Fördermaßnahme 'Nachhaltiges Landmanagement' vom 24.10.2008. www.bmbf.de/foerderungen/bekanntmachung-389.html.

BMBF Bundesministerium für Bildung und Forschung. (2018). www.fona.de/de/3rd-german-future-earth-summit.

Bracken, L.J., Bulkeley, H.A., Whitman, G. (2014). Transdisciplinary research: Understanding the stakeholder perspective. *Journal of Environmental Planning and Management* 58(7): 1291–1308.

Bromley, D.W. (2008). Volitional pragmatism. *Ecological Economics* 68(1–2): 1–13.

de Bremond, A., Ehrensperger, A., Providoli, I., Messerli, P. (2019). What role for global change research networks in enabling transformative science for global sustainability? A global land programme perspective. *Current Opinion in Environmental Sustainability* 38: 95–102.

DNK Future Earth. (2018). From Knowledge to Action. *3rd German Future Earth Summit (2018) Conference Report*. DNK, Bonn.

Durham, E., Baker, H., Smith, M., Moore, E., Morgan, V. (2014). *The BiodivERsA Stakeholder Engagement Handbook*. Paris, France, BiodivERsA.

EEA European Environment Agency. (2001). *Late lessons from early warnings: The precautionary principle 1896–2000*. Environmental Issue Report No. 22. Luxembourg, Office for the Official Publications of the European Communities.

European Commission. (2019). https://ec.europa.eu/research/iscp/index.cfm?pg=projects.

Falk, T., Spangenberg, J.H., Siegmund-Schultze, M., Kobbe, S., Feike, T., Kuebler, D., Settele, J., Vorlaufer, T. (2018). Identifying governance challenges in ecosystem services management: Conceptual considerations and comparison of global forest cases. *Ecosystem Services* 32: 193–203.

Faucheux, S., Hue, C. (2001). From irreversibility to participation: Towards a participatory foresight for the governance of collective environmental risks. *Journal of Hazardous Materials* 86(1–3): 223–243.

Fritz, L., Binder, C. (2018). Participation as relational space: A critical approach to analysing participation in sustainability research. *Sustainability* 10(8): 2853.

Funtowicz, S.O., Ravetz, J.R. (1990). *Uncertainty and quality in science for policy*. Dordrecht, Netherlands, Kluwer Publ.

Funtowicz, S.O., Ravetz, J.R. (1993). Science for the post-normal age. *Futures* 25(7): 739–755.

Funtowicz, S.O., Strand, R. (2007). Models of science and policy. T. Traavik, L.C. Lim (Eds.) *Biosafety first: Holistic approaches to risk and uncertainty in genetic engineering and genetically modified organisms*. Trondheim, Norway, Tapir Academic Press: 263–278.

Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott, P., Trow, M. (1994). *The new production of knowledge: The dynamics of science and research in contemporary societies*. London, UK/Thousand Oaks, CA, USA, SAGE Publications.

Görg, C., Spangenberg, J.H., Tekken, V., Burkhard, B., Truong, D.T., Escalada, M., Heong, K.L., Arida, G., Marquez, L.V., Bustamante, J.V., Ho Van Chien, Klotzbücher, T., Marxen, A., Nguyen Hung Manh, Nguyen Van Sinh, Villareal, S.B., Settele, J. (2014). Engaging local knowledge in biodiversity research: Experiences from large inter- and transdisciplinary projects. *Interdisciplinary Science Reviews* 39(4): 323–341.

Hadorn, G.H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Hoffmann-Riem, H., Joye, D., Pohl, C., Wiesmann, U., Zemp, E. (2008). *Handbook of transdisciplinary research*. Dordrecht, Netherlands, Springer Science Publ.

Hargreaves, T. (2011). Practice-ing behaviour change: Applying social practice theory to pro-environmental behaviour change. *Journal of Consumer Culture* 11(1): 79–99.

Huan, N.H., Thiet, L.V., Chien, H.V., Heong, K.L. (2005). Farmers' participatory evaluation of reducing pesticides, fertilizers and seed rates in rice farming in the Mekong Delta, Vietnam. *Crop Protection* 24(5): 457–464.

Hurlbert, M., Gupta, J. (2015). The split ladder of participation: A diagnostic, strategic, and evaluation tool to assess when participation is necessary. *Environmental Science and Policy* 50: 100–113.

IPBES, Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services, Brondizio, E.S., Díaz, S., Settele, J. (2019). *The IPBES global assessment on biodiversity and ecosystem services*. Bonn, Germany, Secretariat of the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystem Services.

Jahn, T., Bergmann, M., Keil, F. (2012). Transdisciplinarity: Between mainstreaming and marginalization. *Ecological Economics* 79: 1–10.

Jantsch, E. (1972). Inter- and transdisciplinary university: A systems approach to education and innovation. *Higher Education Quarterly* 1(1): 7–37. https://doi.org/10.1111/j.1468-2273.1947.tb02067.x.

Lang, D.J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M., Thomas, C.J. (2012). Transdisciplinary research in sustainability science: Practice, principles, and challenges. *Sustainability Science* 7, 25–43.

Max-Neef, M.A. (2005). Foundations of transdisciplinarity. *Ecological Economics* 53(1): 5–16.

Meppem, T., Bourke, S. (1999). Different ways of knowing: A communicative turn to sustainability. *Ecological Economics* 30(3): 389–404.

Nauen, C.E. (Ed.), Bogliotti, C., Fenzl, N., Francius, J., Kakule, J., Kastrissianakis, K., Michael, L., Reeve, N., Reyntjens, D., Shiva, V., Spangenberg, J.H. (2006). *Increasing impact of the EU's international S&T cooperation for the transition to sustainable development*. Brussels, Belgium, European Commission DG RES.

Neef, A., Neubert, D. (2011). Stakeholder participation in agricultural research projects: A conceptual framework for reflection and decision-making. *Agriculture and Human Values* 28: 179–194.

Newig, J., Gaube, V., Berkhoff, K., Kaldrack, K., Kastens, B., Lutz, J., Schlußmeier, B., Adensam, H., Haberl, H. (2008). The role of formalisation, participation and context in the success of public involvement mechanisms in resource management. *Systemic Practice and Action Research* 21: 423–441.

Nowotny, H. (2003). Democratising expertise and socially robust knowledge. *Science and Public Policy* 30(3): 151–156.

O'Connor, M. (1999). Dialogue and debate in a post-normal practice of science: A reflection. *Futures* 31: 671–687.

Pohl, C., Hirsch Hadorn, G. (2007). *Principles for designing transdisciplinary research*. Munich, Germany, oekom Publ.

Pohl, C., Hirsch Hadorn, G. (2008). Methodological challenges of transdisciplinary research. *Natures Sciences Sociétés* 16(2): 111–121.

Pohl, C., Krütli, P., Stauffacher, M. (2017). Ten reflective steps for rendering research societally relevant. *GAIA: Ecological Perspectives for Science and Society* 26(1): 43–51.

Polk, M. (2014). Achieving the promise of transdisciplinarity: A critical exploration of the relationship between transdisciplinary research and societal problem solving. *Sustainability Science* 9(4): 439–451.

Reed, M.S. (2008). Stakeholder participation for environmental management: A literature review. *Biological Conservation* 141: 2417–2431.

Regeer, B., Bunders, J. (2009). *Knowledge co-creation: Interaction between science and society: A transdisciplinary approach to complex societal issues*. RMNO Preliminary studies and background studies, number V.10e (2009). Den Haag, Netherlands, RMNO.

Rosendahl, J., Zanella, M.A., Rist, S., Weigelt, J. (2015). Scientists' situated knowledge: Strong objectivity in transdisciplinarity. *Futures* 65: 17–27.

Rotmans, J., Kemp, R., van Asselt, M. (2001). More evolution than revolution: Transition management in public policy. *Foresight* 3(1): 15–31.

Schmidt, L., Falk, T., Siegmund-Schultze, M., Spangenberg, J.H. (2020). Stakeholder involvement for what objective? A conceptual and empirical view on a central dogma of transdisciplinarity. *Ecological Economics* 176: 106751. https://doi.org/10.1016/j.ecolecon.2020.106751.

Schmidt, L., Hartberger, K., Kobbe, S., Falk, T., Wesselow, M., Schumann, C. (2018). Stakeholder involvement in transdisciplinary research: Lessons from three projects on sustainable land management in a North-South setting. *GAIA: Ecological Perspectives for Science and Society* 27(3): 312–320.

Schmidt, L., Pröpper, M. (2017). Transdisciplinarity as a real-world challenge: A case study on a North-South collaboration. *Sustainability Science* 12: 365–379.

Schneidewind, U. (2013). Transformative literacy: Gesellschaftliche Veränderungsprozesse verstehen und gestalten. *GAIA: Ecological Perspectives for Science and Society* 22(2): 82–86.

Scholz, R.W., Steiner, G. (2015). The real type and ideal type of transdisciplinary processes: Part I: Theoretical foundations. *Sustainability Science* 10: 527–544.

Shove, E., Pantzar, M., Watson, M. (2012). *The dynamics of social practice: Everyday life and how it changes*. Thousand Oaks, CA, USA, SAGE Publications.

Siew, T.F., Aenis, T., Spangenberg, J.H., Nauditt, A., Döll, P., Frank, S.K., Ribbe, L., Rodriguez-Labajos, B., Rumbaur, C., Settele, J., Wang, J. (2016). Transdisciplinary research in support of land and water management in China and Southeast Asia: Evaluation of four research projects. *Sustainability Science* 11(1): 813–829.

Spangenberg, J.H. (2011). Sustainability science: A review, an analysis and some empirical lessons. *Environmental Conservation* 38(3): 275–287.

Spangenberg, J.H. (2012). NGOs between influence and participation overkill: The merits, strengths and weaknesses of environmental civil society organisations. In O. Renn, A. Reichel, J. Bauer (Eds.) *Civil society for sustainability: A guidebook for connecting science and society*. Bremen, Germany, Europäischer Hochschulverlag: 5–17.

Spangenberg, J.H., Görg, C., Settele, J. (2015). Stakeholder involvement in ESS research and governance: Between conceptual ambition and practical experiences: Risks, challenges and tested tools. *Ecosystem Services* 16: 201–211.

Spangenberg, J.H., Heong, K.L., Klotzbücher, A., Klotzbücher, T., Nguyen, Q.A., Tekken, V., Truong, D.T., Türke, M., Settele, J. (2018). Doing what with whom? Stakeholder analysis in a large transdisciplinary research project in South-East Asia. *Paddy and Water Environment* 16(2): 321–337.

Stauffacher, M., Flüeler, T., Krütli, P., Scholz, R.W. (2008). Analytic and dynamic approach to collaboration: A transdisciplinary case study on sustainable landscape development in a Swiss prealpine region. *Systemic Practice and Action Research* 21: 409–422.

Theobald, E., Ettinger, A., Burgess, H., DeBey, L., Schmidt, N., Froehlich, H., Wagner, C., HilleRisLambers, J., Tewksbury, J., Harsch, M. (2015). Global change and local solutions: Tapping the unrealized potential of citizen science for biodiversity research. *Biological Conservation* 181: 236–244.

Valentin, A., Spangenberg, J.H. (2000). A guide to community sustainability indicators. *Environmental Impact Assessment Review* 20: 381–392.

van Etten, J., de Sousa, K., Aguilar, A., Barrios, M., Coto, A., Dell'Acqua, M., Fadda, C., Gebrehawaryat, Y., van de Gevel, J., Gupta, A., Kiros, A.Y., Madriz, B., Mathur, P.,

Mengistu, D.K., Mercado, L., Nurhisen Mohammed, J., Paliwal, A., Pè, M.E., Quirós, C.F., Rosas, J.C., Sharma, N., Singh, S.S., Solanki, I.S., Steinke, J. (2019). Crop variety management for climate adaptation supported by citizen science. *Proceedings of the National Academy of Sciences* 116(10): 4194–4199.

van Kerkhoff, L., Lebel, L. (2006). Linking knowledge and action for sustainable development. *Annual Review of Environmental Resources* 31, 445–477.

Walker, W.E., Harremoes, P., Rotman, J., Van der Sluijs, J.P., Van asselt, M.B.A., Janssen, P., Krayer von Kraus, M.P. (2003). Defining uncertainty: A conceptual basis for uncertainty management in model-based decision support. *Integrated Assessment* 4(1): 5–17.

Wiek, A., Lang, D.J., Stauffacher, M., Walter, A.I., Scholz, R.W. (2006). Transdisciplinary case studies as a means of sustainability learning: Historical framework and theory. *International Journal of Sustainability in Higher Education* 7(3): 226–251.

Zscheischler, J., Rogga, S., Weith, T. (2014). Experiences with transdisciplinary research. *Systems Research and Behavioral Science* 31(6): 751–756.

6 Transdisciplinarity for sustainability management

Annik M. Fet and Haley Knudson

6.1 Introduction

Sustainability embodies the defining characteristics of a wicked problem, and enabling sustainable transformations in ecological, social and economic systems therefore becomes a definitively transdisciplinary problem due to the complexities, interactions and multiple perspectives essential to its solution (Brandt et al., 2013). In this chapter, transdisciplinarity (TD) is defined as a 'critical and self-reflexive research approach that relates societal with scientific problems; it produces new knowledge by integrating different scientific and extra-scientific insights; its aim is to contribute to both societal and scientific progress' (Jahn et al., 2012, p. 8). Further, the chapter recognizes the special qualities of TD collaboration, including its focus on wicked problems; need for a collaborative problem definition and group approach with team members with diverse views; and a resulting synthesis of integrated and reflexive knowledge (McGregor, 2017).

This chapter describes two aspects of a transdisciplinary capacity building (CB) project between universities and local stakeholders in Norway, the Netherlands, Portugal, India, Nepal and Uganda. These aspects are, first, the *project implementation process* and, second, a *stepwise model* of tools that companies can follow to learn and implement sustainability and environmental management strategies into different operational levels. After the interuniversity project, Capacity building in Sustainability and Environmental Management (CapSEM), is briefly introduced in section 6.2, the stepwise model is presented in section 6.3. Then, section 6.4 discusses project activities in relation to Jahn et al.'s (2012) ideal three-phase TD process and reflects upon strengths and challenges in both project implementation and fostering transdisciplinarity and deliverable achievement in its context of multiple cultures, EU funding rules and varying levels of sustainability maturity between university partners. The stepwise model was used to guide project development and activities surrounding curriculum development and knowledge-sharing and -implementation in universities and in local industry case studies in Uganda, India and Nepal. It has also helped facilitate TD case-study examples in Portugal, the Netherlands and Norway. Section 6.5 expands specifically on the way the stepwise model enables multi-stakeholder and multi-disciplinary engagement leading to a TD approach to sustainability management.

Industrial case-examples from the project partners are presented as examples in section 6.6, along with an example of how the United Nations Sustainable Development Goals (SDGs) (United Nations General Assembly, 2015) can be mapped along the stepwise model for facilitated communication with industry. Section 6.7 provides concluding remarks about the role of TD in both the project and stepwise model, along with considerations for how to overcome some of the challenges from the process.

The case presented in the chapter represents the 'taste' of *small-range TD*, as outlined in Chapter 2 of this book, as it includes the explicit link to non-academic actors and their needs, but has not yet had the time to become more empowering for involved stakeholders. Although the involvement of stakeholder and industry partners in the project was not mandated, it is essential within the fields of environmental and sustainability management, which depend on companies as the object of study. Within the project time frame, however, collaboration mainly surrounded university–university interaction with industry partnerships as a component, and began to move into reflexive university–stakeholder/industry collaboration towards the end of the project. For impact to transition further from environmental management of companies (a part of the solution) to the solution of complex societal sustainability problems, wider involvement of and direction from stakeholders is required. The TD impact for transformation may therefore be minimal or 'small-range' at this stage, with limits to the mutual creation of knowledge and its wider transformational effect due to the recognized limitations of time and resources (Stokols, 2006; Lang et al., 2012; Mitchell et al., 2015). However, the stepwise model used in the project and presented in section 6.3, in its very design, provides a framework to help explain and motivate stakeholder engagement into companies' sustainability strategies.

6.2 About the CapSEM project

CapSEM – Capacity building in Sustainability and Environmental Management – is an interuniversity curriculum development and industry training project based in environmental management and sustainability principles. It is co-funded by the Erasmus+ Program of the European Union and was implemented from October 2016 through October 2019. Project objectives surround 1) developing sustainability and environmental management curricula at universities that meet local, regional and international needs; 2) developing and hosting industry training seminars that provide companies with practical methods for improving their sustainability and bridge the gap between academia, industry and wider society; and 3) facilitating cooperation between the consortium, industry partners and their stakeholders. Quantitative indicators of objective achievement outlined at project initiation were, in terms of objective 1, that each university develop, approve, implement and test at least one new master's-level course and assess their other courses and programmes for potential improvement and adaptation according to the stepwise model. In terms of objective 2, each partner country (India, Nepal and Uganda) was to develop and hold at least three industry training seminars,

with evaluation and improvement between each. Indicators for objective 3 included scheduled CB workshops and seminars, project meetings, consortium in-person and online discussion and industry best practice showcases in each country, along with the achievement of indicators associated with objectives 1 and 2. The achievement and/or difficulty associated with these indicators is addressed later in section 6.4.

6.2.1 Project consortium

The project consortium is made up of ten universities, along with supporting industry and stakeholder partners. The EU universities, known as 'programme universities', consist of the Norwegian University of Science and Technology (NTNU), Delft University of Technology (TU Delft) and the University of Lisbon (ULisboa). Each of these partners are heavily based in engineering and work with industry to develop innovative strategies for improved environmental performance and industrial best practice across global value chains, and recognize the importance of stakeholders and industry engagement in sustainable solutions. Expertise and international collaboration across technologic, economic and social disciplines, and with a variety of stakeholders, supports the TD perspective essential to the project. However, it should be mentioned that disciplines directly present in the consortium were mainly engineering disciplines, with economists as the only representatives of the social sciences.

Consortium partners outside of the EU, referred to as 'partner universities', include three universities in Uganda and two universities in each Nepal and India. Based on existing research networks and previous collaboration with the selected partner universities, the consortium was created around the common need for increased sustainability capacity in the selected regions. Strategies for poverty reduction and inclusive and sustainable growth are outlined in Uganda, Nepal and India's national development strategies.

Table 6.1 lists the consortium partners and outlines the interdisciplinary make-up of the project team, with departments and disciplines ranging from business and economics, to climate change, engineering, architecture and health studies. Additionally, the geographic spread of partners brought in a diverse range of cultures and livelihoods. As the project was initiated by the engineering, industrial economics and technology management partners in the EU, it must be noted that partner university disciplines also mainly come from these approaches because of previous scientific collaboration. To increase the level of interdisciplinarity within the consortium, sociologists, geographers and political scientists could have been included as well. Table 6.1 shows that many of the partners' departments are rooted directly in the disciplines that frame the levels of the stepwise model, soon presented in section 6.3, but that not all are based in disciplines that typically undertake the methods suggested by the model. These consortium aspects helped create a diverse project team, but also presented challenges surrounding differences in cultures, values and base-level competencies often recognized in TD projects (McGregor, 2017).

Table 6.1 CapSEM consortium overview

University	*Location*	*Involved department(s)*
Programme universities		
Norwegian University of Science and Technology	Trondheim and Ålesund, Norway	Department of Industrial Economics and Technology Management; Department of International Business
Delft University of Technology	Delft, the Netherlands	Department of Engineering Services and Systems
University of Lisbon	Lisbon, Portugal	Instituto Superior Téchnico, Center for Innovation, Technology and Policy Research
Partner universities		
Makerere University	Kampala, Uganda	Department of Geology and Petroleum Studies; Department of Wildlife and Natural Resources Management; Department of Physics
Makerere University Business School	Kampala, Uganda	Department of Marketing and International Business
Mbarara University of Science and Technology	Mbarara, Uganda	Department of Community Health
Tribhuvan University	Kathmandu, Nepal	Center for Applied Research and Development; Department of Architecture and Planning
Kathmandu University	Dhulikel, Nepal	Department of Environmental Science and Engineering
Indian Institute of Technology Bombay	Mumbai, India	Department of Environmental Science and Engineering, Centre for Environmental Science and Engineering
Tata Institute of Social Sciences	Mumbai, India	School of Habitat Studies, Centre for Climate Change and Sustainability Studies

Through this interregional, -disciplinary and -university network, the partners have collaborated to implement qualitative and quantitative methods for environmental management and sustainability improvement in local organizations, industries and research projects. Recognizing that improving local livelihoods depends on developing infrastructure, reducing resource use and waste and empowering women, among a host of other economic, political and cultural factors, the partners agreed that learning environmental management and sustainability methods and tools could help them assist industries and organizations in their sustainable development.

6.2.2 Project challenges

Before moving to the next section, it is important to mention a few of the challenges associated with the project and its achievement of TD. Many of these are not new and have been presented extensively by scholars (Stokols, 2006; Lang et al., 2012; Mitchell et al., 2015) and in Chapter 3.

6.2.2.1 Funding rules

Funded by the EU, the project was inevitably designed around stipulations of the funding programme. The main objective for this type of project was to build academic capacity for new curriculum development in universities. Although the project designers and resulting consortium recognized the inherent necessity for industry and stakeholder involvement in a project based on improving industrial and organizational sustainability, the funding terms also meant that main deliverables, and therefore time and effort spent, needed to be majorly focused on curriculum development. This posed what Chapter 3 identifies as an 'institutional challenge' (i.e. limitations from current structures, procedures and institutions for knowledge generation). The regulations also mandated that only Higher Education Institutions (HEIs) could receive financial support. In many cases, this left little incentive and few resources for engaging industry and stakeholders. Project objectives of industry training and wider cooperation with stakeholders were still a major part of project design and eventual implementation, but admittedly had to be down-prioritized. This outcome has been a contributing factor to the project's 'small-range TD' classification. However, the authors maintain that although project activities may not have reached the ultimate flexible, open and reflective level of superlative TD research, they did begin the essential linking (Lang et al., 2012) of scientific and academic research with societal needs and stakeholder co-development.

6.2.2.2 Environmental management and sustainability – complex problems

Finally, as widely established by scholars (e.g. Pohl and Hirsch Hadorn, 2007; Vildåsen et al., 2017) and across this book, TD research processes are designed and propitious to address complex and multi-faceted problems facing society,

such as sustainability. The objectives of CapSEM, therefore, merit a TD approach, but also come with the associated challenges of working in a group and towards an outcome with multiple values, actors and ideologies. These difficulties, termed 'inherent challenges' in Chapter 3, result from the very nature of TD processes, and include, among others: different schools of thought, various forms of knowledge, different ways to frame and understand a problem and difficult decision-making and prioritization. As these challenges are addressed in depth in Chapters 2 and 3, they will not be discussed in more detail here, but are evident throughout the remainder of the chapter.

6.2.2.3 Diverse consortium

Multiple aspects associated with the consortium, including its international and interdisciplinary make-up, contributed both to project learning and challenges. A requirement of the funding body, the consortium needed to span world regions and include, at least, three programme universities, i.e. European, and three partner universities from another world region. The more diverse and interregional the project was, the higher the points awarded in the application assessment. Although this is not officially claimed by the EU, discussions since have informally confirmed its validity. CapSEM therefore resulted in an interregional group, spreading across multiple regions, cultures, religions and livelihoods. This diversity brought a richness to discussions and quickly showed a need to adapt much of the European perspectives and expertise to varied infrastructure, value and resource levels. Such therefore required multi-actor reflection, as described in Chapter 3, and also meant that additional time was needed for partners to step out of their comfort zones and adapt to others to overcome these 'teamwork challenges'.

Further, although not mandated by project funders, interdisciplinarity was essential within the consortium to work to influence sustainability and environmental management teaching and implementation in local industry. As a result, this made it difficult for the team to decide on synergistic goals, as the business school academics of marketing and accounting had a very different approach to increasing sustainability principles in the companies they worked with, than those from the multidisciplinary perspectives of academics from a school of livelihood and habitat studies. Plenary discussions at project meetings therefore often reverted to discussions of the philosophy of sustainability and creating a better world, influenced not only by disciplinary differences, but also religion and value-based opinions. As asserted in Vildåsen et al. (2017), this can often lead to confusion around decision-making, and the project team therefore had to agree to move forward with activities and time schedules without defining sustainability goals that satisfied the beliefs of all partners. Because partners were selected based on previous collaboration and of course each had their own agenda for development at their university, it could be argued that there was a level of multidisciplinarity rather than interdisciplinarity to the team, i.e. self-contained work by various disciplines that consider varying perspectives but do not necessarily reach full synergy in the outcomes (Hirsch Hadorn et al., 2008). However, as these aspects

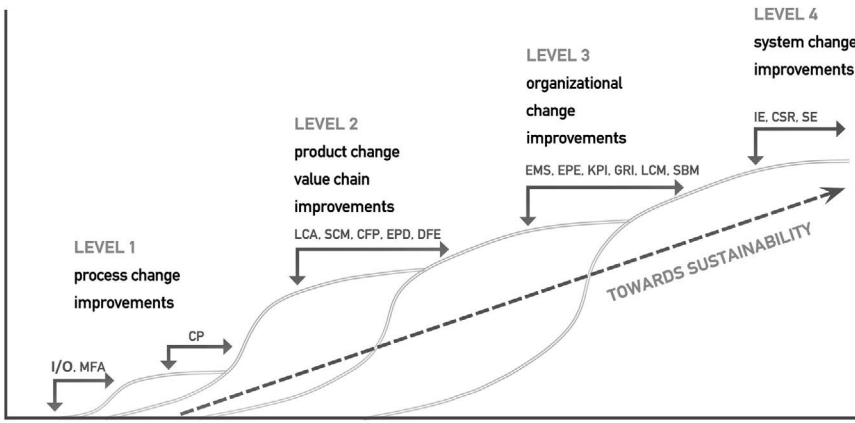
refer to different levels of collaboration (Chapter 2), the authors refer to the team as interdisciplinary because of their commitment to common objectives and increased collaboration between heterogeneous actors.

Although this list is brief and does not elaborate on all specific challenges, it frames some of the factors that maintained the project's small-range TD and contributed to keeping the project between traditional knowledge creation and problem-oriented – i.e. 'mode 2' and TD (Gibbons et al., 1994; Gibbons and Nowotny, 2001) – knowledge creation.

6.3 A stepwise model for sustainability management

To help focus and guide the academic consortium to reach its objectives and achieve sustainability-related impact, CapSEM activities were structured around a model of environmental management and sustainability tools. Companies around the world are increasingly faced with the challenge of how to implement sustainability strategies in their business models. Future business models will need to coordinate technological and social innovations with system-level sustainability. As a wicked and complex problem, sustainable development must be approached from a holistic perspective that can combine the totality of its specialized parts (Lang et al., 2012; Brandt et al., 2013; Schaltegger et al., 2013).

A toolbox for the systematic implementation of sustainability knowledge is therefore organized in a stepwise progression through four levels: 1) process; 2) product/value chain; 3) organizational; and 4) systemic (see Figure 6.1). Similar



I/O – Input-Output Analysis
MFA – Material Flow Analysis
CP – Cleaner Production
LCA – Life Cycle Assessment
SCM – Supply Chain Management
CFP – Carbon Footprints of the Product
EPD – Environmental Product Declarations
DFE – Design for Environment
EMS – Environmental Management System
EPE – Environmental Performance Evaluation
KPI – Key Performance Indicator
GRI – Global Reporting Initiative
LCM – Life Cycle Management
SBM – Sustainable Business Models
IE – Industrial Ecology
CSR – Corporate Social Responsibility
SE – Systems Engineering

Figure 6.1 A stepwise model of tools and methods towards sustainability

classifications have been performed by other scholars (e.g. Robèrt et al., 2002; Singh et al., 2012), and different typologies can be argued. The stepwise model in Figure 6.1 has been developed by researchers at NTNU over many years to effectively communicate and demonstrate the need for companies and stakeholders to look beyond a lower level, i.e. Level 1 and/or 2, to build more holistic sustainability management (Fet, 2002).

The tools referred to in this model span both quantitative and qualitative methods; from material flow analysis (MFA) and life cycle assessment (LCA), to corporate social responsibility (CSR) strategies, industrial ecology (IE) and systems engineering (SE) principles. For the majority of the tools and methods, the focus is on monitoring environmental aspects, especially in Levels 1 and 2. As one moves towards Level 3, and especially 4, more complete sustainability aspects are considered – mandating the inclusion of social aspects. It is important to see the model as a transitionary process where environmental management strategies become more holistic and complete towards triple-bottom-line sustainability as tools at each level build upon each other.

The waves between levels demonstrate how the methods build upon each other. Each wave increases the number of environmental and social aspects managed and stakeholder needs incorporated into a firm's strategy. As a firm moves from one wave to the next, they advance towards a higher level of sustainability maturity and a broader inclusion of stakeholders. Many of the methods presented are valuable for the study of complex cases in which knowledge integration is necessary, e.g. cases of TD research. For example, Scholz and Tietje (2012) present MFA, LCA and systems dynamics as methods that can link knowledge from varying disciplines, systems perspectives and modes of thought.

Level 1 tools target production *processes* and identify potential improvements through input–output analyses (I/O) and material flow analyses (MFA), in which objectives are set related to environmental aspects of resource use, energy, water consumption, emissions and waste generation. On this level, efforts are usually driven by economic incentives since better environmental resource efficiency can equate to economic gain. Resource efficiency is also the core of cleaner production (CP) principles where source reduction, 'getting more from less', is the focus rather than end-of-pipe solutions.

Level 2 tools focus on sustainability improvement for *products and their value chains*. The most recognized tool for mapping the potential improvements of a product's environmental footprint is life cycle assessment (LCA). This tool quantifies material flows across the entire life cycle of the product, from 'cradle to grave'. The results from the analyses are classified into several environmental impact categories such as global warming potential, acidification potential and eutrophication potential. Based upon a set of weighted criteria, the results can be applied within supply chain management (SCM) to set requirements upstream in the supply chain. Examples could be to replace material with a high impact factor to one with less environmental impact, or to change transport means that contribute to high greenhouse gas emissions. Results from an LCA can further be used to document the footprint of the product across all environmental criteria, e.g. through environmental product declarations (EPD), or

on selected criteria, e.g. quantified carbon footprints of the product (CFP). By applying principles of design for the environment (DFE), great achievements can be made, also for the end of life treatment of the products where material can be separated into their recycling loops (design for dismantling-principle). Similar to Level 1, quantitative information contributes to an understanding of how to shift to more sustainable material and design of products. Cleaner production principles can also be applied on the product level as well as the organizational level, Level 3.

Level 3 tools are concerned with an *organization's management* of its sustainability challenges through, for example, the implementation of an environmental management system (EMS). An EMS is often designed in accordance with ISO 14001 for certification. Small and medium sized companies are often recommended to use their health, safety and environment (HSE) system as the first approach to EMS implementation. Other companies may only want to set up an environmental account of aspects and impacts for the purpose of internal benchmarking and for an inhouse environmental performance evaluation (EPE), using key performance indicators (KPI) for reporting purposes. For larger corporations, the global reporting initiative (GRI) is often used to evaluate performance against international branch standards. A wider focus through life cycle management (LCM) is another approach to an organization's sustainability management and can help a firm translate its business model into one with sustainability as a core value – a sustainable business model (SBM). It is within this level that the consideration of social aspects, e.g. labour issues, HSE systems, societal impact, may begin. Through these mechanisms, a company will become aware of their environmental and sustainability performance and will learn how to monitor and present it according to international standards and systems.

The highest level in the model, Level 4, represents tools that facilitate a *systemic* focus. It should again be noted that Levels 1–3 deal mainly with the environmental aspects of a production process, product, value chain or organization. However, through the process of e.g. identifying and implementing more environmentally efficient technologies, the economic and social aspects of sustainability have to be addressed and weighted to find the best solution for the company and its stakeholders. In Levels 3 and 4, the methods define the system boundary outside of a specific company or organization and incorporate stakeholders, policy makers, industry representatives and academia more extensively. Corporate social responsibility (CSR) embraces the triple bottom line of sustainability and is one approach to stakeholder engagement. Additionally, principles of industrial ecology (IE) and systems engineering (SE) provide methods for the holistic and embedded study of sustainability management.

The four-level model can be regarded as the backbone of many roadmaps and standards for strategic and systemic innovation and implementation, and as a foundation for business decisions at different systems levels. It provides a way to integrate knowledge across the breadth of sustainability management tools and compile them into a coherent framework for use in academia and by practitioners.

Table 6.2 summarizes the disciplines addressed throughout the CapSEM project and the implementation of the model. For example, to achieve process

Table 6.2 Overview of the methods and main disciplines at each level of the stepwise model

Level	*Scope of level action*	*Recommended methods*	*Main disciplines*
Level 4	Systemic improvements	Industrial ecology principles, networks, industrial symbiosis, systems engineering, circular economy	Engineering, social sciences, political science, economics
Level 3	Organizational improvements	Environmental management system, sustainability communication and reporting (GRI and SDGs), environmental performance evaluation, key performance indicators, sustainable business models, corporate social responsibility	Technology management, economics, management, social sciences
Level 2	Product- and value chain improvements	Life cycle assessment, supply chain management, carbon- and water-foot printing, environmental product declaration, design for environment	Engineering, natural sciences, industrial ecology, technology management, economics
Level 1	Process improvements	Block diagrams, pollution prevention strategies, cleaner production, material flow analysis, energy analysis	Engineering, industrial ecology, natural sciences, economics

improvements at Level 1, a few methods are recommended to map and measure areas where resource or material efficiency can be improved. These methods are rooted in competence from the disciplines of engineering, industrial ecology and the natural sciences. To solve complex problems, it is important to use methods that integrate multiple disciplines and use quantitative and qualitative data to calculate the holistic picture (Scholz and Tietje, 2012; see also section 2.3). The table demonstrates the recommended methods (the principles and tools to understand which improvements should be made to move towards more sustainable solutions) and the related disciplines for the other three levels. Coupling the multidisciplinary tools and methods with the model's specific design can assist companies in reaching holistic sustainability management that extensively incorporates its stakeholders – making it a transdisciplinary model.

Now that the CapSEM consortium and objectives and the stepwise model have been introduced, the next sections discuss the project activities and methods (section 6.4) and the model (section 6.5) specifically in relation to TD.

6.4 Project activities and methods

Project methods and activities have surrounded a combination of stock taking, material sharing, industry visits, workshops, seminars and direct teaching and training. This allowed for mutual learning between partners along the stepwise model. The model presented in Table 3.1 in Chapter 3 and below in Figure 6.2 by Jahn et al. (2012) can be used to demonstrate the systems thinking approach applied in the design and implementation of the CapSEM project. This model proposes three phases of an ideal TD research process. In phase 1, *Formation of a common research object*, societal and scientific problems are linked and transformed into a shared problem. Next, in phase 2, *Production of new knowledge*, knowledge relating to the problem is combined and integrated across disciplines. When a project reaches phase 3, *Transdisciplinary integration*, the knowledge integrated in phase 2 is evaluated for its application and value in both societal and scientific praxis. Jahn et al. (2012) highlight the non-linearity and iterative nature of their model and emphasize that the steps of their process are likely to receive unequal weight depending on the nature of the research project.

This approach can also be aligned with the systems engineering (SE) framework (Fet, 1997) according to the six-step methodology: 1) identify needs; 2) define requirements; 3) specify performance; 4) analyse and optimize; 5) design, solve and improve; and 6) verify and test. Phase 1 in Jahn et al. (2012) corresponds to 1) and 2), phase 2 with 3), 4) and the first part of 5), and phase 3 corresponds to 5) and 6).

Table 6.3 presents the seven activity phases of the CapSEM project generally aligned with Jahn et al.'s model. Project activities 1–3 can be related to TD phase 1. These activities also ascribe to the TD aspects of problem identification and structuring and problem analysis asserted in Pohl and Hirsch Hadorn (2007). First is the development of the *project idea and application*, which used the stepwise model as a guiding and common framework for activities and objectives. Notedly, the problem formation at this stage was informed majorly by the funding agency and their expectations for awarding support, i.e. building academic capacity and curricula at partner universities. As mentioned, the involvement of stakeholders and industry partners was not an explicit requirement set by the funders, although it was highly valued and an essential part of any sustainability management project. Their stipulations, however, directed the project from the beginning to less of an open research process which, among other factors, may have contributed to the small-range TD of the project (Mitchell et al., 2015; Chapter 2).

Next, activity 2 focused on *establishing clear baselines*. Programme partners gathered teaching material developed at their home institutions during previous research projects with industry and public bodies. From NTNU, for example, experience from the Fiskerstrand Shipyard case (presented in section 6.6.1) was added to the CapSEM material. In parallel, partner universities performed *gap analyses* of existing curricula and identified areas along the stepwise model in which they wanted to focus and further develop their capacity. Throughout the project period, the identification of stakeholder needs became more explicit and

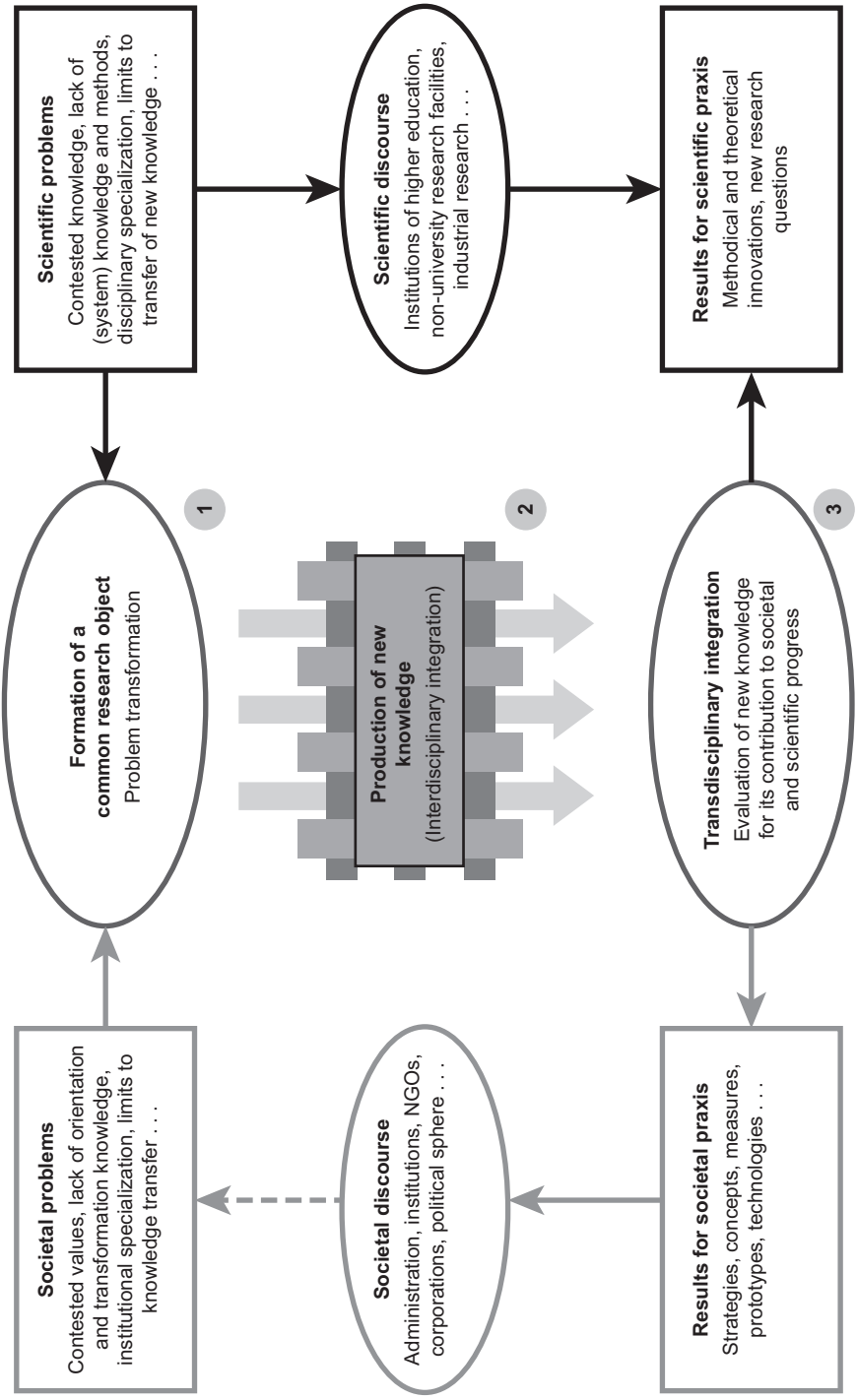


Figure 6.2 A conceptual model of the 'ideal' TD research process

Source: Redrawn from Jahn et al. (2012, p. 5)

Table 6.3 CapSEM project activity phases in relation to the ideal TD process

TD phase 1: Joint problem framing activities			
1) Project development	a) Problem formulation b) Selection of stepwise model and project design		
2) Establishing baselines	c) Available material at programme universities d) Gap analysis of partner university curricula		
3) Material packages	a) Material combination into modular packages b) Package updating throughout project		
TD phase 2: Production of new knowledge			
Societal		*Scientific*	
6) Industry and stakeholder training	a) Partner university professors and researchers design and hold training within or across the stepwise model b) Evaluate and improve upon trainings c) Best practice showcases for project partners	4) Capacity building at partner universities	5) New or adapted curriculum development
		a) Collaborative seminars with programme and partner university professors and researchers b) Internal workshops at partner universities c) Identification of focus areas, depending on existing curricula and local needs d) Partner exchanges	a) Course design b) Administrative approval c) Course testing d) Course offering
TD phase 3: Transdisciplinary integration			
7) Online course development	a) Updating material packages and transforming into video lectures b) Designing open online course with video lectures and MPs c) Testing course among project partners d) Offering online course		

Source: Authors' alignment with Jahn et al. (2012)

was pinpointed more directly by some partners. Such supports the reiterative and unequally weighted aspects of Jahn et al.'s (2012) model and highlights both the challenges and need for TD collaboration in the context of sustainable development. It was in this initial baseline activity that the span of partner perspectives and needs began to grow beyond those expected when developing in the project, and individual objectives of each university became apparent. These included the need for a wide range of input materials, from the very basic, to extremely technical, and the expectation from some partners to receive all material and teaching directly from the European universities without much engagement, and that of others to work cooperatively to share knowledge.

In activity 3, the gaps and resulting focus areas were then incorporated into a reiteration of the *material packages*, which included training material on each of the four levels for further development and knowledge sharing. Within project activity phases 1–3, the project boundary was defined by gathering perspective on expected project impact and the types of materials and training that might result (Mitchell et al., 2015).

Moving to phase 2 of the TD model and the production of new knowledge, project activities 4–5 can be discussed. After clarifying project boundaries in the previous phase, the next steps required that different perspectives and needs could be accommodated with a common understanding (McGregor, 2017). Here the stepwise model is essential, as it helped to frame the views of various partner disciplines around a common research object. Using the material packages and input from national partner teams in India, Nepal and Uganda, the *capacity building* activity began (activity 4) with CB seminars developed around the material packages and adapted for and held in each partner country. The application of the stepwise model as a shared framework gave all partners a common discourse for the future creation of curricula and other projects aimed at local industry and regional environmental management initiatives (ibid.). Indicators for achievement of this activity included the national-level CB training seminars and industry best practice showcases each held in Nepal, India and Uganda where consortium partners began their discussions and training in CapSEM methods and tools. Activity 4 CB continued through the duration of the project period and the achievement of all remaining deliverables and indicators.

As the CB phase continued, each partner university identified a focus for activity 5 of *course development or improvement*. Decided during project development, each partner university was to be responsible for developing at least one new master's course related to the knowledge embedded in the stepwise model and project CB. During the activity, however, the consortium quickly realized that it would be impossible to achieve this indicator across all partner universities, not only due to time constraints and bureaucratic difficulties, but also because of the varying needs at each, where some felt an earlier bachelor's-level course should be prioritized, or that improving existing master's-level courses would bring more value. Courses therefore became based on the greatest perceived need at each partner, determined through the gap analysis and CB phase, and consistent with regional and national priorities. This resulted in the development and testing of at

least one new or heavily adapted course at each partner. Upon project completion, this totalled two new and one improved bachelor's-level courses and three new and 16 improved master's-level courses. Although it could be argued that the curriculum development phase is only university–university collaboration, TD was present in the involvement of industry actors and stakeholders in the design and offering of many of the courses. Company and stakeholder engagement and the relevance and implementation of methods for local industry were inherent to the design of each of the courses and to the stepwise model around which they were built. For example, one of the newly improved courses in India has incorporated a case-based project where students are required to undertake a small development project on their campus. This requires collaboration and discourse with professors, PhD students, university bodies and local industry for implementation.

At this point, activities split and reiterated into parallel tasks of continued capacity building and further course development (scientific) and industry training development (societal). This also represents the transition to TD phase 3, transdisciplinary integration, and the beginning of some of the first iterations of the left and right feedback loops essential in Jahn et al.'s (2012) model (refer back to Figure 6.2). Knowledge exchanged in earlier phases helped partner universities identify important local companies and stakeholders, presented in Table 6.4. To improve the quality of sustainability and environmental management curricula, and its relevance to the labour market and local society, partners then collaborated with their identified companies and stakeholders. *Industry training seminars* (activity 6) were developed and held to facilitate cooperation between partner universities and local industries for practical and case-based learning. In Nepal, India and Uganda, a minimum of three training seminars each were given directly to industry and organization partners, along with a best practice industry showcase in each of the six consortium countries.

Finally, the capacity built through these activities has contributed to the development of a video lecture series and material for use by partners and applied in an *open online course* (activity 7). The video lectures were designed in a modular format along the stepwise levels for use and application as needed. The final video modules and related material are openly available on the project website (https://capsem.wordpress.com/learning-material) for use for baseline capacity building, teaching and training, and were designed to be accessible for both academic and non-academic audiences. They have further been incorporated into an open online course (https://onlinecourses.tudelft.nl/courses/course-v1:TUDelft+CAPSEM01+2019/course/). The online course and video modules represent a common project result that is valuable for its TD synthesis and comprehensiveness (McGregor, 2017), and are used for engagement in both scientific settings, i.e. with professors and students, and societal settings, i.e. with companies, governmental and non-governmental bodies and other stakeholders.

Referring again to the 'ideal' TD process model (Jahn et al., 2012), the concept of both the left and right feedback loops is especially important. It is within the initial rounds of these reiterating loops that the project remains currently. Most weight has been placed on the right academic loop, but the *lifeworld approach* of

Table 6.4 Industry sectors, NGOs and public organizations in case-examples

Industry sectors and organizations	*Location*	*Partner university(ies)*
Partner countries		
Cement 1	Kampala, Uganda	Makerere University
Agriculture 1 (Oil palm)		
Agriculture 2 (Tea)	Kampala, Uganda	Makerere University Business School
Agriculture 3 (Sugarcane)		
Wildlife education	Mbarara, Uganda	Mbarara University of Science and Technology
Local government environment officers		
National Planning Authority		
Renewable energy 1	Kathmandu, Nepal	Tribhuvan University
Renewable energy 2		
Medicinal plants	Dhulikel, Nepal	Kathmandu University
Cement 2		
Telecom		
Women's foundation for wastewater management	Mumbai, India	Indian Institute of Technology Bombay
Municipal Council		
Environmental consultancy	Mumbai, India	Tata Institute of Social Sciences
Environmental technology 1		
Environmental technology 2		
Plastic recycling association		
Programme countries		
Cement 3	Trondheim and Ålesund, Norway	Norwegian University of Science and Technology
Waste management and recycling		
Maritime		
Energy	Delft, the Netherlands	Delft University of Technology
Port management		
Cement 4	Lisbon, Portugal	University of Lisbon
Environmental management consultancy		

the left loop has also cycled to help better inform scientific partners of the societal problems and discourses in project contexts. While the project maintains a smaller scale application of TD, the next section elaborates on the stepwise model and the broader and more holistic TD for sustainability management that results from it.

6.5 Transdisciplinarity and the CapSEM model

While section 6.4 discussed specific aspects of TD in the CapSEM project process, this section discusses the TD embedded in the stepwise model (Figure 6.1) and the ways in which it encourages and requires engagement from a range of actors. By structuring environmental management and sustainability methods and concepts within the four-level model, the potentially daunting expanse of methods and theories are taught in a manageable and logical way for practical application and knowledge transfer. A common knowledge integration model builds consensus on

the way forward. In the project, this consensus has been sustained in the level-based modules of learning material. By building a base level of sustainability and environmental management capacity, the application of new knowledge in both academic and industrial settings could begin to help break down barriers between academic and industrial actors in local communities.

For example, during the final project meeting, one representative from a university in Uganda expressed his initial hesitation in joining the project because of lacking formal ties with industry. The use of the standard model, however, helped him to recognize that the existing engagement with local agricultural stakeholders was already quite strong through course involvement and student projects. The project methods were only first daunting because they presented different terminology and were more technically complex than what existed at the university. Using the model as a framework for learning helped the team apply the general principles it teaches to their own context and realize the work they were already conducting towards more holistic sustainability in their community. The next sections describe the TD value of the stepwise model in more detail, first by outlining the disciplines within which it is rooted and can be applicable for, and next through the presentation of industrial case studies from CapSEM partners in which it was used.

6.5.1 Stakeholders addressed across the stepwise model

As shown in Table 6.2 and affirmed by the literature (e.g. Brandt et al., 2013; Schaltegger et al., 2013; Popa et al., 2015), knowledge rooted in many disciplines is a must to achieve improvements that lead towards more sustainable practices. Different stakeholders with the actual competence needed for the transition will often be involved through actors in the supply chain, through consultancy work or through training and capacity building. Thus, the model has greatly strengthened the focus on how to implement solutions for improvements in industries in project countries. NTNU, TU Delft and IST have a long tradition of working with companies, and the transfer of these experiences has been a focused effort throughout the three-year project period.

The span of disciplines included in the model (Table 6.2) and across the consortium (Tables 6.1 and 6.4) contributes to a holistic systems perspective that considers environmental, social and economic aspects of sustainability. As discussed in section 6.3, the CapSEM stepwise model does however place its main focus on the environmental pillar of sustainability. As the stepwise model moves towards greater sustainability, it is in Level 4, and the higher degrees of Level 3, that the incorporation of stakeholders, and social sustainability, is most extensive. Stakeholder involvement in the lower levels is still important for the implementation of the recommended tools and methods, e.g. consideration of consumer needs and existing recycling practices in design for environment. Although it may be more selective at these levels, and based mainly on the organization making improvements for themselves, rather than the greater good, stakeholder involvement is vital and required for companies to make sustainability improvements at all levels.

At Level 1, for example, to make improvements in waste treatment processes, TD engagement must take place between engineers, economists, communities/municipalities and other policy makers. In addition, consumer or employee pressure could be what influences a company to undertake better waste management strategies in the first place. Stakeholder engagement takes place in many parts of a value chain. Level 2 improvements therefore rely on knowledge from various actors on the materials of a product, associated costs, maintenance practices, transportation and marketing, to name a few. Level 3 requires communication with stakeholders to best define management plans for improved sustainability. For example, in establishing strategy benchmarks, a company will need to select environmental and social performance indicators in collaboration with stakeholders in order to measure their progress. In this case, they may be employees, consumers, local community members, marketing firms and company management. At Level 4, stakeholders are extensively involved and their input provides necessary input to all tools at this level. To better illustrate the TD processes at work in the stepwise model, case studies of its use by CapSEM partners are presented in the next section.

6.6 Industrial case studies

Along with the capacity building activities at partner universities, industry training and engagement was an important part of the project for all partners. Although not explicitly designed as a TD project, an essential part of CapSEM has been to develop training seminars for the dissemination of sustainability management methods into practice. Strengthening and utilizing partners' existing experience working with private and public sector actors, training seminars were designed to effectively reach practitioners and policy makers through practical and easy-to-follow guidelines that took into account local contexts. Using the stepwise model as a baseline, relationships between universities, companies and local policy makers could be initiated or grown. Industry impact is an essential component of CapSEM success since the reduction of a nation's level of poverty and environmental degradation is dependent on a transformation in local industry through socially and environmentally sound practices and technologies. The four-level CapSEM model is designed to help show companies how they can improve their processes, products and organizations, and further how they can contribute to a systemic change of mindsets in society, illustrated with the fourth level.

Table 6.4 gives an overview of the industry sectors and adjacent organizations that have been involved through the project period. It should be noted that many of the sector companies, NGOs and public organizations were already partnered with the university(ies) before the project began. The cases are varied across public and private actors, and industry sectors, from agriculture, wildlife and resource management, to cement, environmental technology and renewable energy. Examples from the project partners' application and use of the stepwise model follow in the next section.

6.6.1 Programme country case

Industry sectors in the programme countries have contributed with experiences from each of the levels in the CapSEM model.

6.6.1.1 Case-example from Norway

One example is from the maritime sector in Norway where Fiskerstrand Shipyard has moved along all levels in the model over a period of 25 years. Table 6.5 shows how they have engaged with each of the levels to build their comprehensive understanding of sustainability management for their operations and stakeholders. The process demonstrates the need for reiterations between researchers and company actors over a long period of time to produce an integrated result.

Table 6.5 Application of the stepwise model to improve sustainability management at Fiskerstrand Shipyard

Year	*Action*
1992	Intensified work on HSE (Level 3)
1993–94	Built capacity through a cleaner production project on how to reduce costs and materials connected to the processes of bottom hull cleaning, outdoor painting, waste disposal after rebuilding a ferry, waste treatment of blasting sand from cleaning of painted steel (Level 1, Level 2 and Level 3)
1994	Established baseline for environmental management system, hereunder environmental strategy, environmental accounting, setting goals and plans for environmental performance improvement programmes (Level 3)
1995–96	Implemented methods for environmental performance assessments for increased waste minimization in the ship building industry (Level 1)
1997–98	Updated HSE manual, in addition to performing risk analyses and revising procedures in their external safety manual (Level 3)
1999	Started work on an environmental management certification, developed industry specific environmental requirements and published their first environmental report. Received the certificate for good environmental 'housekeeping' practices for repair and new building yards (Level 3 and Level 4)
2004–07	Updated HSE manual and incorporated it as part of the quality assurance manual in accordance with the requirements of ISO 14001 standard for environmental management (Level 3)
2007 – today	Have maintained and improved their approach to an annual environmental accounting system, using key performance indicators, produce an annual report on environmental aspects and impacts and contribute to systemic regional improvements (Level 1, 3 and 4)

Source: Fet (2018)

6.6.2 Partner country cases

The focus in the case-examples from India, Uganda and Nepal was mainly on Level 1 (cleaner production) and Level 3 (environmental management) of engineering, agriculture and natural resource management, and reflected the industries that currently support regional and national development needs. Case-based work has made the biggest impact and brings necessary sustainability management strategies to areas in need of capacity to better local livelihoods. In a larger context, case-examples related to Level 4 (industrial symbiosis and circular economy) have as a result seen the necessity of working with regional governmental bodies and municipalities. Although partners took different approaches, some with open trainings for multiple companies, and others with more focused seminars for specific stakeholder groups or local organizations, all applied the stepwise model of tools as appropriate. Each partner university held at least three training seminars with evaluation and improvement between each. Strengthened industry partnerships helps translate the sustainability knowledge into practical application and inform researchers about the needs of their industry partners and their stakeholders.

As asserted in Chapter 3 of this book and by Lang, et al. (2012), the objective of TD research is to use the combination of cycles of both empirical academic research and practical solutions for societal problems to develop consequential outcomes for society. Making the link between the two cycles is the essential step to create useful solutions. The case-examples below therefore demonstrate the beginning initiatives of combining cycles of academic research and practitioner knowledge away from 'mode 1' research. Although this combination has not yet led to the creation of completely new knowledge, in most cases, knowledge sharing and building have begun to cohesively frame societal problems that the two groups can begin to attempt to solve.

6.6.2.1 Case-example from Nepal

In Nepal, partners focused on industries that are growing to fulfil the country's demands in food, infrastructure, energy and consumer goods. Throughout the project, industry partners were based in renewable energy technologies, such as wind, solar and biogas, for use in both rural and urban settings. In response to the 2015 earthquake, expanding urbanization and the need to improve infrastructure and livelihoods in rural and city areas, infrastructural partners – such as telecom to improve communication technologies and cement factories for construction and rebuilding purposes – also engaged with professors and PhD and master's students from the Institute of Engineering at Tribhuvan University and the Department of Environmental Science and Engineering at Kathmandu University. An official from the Government of Nepal's Alternative Energy Promotion Centre (AEPC) participated in a full-day industry training session on MFA (Level 1), LCA (Level 2) and EMS (Level 3). He participated in discussions with researchers and companies about the tools and their grounding in the essential long-term and holistic perspective for environmental sustainability that must accompany national policies

and economic development. Nepalese industry partners also gained insight into the possibilities for expanding their thinking to the entire product life cycle by learning from advanced and proven sustainable techniques applied in the programme and partner countries. Although at this point, knowledge is flowing more from university actors to practitioners and not as a full co-production process, applying the stepwise model in CapSEM meetings and workshops has contributed to the initiation of more synergistic collaboration between the universities, partner industries and policy makers for implementing environmental and societal management tools.

6.6.2.2 Case-example from Uganda

In Uganda, priority areas for national development include energy access, infrastructure development, and access to services such as waste management. Petroleum is another important aspect for sound environmental management, to avoid large environmental disasters or the displacement of local people. Agriculture management in line with sustainability, including tea processing plants, oil palm growers and sugar producers, are another main focus. Additionally, resource provision to large refugee camps must be improved. In a full-day industry session hosted by the three Ugandan partner universities, the waste management strategies of other project countries were discussed with representatives from the National Planning Authority, National Environmental Management Authority and the director of a waste management initiative to attempt to implement systems level thinking into future management plans. In addition, collaboration between programme and partner universities and with industry practitioners led to an in-depth analysis of a local cement factory and quarry. Applying LCA approaches (Level 2) learned at NTNU, Makerere University professors and researchers spent time collecting impact data from the company related to resource consumption, emissions and waste. Working with the plant manager, its geologists, electrical and mechanical engineers, environmental officer, quality control manager and production manager, the Makerere team identified operational, institutional and organizational gaps, and has performed the first two steps of an LCA. The remaining steps are expected to be completed within 2021. This analysis has already exposed areas to improve resource efficiency, reduce pollution and improve safety in the factory and quarry, and would not have been possible without the dynamic team and reflexive approach.

6.6.2.3 Case-example from India

In India, the team at IITB has conducted a demonstration project for the circular reuse of wastewater in the rural town of Mhaswad in the State of Maharashtra. Recognizing the importance of and correlation between the reduction of hunger and poverty and the empowerment of women, the team has supported the intervention of sustainable wastewater treatment technology while insisting on the participation of the members of the community in shaping the policy response for transitioning to

sustainable futures. The introduction of constructed wetland beds is therefore aimed at empowering a group of women through the production of recycled water. The beds make up a municipal wastewater treatment plant that is capable of treating 250 m^3/day of raw municipal wastewater generated by approximately 40% of the population of Mhaswad. With the conception, design, support and monitoring from IITB, the plant was constructed with an NGO in collaboration with the Municipal Council. Mhaswad and the surrounding area have faced severe droughts and low rainfall over the past five years. The treated water has therefore been very much welcomed and is utilized in the adjoining community garden, for construction activities and, most importantly, in the fodder camp that has saved more than 3000 cattle by providing fodder, shelter and treated water. The case has demonstrated the benefits of adopting a circular economy approach (Level 4) while addressing the need of water in a community and its concurrent socio-economic benefits. In addition, the Municipal Corporation of Greater Mumbai announced that the technology of constructed wetland developed by the group at IITB would be implemented at a larger scale for treatment and reuse of wastewater in the municipality. This was prompted through engagement with the IITB researchers, circular economy concepts and a visit to their pilot-scale research station during the CapSEM project.

6.7 The stepwise model and the SDGs

These case examples, along with numerous others, demonstrate how transdisciplinarity facilitated through the tools and objectives of the stepwise model can support the design and uptake of sustainable approaches for local, regional and global sustainable development.

Furthermore, for system-level initiatives like the SDGs to shift the global system onto a sustainable path, there is an increased need for transdisciplinary thinking and action. Figure 6.3 therefore illustrates how the SDGs can be placed along the same stepwise model to communicate the framework's objective easily to companies. The figure was developed during the CapSEM project period to meet

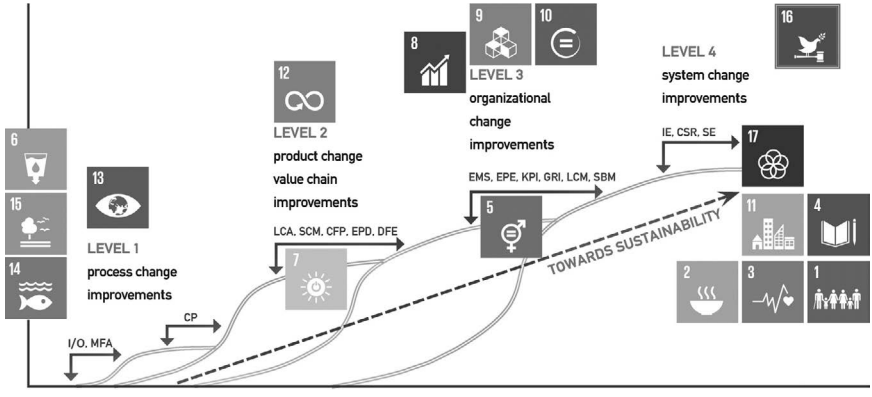


Figure 6.3 Example of connecting the stepwise model to the SDGs

a growing number of questions from the partners about how to encourage industry partners to see the holistic picture of the model and the SDGs, and communicate progress towards the goals. Recognizing the systemic foundation of the framework, it must be noted that even though the goals are placed to illustrate areas of improvement at a specific level, they also fit into each of the other levels. Additionally, because the UN's formal indicators are written for national governments, industry-specific indicators must also be selected for firm-level measurement. By placing each of the goals on a level, however, companies are able to easily begin to apply systemic thinking to their work towards the SDGs by using the goal at the specific level as a starting point. As described earlier in this chapter, material flows connected to production processes (Level 1) generate impacts on the natural environment, here indicated with SDGs 6, 13, 14 and 15. At Levels 2 and 3, SDGs 8, 9, 10 and 12 are connected to circular economy, innovation, equity and sustainable economic growth, all with economic implications. The other nine SDGs are all connected to societal development, and the impact of e.g. access to clean energy (SDG 7), competence and education (SDG 4) and good health (SDG 3) as shown in the figure.

The SDGs as a framework help contribute to coherent framing of sustainability problems, one challenge of TD asserted in Brandt et al. (2013). Although Figure 6.3 is in its early state, the authors believe that its simplicity can help communicate with industry actors to make the overwhelming 17-goal framework become more manageable. The figure may not represent new knowledge in itself, but it serves as a way to jointly frame problems for effective communication between actors for future TD research.

6.8 Concluding remarks

The chapter has reflected upon how TD has been achieved along two main tracks, namely through the interuniversity CapSEM project and the stepwise model. The project's activities followed a TD process to integrate sustainability principles along a network of professors, researchers, students, industry and stakeholders. This collaboration helped to build ability to practically address local sustainability challenges. Using the structured model as a baseline and taking stock of existing capacities, strengths and gaps allowed the consortium to work together to develop and implement environmental management principles that meet local, regional and international needs and contribute to a more holistic understanding of sustainability. CapSEM's systemized, transdisciplinary and practical approach has helped share international best practices and benefits of sustainable transition strategies for companies and governments. Project activities facilitated the cooperation of academics from multiple disciplines for the development of material for academic and practical use. Other organizational representatives also contributed to model implementation. Industry–academia partnerships that developed through project activities helped to break down existing barriers and make the practical application of sustainability methods an accessible part of local business capacity.

Even with this beneficial cooperation and achievement of common goals, challenges related to the TD process were also present in the project. These included the messy and complex problem of sustainability (an inherent challenge); dictated guidelines from the funders regarding expenditure; limited opportunity for flexibility from the original project plan and a set time limit for achievement (institutional challenges); and differing cultural, value and disciplinary opinions (teamwork challenges). Although the project's approach to TD may be considered small-range, the TD of the stepwise model presented the important perspective of systems thinking to solve complex problems.

To achieve more extensive TD within the project, stakeholder collaboration could be more explicitly undertaken to achieve mutual learning and impact (Mitchell et al., 2015) through all project activities, and to continue beyond the project lifetime. The progressive stepwise model, however, mandates the involvement and inclusion of stakeholders in its very design. Although the comprehensive involvement of stakeholders takes place mainly at the higher levels, the lower level tools and methods still require companies to move beyond limited firm-only thinking. The stepwise CapSEM model can therefore be further utilized as an approach for TD collaboration across the various system levels. The authors argue that experiences from the CapSEM project and use of the stepwise model are a powerful baseline for reflection upon the implementation and development of environmental management and sustainability knowledge in varying global contexts. They have also created a family of academic researchers that, despite disciplinary and personal distinctions, have supported each other's knowledge creation and application for livelihood and sustainability improvement. Future projects will categorically include a more extensive range of stakeholder collaboration, and, ideally, find funding with more flexibility for adaptation based on knowledge created and a longer time period to get there.

References

Brandt, P. et al. (2013) 'A review of transdisciplinary research in sustainability science', *Ecological Economics*, 92, pp. 1–15. doi: 10.1016/j.ecolecon.2013.04.008.

Fet, A. M. (1997) 'Systems engineering and environmental life cycle performance within ship industry', Doctoral Thesis, The Norwegian University of Science and Technology, Trondheim, Norway.

Fet, A. M. (2002) 'Environmental management tools and their application: A review with references to case studies', in Conceição, P. et al. (eds.), *Knowledge for Inclusive Development: International Series on Technology Policy and Innovation*. Santa Barbara, CA: Greenwood Publishing Group, pp. 449–464.

Fet, A. M. (2018, October 24) *Environmental management at Fiskerstrand Shipyard: A 25 year journey*. CapSEM Meeting Presentation, Ålesund, Norway.

Gibbons, M. and Nowotny, H. (2001) 'The potential of transdisciplinarity', in *Transdisciplinarity: Joint Problem Solving among Science, Technology, and Society*. Basel: T. Birkhauser.

Gibbons, M. et al. (1994) *The New Production of Knowledge: The Dynamics of Science and Research in Contemporary Societies*. London: Sage.

Hirsch Hadorn, G. et al. (2008) 'Handbook of transdisciplinary research', in *Handbook of Transdisciplinary Research*. Dordrecht, Netherlands: Springer, p. 506. Available at: http://link.springer.com/10.1007/978-1-4020-6699-3_5.

Jahn, T., Bergmann, M. and Keil, F. (2012) 'Transdisciplinarity: Between mainstreaming and marginalization', *Ecological Economics*, 79, pp. 1–10. doi: 10.1016/j.ecolecon.2012.04.017.

Lang, D. J. et al. (2012) 'Transdisciplinary research in sustainability science: Practice, principles, and challenges', *Sustainability Science*. Springer Japan, 7(S1), pp. 25–43. doi: 10.1007/s11625-011-0149-x.

McGregor, S. L. T. (2017, April–June) 'Challenges of transdisciplinary collaboration: A conceptual literature review', *Integral Leadership Review* (Feature Articles). Available at: http://integralleadershipreview.com/15402-challenges-of-transdisciplinary-collaboration-a-conceptual-literature-review/ (Accessed 27 August, 2019).

Mitchell, C., Cordell, D. and Fam, D. (2015) 'Beginning at the end: The outcome spaces framework to guide purposive transdisciplinary research', *Futures*. doi: 10.1016/j.futures.2014.10.007.

Pohl, C. and Hirsch Hadorn, G. (2007) *Principles for Designing Transdisciplinary Research: Proposed by the Swiss Academies of Arts and Sciences*. Munich, Germany: Oekom Verlag. Available at: http://www.transdisciplinarity.ch/en/td-net/Publikationen/Publikationen-td-net/mainColumnParagraphs/08/text_files/file2/document/knowledge forms_principles.pdf

Popa, F., Guillermin, M. and Dedeurwaerdere, T. (2015) 'A pragmatist approach to transdisciplinarity in sustainability research: From complex systems theory to reflexive science', *Futures*. doi: 10.1016/j.futures.2014.02.002.

Robèrt, K. H. et al. (2002) 'Strategic sustainable development: Selection, design and synergies of applied tools', *Journal of Cleaner Production*, 10(3), pp. 197–214. doi: 10.1016/S0959-6526(01)00061-0.

Schaltegger, S., Beckmann, M. and Hansen, E. G. (2013) 'Transdisciplinarity in corporate sustainability: Mapping the field', *Business Strategy and the Environment*. John Wiley & Sons Ltd, 22(4), pp. 219–229. doi: 10.1002/bse.1772.

Scholz, R. and Tietje, O. (2012) *Embedded Case Study Methods*. Thousand Oaks, CA: SAGE Publications. doi: 10.4135/9781412984027.

Singh, R. K. et al. (2012) 'An overview of sustainability assessment methodologies', *Ecological Indicators*. doi: 10.1016/j.ecolind.2011.01.007.

Stokols, D. (2006) 'Toward a science of transdisciplinary action research', *American Journal of Community Psychology*, 38(1–2), pp. 63–77. doi: 10.1007/s10464-006-9060-5.

United Nations General Assembly (2015) 'Transforming our world: The 2030 agenda for sustainable development', (1), pp. 1–5. doi: 10.1007/s13398-014-0173-7.2. https://sustainabledevelopment.un.org/content/documents/7891Transforming%20Our%20World.pdf.

Vildåsen, S. S., Keitsch, M. and Fet, A. M. (2017) 'Clarifying the epistemology of corporate sustainability', *Ecological Economics*, 138, pp. 40–46. doi: 10.1016/j.ecolecon.2017.03.029.

7 Transdisciplinary collaboration in architecture and design

The case of Chhobhar, Nepal

Bijay Singh and Martina M. Keitsch

7.1 Introduction

Social actors request knowledge in the life-world (Harrington, 2006) to address their societal problems from the local to the global scale. Knowledge then becomes an integral part of innovation and problem-solving strategies. For any professional, the aim of developing problem-solving strategies is to be sustainable. This means that even after the problem is solved, it is important that the strategies implemented carry into the future, or that their impact continues.

As such, the process of problem-solving is often accompanied by knowledge generation and application involving a wide range of disciplines and associating experts. This is especially the case with sustainability challenges, where the focus is to develop a coherent framework from different scientific disciplines that allows a continued desirable impact of any strategies. For example, the triple bottom line of sustainability is used in an accounting framework that included environmental and social dimensions, and went beyond traditional measures of profits, return on investment and shareholder value. Simultaneously, such a framework has to inform the local solutions in specific contextual settings that may include one or multiple disciplines.

A plethora of different disciplines involved in sustainability research contributes to sophisticated concepts, theories, and methods, for example, in architecture and design. However, scientists in these and other disciplines are usually concerned with examining and analysing problems and developing solutions based on universal concepts, theories and models. For example, in architecture and design, while adopting the triple bottom line of sustainability, the concern is mainly on if the solutions are economically viable (economic sustainability), are less consuming of natural resources (environmental sustainability) and involve equity access to the solutions (social sustainability). The resulting overall knowledge, often referred to as scientific knowledge, is a combination of scientists' expertise, as patterns of insights, achieved from methodologies in the respective disciplines. Monodisciplinary knowledge patterns are sometimes more reminiscent of the 'blind men and elephant' story than representative of organized epistemic approaches (Kleineberg, 2013). The story tells of seven blind men who examine an elephant, each focusing on a different aspect. The result is seven partly

incommensurable descriptions of the very same object of interest. The task to modify the story is at hand: to integrate partial knowledge within a more significant (sustainability) framework by transcending one's own disciplinarily limited perspective.

One reason for the fragmented nature of scientific knowledge as a contribution to a sustainability framework is epistemological and methodological differentiation between social and scientific problems. For example, promoting sustainability on a local level requires overcoming deductive preoccupations and academically compartmentalized concerns. So far, social and political sciences have dealt with issues of society on an academic level. However, newer research, for example, in this book, indicates that knowledge about and knowledge generation with societal actors can be equally relevant for disciplines like architecture and design. Many disciplines have the maxim to make example sustainability work in real contexts (McElroy, 2018). Since deliberate societal collaboration concepts are still infants in these disciplines, transdisciplinary approaches do not only benefit in meeting sustainability and societal challenges but also contribute to the development of research and design in the architecture and design curricula and decrease epistemological fragmentation. Likewise, the sustainability framework and models such as the triple bottom line are habitually devoid of societal knowledge. Actors and societal stakeholders are usually concerned with the social legitimacy of strategies that can address a plurality of values and worldviews associated with the application of knowledge. However, scientists (experts) want to solve problems from a perspective of technical–instrumental rationality, ignoring non-scientists' values and worldviews. This chapter applies the terms 'actor' and 'stakeholder' synonymously.

Societal knowledge is often tacit. This makes it easy to disregard, for example, actors' life-worlds, values and views. Still, these can be factors that eventually lead to uncertainty when scientific knowledge is practically tested in contextual situations. In general, it seems questionable that the scientific knowledge that is solely theory-generated can adequately describe, explain, understand, reflect and handle the reality of concrete problem situations.

In some cases, generic and abstract scientific knowledge contradicts knowledge required for society; in some cases, it can supplement and provide immediate solutions but turn out counterproductive in the long run. One possibility for reconciling scientific and societal knowledge is integrating ideographic and nomothetic ways of knowing (Corwin, Redeker, Richmond, Docherty, & Pickler, 2019), thereby, diminishing the gap between theory and practice. This presumes that both experts and social actors are involved in a co-production of knowledge generation and its application process. An epistemological condition for co-produced knowledge is the perception that knowledge generation is not a one-way transfer of technical–instrumental rationality from experts to social actors, but a result of information integration, where both scientists and societal stakeholders contribute. Co-production of knowledge that involves various actors has, among other things, the advantage of enabling them to commonly comprehend, discuss and negotiate problems and their possible solutions.

Dealing with societal problems within a transdisciplinary research approach would then comprise a shift in focus from developing a coherent theoretical framework as in scientific disciplines to co-producing a body of integrated knowledge as example suggested in Chapter 2 of this volume.

An important task in transdisciplinary co-production of knowledge is the incorporation of multiple perspectives in complex practical issues and the connection of perspectives from heterogeneous actors with available solutions, concepts, methods and goals. One way to meet this task within a mixed team of actors is the incorporation of different experiences from scientists and social actors in the discourse on conceiving solutions. Integration is not the value in itself here but rather part of a necessary methodology and strategy for collaboration to consider and provide solutions that different actors can perceive.

In this context, a researcher can be the facilitator for integration by understanding the complexity of societal problems and, within this complexity, providing space for communication and interaction among experts with different scientific disciplines and social actors with different values, views and skills. Providing space is necessary for the co-production of integrated knowledge through co-productive research and exploration. Here, knowledge generation concerns not only co-production but also facilitation for different interpretations, dissemination and implementation of knowledge in contextual situations. In a real-life scenario, the knowledge co-production process comprises cooperation between different scientific domains and societal actors to solve a problem. A collective process of problem framing, problem analysing and project implementation, which directly involves scientific and non-scientific stakeholders (experts and social actors), may contribute to developing satisficing solutions for all partners (Simon, 1996). Simon coined the term 'satisficing', a combination of two words: 'satisfy' and 'suffice'. In situations, actors seek something that is 'good enough', instead of looking for some-thing that is ideal. The real-world behaviour is what Simon called satisficing: 'We must trade off satisficing in a nearly-realistic model against optimizing in a greatly simplified model. Sometimes one will be preferred, sometimes the other' (p. 28).

TD in research and stakeholder collaboration comes to the forefront in the context of co-productive knowledge generation and implementation. Transdisciplinary research aims at identifying, structuring, analysing and handling issues in problem fields with at least four types of aspirations:

(a) to grasp the relevant complexity of a problem
(b) to consider the diversity of life-world and scientific perceptions of problems,
(c) to link abstract and case-specific knowledge, and
(d) to develop knowledge and practices that promote what is perceived as the common good.

(Pohl & Hirsch Hadorn, 2007)

In transdisciplinary research, these aspirations are met by designing the research process in a recurrent order of the following phases: problem identification

and problem structuring, the stage of problem investigation and the phase of bringing results to fruition. The order of phases and the number of resources dedicated to each stage depend on the kind of problem under investigation and the state of knowledge (Maguire & Britten, 2017). In transdisciplinary collaboration, integration of scientific, professional and everyday narrative knowledge is both an epistemological and a normative maxim throughout the teamwork process. Integration has its normative basis in Habermas' discourse ethics as a claim to connect the life-world and the system (see Chapter 4 in this book). Collaboration is mapped as spaces between these spheres and therefore, between the social norms pertaining to them. In this way, collaboration spaces are liminal, in-between or threshold spaces. Transdisciplinary collaboration allows new insights on both the opportunities and the conflicts integral to the ambiguous, and complex interactions which take place in these spaces (see Chapter 4).

A significant challenge associated with knowledge integration in TD is that actors have diverging perspectives and, initially, do not 'speak the same language', which impedes understanding the view of others. This means that even though actors share the awareness of common problems and, for example, a vision of sustainability, their ideals, values and knowledge differ. Differences relate to at least three factors: 1) variations in the epistemological orientation of different actors, for example in identifying crucial elements of a problem; 2) variations in their pragmatic orientation towards suitable solutions; and 3) the volatility of actors' views in 1) and 2) in different phases of a transdisciplinary project.

As a result, misunderstandings among the diverse actors in TDC are inevitable, and tasks for a TDC facilitator can be categorized within the following aspects:

1 To grasp the relevant complexity of a problem and to make complexity and relations understandable and comprehendible for all actors;
2 To presume and consider a gap between everyday life-world and scientific perceptions, and ideographic and nomothetic ways of knowing;
3 To connect abstract and case-specific knowledge, i.e. to link the generality with contextuality and convert both for concrete situations;
4 To develop, promote and maintain practices that facilitate formulating a 'common good' in the teams.

Based on Hirsch Hadorn et al. (2008)'s transdisciplinary collaboration approach, as illustrated in Chapter 2, the following sections attempt to analyse transdisciplinary problem-solving with two communities in a design project in Chhobhar, Kathmandu, Nepal. The diversity of stakeholders and the inevitability of including diverse, non-scientific actors and their values in the design of physical shade have established the transdisciplinary setting. The focus of analysis is on possibilities and challenges to integrating professional and different stakeholders' perspectives to form societal knowledge. The roles of experts and social actors in the integrated knowledge co-production and application process are identified and mapped. The final sections of the chapter discuss how co-produced knowledge

became comprehendible for all involved actors and integrated into their value system and worldviews for the social legitimacy and continuity of it and other collaboration projects in the future.

7.2 Methods

The following sections present a retrospective study and posthoc analysis. One of the authors participated in the project not only as a professional practitioner and designer but also as a researcher, in analysing his role and collaboration with stakeholders. Engaging in retrospective reflection allows the researcher to construct knowledge from experience (Stefl-Mabry, Dequoy, & Stevens, 2012). The credibility of his approach is based on discussing reflections and findings with the other author of this chapter and with the project's stakeholders. His activities as researcher enabled him to reflect on actions and the roles he and other actors played in co-producing knowledge. Reflection is understood as an analytical tool that gives feedback into either enhanced theory or experience. Activities can be summarised as reflective practice (Schön, 2017).

Schön combines reflection with action in three pivotal constructs: reflective practice, reflection-in-action and reflection-on-action. In each construct, reflection transpires in and on actions that occur in a dialectic sequence (Stefl-Mabry et al., 2012). Schön uses 'reflective practice' as an umbrella term that comprises a dialogue of thinking and doing, while critically assessing one's behaviour as a means towards developing professional abilities in the workplace within a dialectical process, where thought and actions are linked (Schön, 2017). Reflection-in-action is undertaken during a task; reflection-on-action is done retrospectively after the completion of the task.

The following section attempts to analyse how a practitioner conducts reflection-in-action and, links theoretical, professional knowledge with practical knowledge in the project phases. Figure 7.1 illustrates some aspects of the linkages within a triangulation of roles of the practitioner, the researcher and the designer. The figure is analytic in the sense that it attempts to explain the different characteristics and tasks of these roles. In real life, the roles are oscillating, and transgressions between reflection, research, and design are fluent.

The model illustrates roles and stakes in different situations in transdisciplinary collaboration during knowledge co-production and conduction of a development and design process. The researcher reflects, for example, on problem formulations, context and analysis, and on implementing and assessing the solutions, while the designer attempts to manifest insights gained. The potential to influence future actions and impact a broader context is considered 'reflection-on-actions' in all roles; however, with a different focus.

The following sections present the model concerning our case. The section concludes with a discussion on the reflective practitioner's overall role in transdisciplinary collaboration with special focus on his challenges of facilitating with the knowledge co-production.

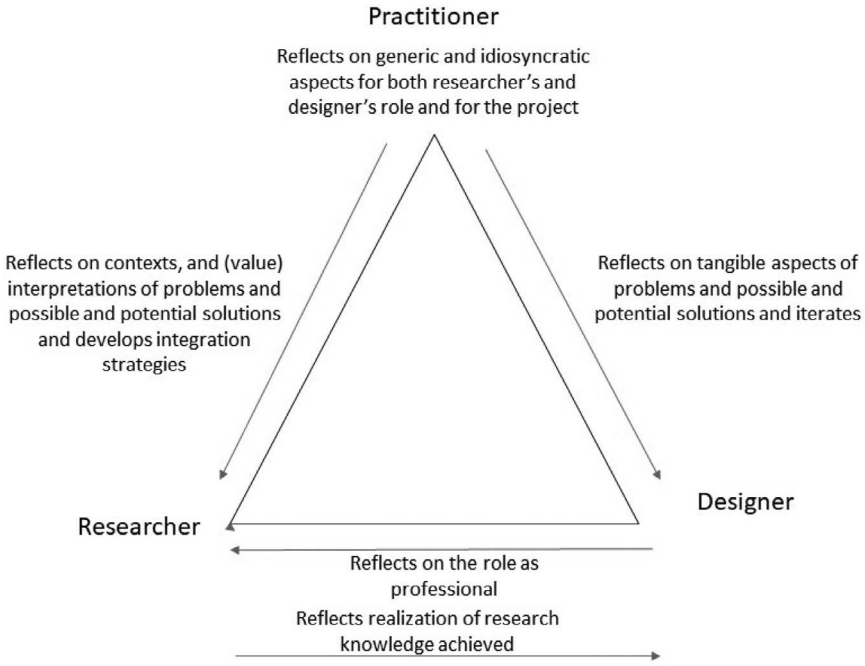


Figure 7.1 Role models based on reflective practice
Source: © M. Keitsch, B. Singh

7.3 The project

The following section presents the fundament for the project. Chhobhar community lies in the Kathmandu valley approximately 10 km from Kathmandu centre. Indrachowk community lies in the centre of Kathmandu. Both communities have had an ongoing relationship since 2009. The collaboration project between Chhobhar and Indrachowk is not necessarily an exemplary transdisciplinary research and development approach. The project was developed through a process of intense discourse among different stakeholders representing two different communities, Indrachowk and Chhobhar. The author, who was part of the project as a practitioner, is a member of the Indrachowk community.

The initial goal of the project was to build a semi-covered space that different social actors could use as a simple shade. When the project on 'shade construction' was conceptualized in 2009, it was interpreted as a physical contribution of Indrachowk community to Chhobhar community. The discourse has continued by translating the various aspects of the relationships since 2009 between the two communities into building strong future relationships through different activities, as illustrated in Table 7.1. The participation of Indrachowk community

Table 7.1 Chronological development of the transdisciplinary collaboration between different actors in the project

Date	*Actions*	*Actors*
November 29, 2008	Propose a new pine tree for religious purpose	Indrachowk community
February 21, 2009	Propose Chhobhar community provide pine tree	Indrachowk community
March 18, 2009	Cut pine tree from community forest at Chhobhar	Indrachowk and Chhobhar communities
July 7, 2009	Initiation of participation in plantation programme at Chhobhar	Indrachowk and Chhobhar community
July 25, 2009	Establishment of plantation sub-committee committee at Indrachowk	Members from Indrachowk community
July 9, 2009	Conceptualisation of construction of shade	Indrachowk community
November 14, 2013	Agreeing to proposal-making on constructing the shade at Chhobhar	Indrachowk community
July 29, 2016	Formation of the ad hoc committee	A committee consisting of executive members (11), technical experts (designer 1, engineer (1), advisors (4) – all from Indrachowk community
December 12, 2016	Formation of the shade construction committee	Executive committee (9 members – 6 from Indrachowk, 3 from Chhobhar), advisors (2 members – each from Indrachowk and Chhobhar)
	Establishment of joint account including two members from Indrachowk, one from Chhobhar and deposit of Rs 1,00,000 from Indrachowk community	
	Letter pad and receipt for donations printed	Treasurer from Indrachowk
	Authorized stamp	
January 29, 2017	Formation of technical sub-committee	Researcher/designer – 1 from Indrachowk engineer – 1 from Chhobhar
March 16, 2017	The decision was made on allocating shade-construction to the lowest bidder; technical supervision was done by technical sub-committee	Construction committee
March 18, 2017	Inauguration of the foundation laying	Construction committee
October 13, 2017	Finance reviewing	Construction committee
October 28, 2017	The official inauguration of the shade	Construction committee; donors; minister of sports and youth; mayors from Kathmandu metropolitan city and Kirtipur municipality

Date	*Actions*	*Actors*
November 10, 2017	Handover of the responsibility and remaining finance to Chhobhar community for the maintenance of the shade and terminate the committee. In case of decisions relating to the status of the shade (major construction, demolition and maintenance), the decisions shall be made by activating the construction committee with both communities	The committee remains as the maintenance and management committee that will undertake future decisions on the shade

in the annual plantation programme can be seen as the first step towards building the relationship. A sub-committee was established in Indrachowk community's organisation to participate in the yearly plantation programme as a promise for providing the tree. The establishment of the sub-committee in Indrachowk community's organisation facilitated developing the trust between the two communities. The prolonged relationships between two communities through discourse allowed the concept of shade construction to evolve into a concrete design. Each community forwarded developing their ideals for the shade. As such, the concept of shade underwent iteration with more elaborations on the design concepts, symbols and functions into a rest house as a concrete end.

From the researcher's perspective, it was important to understand the hidden motives and objectives behind the iterations. While the Indrachowk community emphasized maintaining and planting in the future for a religious purpose, Chhobhar community focused on economic benefits for the community by renting the shade after the construction was accomplished. Both communities used different ideals and objectives, based on a shared vision of improved relationships.

As a researcher, it is important to understand one's role in unveiling different stakeholders' goals and provide the means and methods for them to express them. Different goals from the actors influence the ideals of each stakeholder, and factors embedded in these goals can become situation-determining. An exploration of hidden goals and factors influencing them epistemologically requires leaving the disciplinary comfort zone in the knowledge generation process and acknowledging that transdisciplinary collaboration is not always about the apparent contributions in knowledge co-production.

In our case, both communities anticipated the strengthening of the relationships during and after the completion of the project. They agreed that the shared vision of improved relationship despite different ideals and objectives for the project was more relevant. The collaboration during the project period was the main reason for the successful accomplishment of the concrete results – that is, rest house construction – but also has a bigger impact on the process of strengthening the relationship even after project completion. Successful completion of the project

facilitates the institutionalisation of the relationship, in the form of organisation that includes members from both communities. Now the organisation is formally responsible for the management and maintenance of the rest house. The decisions are now collaborative and have higher stakes.

In hindsight, the 'scaling up' approach of transdisciplinary collaboration must be emphasized, especially in cases of sustainability issues. Transdisciplinary research often focuses on nomothetic problem-solving strategies. Yet, transdisciplinary collaboration can also have a prolonged and profound impact on conditioning factors and the values governing them, as the case in Chapter 8 shows. Values and visions that are not explicitly expressed by problem-solving strategies can become governing factors for the sustainability of a project.

The following section presents the analysis of the shade as an object concerning the broader complex context involving the two communities and the practitioner as researcher and designer. The section also presents challenges for the researcher and the designer during the project implementation.

7.3.1 Analysis of roles

The output of the project in the form of a shade which transformed into a rest house represents a physical manifestation of successfully strengthening the bond between two communities. The following section refers to a systemic thinking of considering the project's physical manifestation as a part and representation of the relationship between the two communities.

In this project, the elements of the system are the problem field (shade in the context of the bond), the practitioner from the professional arena – that is, design – and actors from the non-scientific field. In transdisciplinary research, the term 'system' refers to the interactions of these elements in the research process, that is, by discussing what the problem is about, by investigating the problem, by deliberating the values and goals and, or by developing measures (Pohl & Hirsch Hadorn, 2008). The reason for interactions is their shared aim of improving a situation in problem field of the life-world, for example, the construction of a shade as physical protection against the sun and as a construct to strengthen the communities' bond. The practitioner and social actors from both communities shared the goal of constructing the shade, which is explicitly stated in the project documents. The stakeholders anticipated the strengthening relationship between the two communities, which was is implied but not expressly stated.

The researcher positioned the project as an element in the complexity of the relationships and interaction between two communities, a part-whole relationship. One way to interpret the part-whole relationship is through a hermeneutic circle (Høiseth & Keitsch, 2015). The hermeneutic circle interprets text (or objects and processes) related to human action by setting it in a broader context. The action as a part is interpreted, based on an understanding of the entire existing system, and its interpretation helps to generate a revised understanding of the whole system. In this case, considering the shade as an object in the complexity of relationships between two communities brought the possibility of changes. The shade evolved

towards a rest house, and the goal of the improved relationship between Chhobhar and Indrachowk was made transparent. As a researcher, it was also crucial to reflect upon the role of a practitioner and designer in co-producing and applying the new understanding generated.

Based on the hermeneutic interpretation, the following assumptions were made:

1 The shade is interpreted, conceptualized and manifested as a representation of the relationship between the two communities;
2 The shade is visualized and constructed based on ideals and values from different stakeholders;
3 The shade contributes to a new understanding of the relationship between Chhobhar and Indrachowk, anticipated as a strengthened bond.

The assumptions are related to the knowledge generation process on a societal level through project execution. The knowledge that social actors provide from their understanding includes substantial practical knowledge about what kind of shade they wanted and, further, about religious and cultural activities in the area, people, who visited, different functional requirements for hosting programmes etc. The designer knows which materials and technologies are available to build this kind of shade, plus additional external factors such as costs of the project and government regulations for construction. In turn, as a researcher, it is important to facilitate how the diverse ways of knowing come forth, and how different ideals in the specific problem field are considered actually and potentially. For example, whether the shade has a bigger impact on participation in the local context due to being a free potential way to spend time in an otherwise capitalized and economically usurped area.

The three assumptions mentioned earlier comprise three epistemological challenges the researcher faced while reflecting on the practitioner's role in the project, as explained in the next section.

7.3.2 Three epistemological challenges reflecting on the practitioner's role in the project

At the beginning of the project, high uncertainty in decision-making was at stake. To identify the concept of the shade, the complexity of the situation required understanding beyond the primary function of shade. Diverse interpretations from stakeholders in both communities were presented, creating a need to link general requirements for the shade to the specific demands from the communities. The practitioner's dual role as researcher and designer was to comprehend different interpretations related to the shade, connect them to the underlying worldviews of these interpretations and eventually 'translate' them into a solution (Verganti, 2003).

Both communities expected to strengthen and institutionalize their relationships through collaboration in the project, even though they had different agendas. The institutionalisation of the relationship is not explicitly stated in the project description, although it became clearer during the execution of the project (see section 5.3). The status quo and the future anticipation of shade in the context of

the relationship between the two communities can be analysed as the stakeholders' hermeneutic interpretation.

Common knowledge developed in the process seems to corroborate diverse values in a specific given spatial and temporal context. It addresses iterations of interpretations of the shade in different periods. For the researcher, different interpretations also provide means and methods for transforming a solution from the current status towards future ideals. A challenge here is to integrate knowledge that allows the transformations of contemporary interpretations of a status quo with the potentials for future ideals.

Within this dynamic perspective of current and future development of solutions, the following three epistemological challenges appeared:

The first epistemological challenge relates to the question of how the project, as a problem, is interpreted by different social actors from both communities, and how far professional knowledge can manifest those interpretations in concrete results. The epistemological challenge associated with integrated knowledge is further to connect a plethora of value-based social knowledge with professional knowledge. To meet this challenge, the researcher had to investigate the evolution of the project towards the current status. In a transdisciplinary approach, this form of knowledge refers to the systems knowledge (Pohl & Hirsch Hadorn, 2007). The researcher needs here to comprehend a project as intentional and purposeful action, rather than randomly generated.

The design of shade was guided by knowledge on different underlying worldviews and professional knowledge. The knowledge so generated is an integrative result of an empirical process to develop a concrete solution.

In this regard, the researcher must unveil hidden and subjective values of all stakeholders, including himself, within the evolution process from shade to rest house. The researcher's epistemological challenge lies in stating these values in an unstable setting, stemming from the dynamics of changing views in the subjective interpretations. The designer faces the challenge of working transparently with the stakeholders while dealing with the uncertainties of hidden agendas and goals.

The second epistemological challenge lies in determining the significance of possible interpretations of the shade for the future. This relates to the necessary changes in the status quo and the future outcome of the project. Here, the epistemological challenge associated with the integrated knowledge was clarifying different positions and the priorities of different actors to understand the designer's role and possibilities. The researchers developed categories of ideals for the actors. The categories have significance, agreeing on what is perceived as the common good. In this case, the common good was strengthening and institutionalizing the relationships. Knowledge on the common good signifies the normative element in project planning and development.

In transdisciplinary research, this form of knowledge refers to the target knowledge (Pohl & Hirsch Hadorn, 2007). According to Pohl and Hirsch Hadorn, a researcher must comprehend a project as a process-oriented normative action in achieving the common good, which has priority.

The researcher regards co-produced knowledge as achieved through consensus building among involved actors and reflects upon his role in the consensus-building process. The knowledge co-produced is, in our case, possible desired connotations of the shade. That these connotations were explicitly stated might have contributed to the development from the shade into a rest house.

The epistemological challenge lies in balancing different ideals and connotations of the actors with desirable interpretations regarding the shade.

The third epistemological challenge is practically related to the question of how a project can be executed considering the myriad of complexities. This first concerns the relationships between the two communities, but second external factors as well, like established technologies, social and cultural practices and power and authority that might influence the interpretation of the shade within this relationship. In transdisciplinary research, this is referred to as transformative knowledge (Pohl & Hirsch Hadorn, 2007). The researcher needs to take into account established technologies, regulations, practices and power relations to understand the designer's role in co-producing the knowledge within the contextual situations. The designer's challenge is then making the established technologies, connotations, social conditions and regulations flexible enough to realize the desired output of the shade. While the researcher analyses different interpretations of the shade, the existing relationships and the critiques of it, and anticipates for the better direction based on the current external factors and norms, the designer takes creative action based on the researcher's findings. The designer applies integrated knowledge in the physical manifestation.

Developing and applying integrated knowledge must respond to the challenges mentioned earlier. The integrative perspective is also illustrated in transdisciplinary research, resembling three kinds of knowledge: systems knowledge, target knowledge and transformation knowledge. Epistemologically, the researcher needs to reflect retrospectively on the roles of the designer and the practitioner in different situations (both temporal and spatial).

7.4 Project phases versus transdisciplinary research phases

The following section discusses the chronological development of the project implementation (from conceptualisation to implementation) based on three phases of transdisciplinary research.

In transdisciplinary research, integrated knowledge is constructed through three phases in recurrent order (Hirsch Hadorn et al., 2008): problem identification and structuring, problem analysis and bringing results to fruition. The interdependencies and the order of the phases are dependent upon the kind of problem under investigation and on the state of the knowledge as illustrated in Figure 7.2 (Hirsch Hadorn et al., 2008). Conclusively, knowledge generation and utilisation in transdisciplinary collaboration require reflective action. This, in turn, necessitates that the practitioner iteratively moves backwards and forwards in different roles as a researcher and a designer.

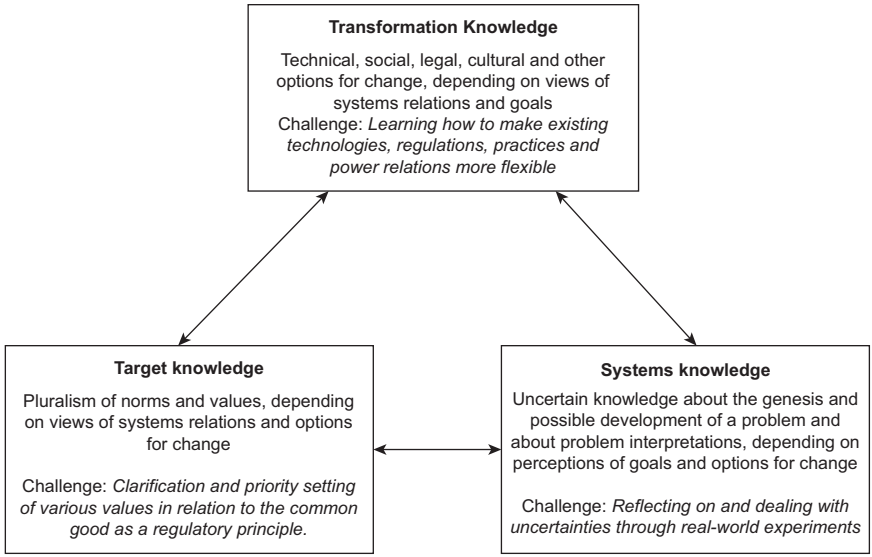


Figure 7.2 Interdependencies between three forms of knowledge

Source: Based on Pohl and Hirsch Hadorn (2007, p. 38)

7.4.1 Problem identifying and structuring

In the problem identifying and structuring phase, all collaborators work jointly on identifying and understanding the issues in a problem field concerning the genesis and possible further developments of the problem (system knowledge); determining and explaining the need for change, desired goals and better ways of acting (target knowledge); and exploring technical, social, legal, cultural and other possible means of transforming existing practices (transformative knowledge).

The phase identifies the origin of the project as well (systems knowledge). For Indrachowk community, the project represented a physical contribution as a part of their favour towards Chhobhar community. The Indrachowk community was expecting that repaying the favour might continue their relationships in the future, and it was in its interest to have access to the tree in the future when required for socio-religious activities. For Chhobhar community, the shade represented an opportunity to have a multifunctional space that might boost their economic prospects. A stakeholder group from Chhobhar community manages the area, which they rent for different social activities, for instance, picnic, annual general meetings (AGMs) of various organisations and institutions, felicitation programmes and school programmes. The Chhobhar community expected that financial and other resources from Indrachowk community could help them to build a multifunctional space that could act as a stage for various programmes and a shade under normal conditions.

From the technical aspect, the designer needed to develop the physical concept that allowed the space's multifunctionality as well as ensuring it was strong enough for catering to those activities. The process of designing the shade reflects on and deals with the uncertainties put forward on different actors' requirements and views. At this stage, the shade had various status quos: a simple, a multifunction space that could act as a stage, strong enough and spatially sufficient to cater to those functions resembling systems knowledge of transdisciplinary research.

Further, the designer was required to see the possible future interpretations of the shade by relating it to the two communities' relationship (target knowledge). One of the possible changes in the design was that it could express a symbolic contribution from Indrachowk community. The forwarded idea was to install the deity of Shree Akash Bhairabnath as one of the possible iterations (transformative knowledge). However, this iteration also had the uncertainty on the cost of installing the deity, among many. The designer clarified that the cost of installing the deity would be his contribution. He believed that with the decision on installing the deity, there could be more financial contributions, from other actors.

At this phase, the shade had multiple target status; a symbolic expression of Indrachowk; and a multifunctional functional shade. The various target status expresses diverse perceptions, simultaneously expressing the communities' vision on strengthening the relationship.

7.4.1.1 Reflective practice on roles and knowledge generation

The double role of the practitioner as a designer and a researcher creates a need to analyse situational decisions on two levels to sort out design-related uncertainties. The researcher reflects upon a diversity of knowledge demands, and the designer applies this knowledge application in different situations through design elements in the physical shade. The situations are dynamic, which is also reflected in various interpretations of the shade over time, and diverse expression of different values.

The dynamic situations of knowledge synthesis have both spatial and temporal aspects. Spatially, knowledge is generated through interactions among different actors with diverse values. It is related to unveiling different hidden agendas in the complexity of different values. Temporally, the knowledge so generated is the consequence of manifesting different ideals in the evolution of the concept. As a result, epistemologically, knowledge is related to mediating the past and seeks to determine its significance for the present and future scenarios. Dynamic changes need considerations because they influence and direct both the practitioner's and stakeholders' knowledge orientations in ways of knowledge generation and of their application.

From the practitioner's inclusive perspective, it seems that when knowledge transcends from one worldview to another, it must be described in terms of comprehensible actions, or something tangible as an entity in a worldview. This illustrates the practitioner's oscillating role in transcending different worldviews or realities in the knowledge generation process. As such, the practitioner seems

to have higher stakes in the knowledge co-production process because of their dynamic transcending role in knowledge co-production in dynamic situations. This also highlights the transdisciplinary elements of the practitioner's role as a researcher and a designer.

Meeting these requirements allows the practitioner in turn to identify the concrete output, the process to be carried out and the comprehendible entity that can transcend different realities, spatially and temporally. In the case presented, the practitioner, as a researcher had a pivotal role in identifying and structuring the purpose of the rest house and connected interpretations and values. Furthermore, the practitioner, as a designer, had the task of incorporating them and applying means and methods to manifest them physically in the shade.

As a researcher, it then becomes vital to comprehend and facilitate organisation and collaboration that highlights the transcending role of the practitioner during knowledge generation and application process in the dynamic contextual situations.

7.4.2 Problem analysis

In the problem analysis phase, stakeholders determine different ways of collaboration that allow them to take into account different interests and circumstances (Hirsch Hadorn et al., 2008). From a knowledge co-production perspective, this means determining organisational structures that allow different interest groups to express their ideals and values, while at the same time differentiating roles and stakes in co-producing the integrated knowledge.

In our case, the organisational structure was established when an ad-hoc committee was formed consisting of members, advisors and technical experts (designer and engineer) from Indrachowk community to construct the shade in the community forest in Chhobhar. The ad hoc committee's primary responsibility was to initiate the dialogue with Shree Adinath Community Forest Group at Chhobhar on the shade construction. Indrachowk community has clear objectives and an associated hidden goal. At this stage, the first author was not directly involved in the process.

Chhobhar community lacked a clear objective regarding the proposal in the initial stage. When the members from Chhobhar community had a clear objective and expectations from the project, the ad hoc committee formalized into a rest-house construction committee. The newly formed committee consisted of representatives from both communities. Since the financial contributions were made by Indrachowk community, the treasurer was appointed from Indrachowk community and was responsible for keeping a record of all incomes and expenses related to the project.

Further, a technical sub-committee under the construction committee was formed, which consisted of the researcher as the designer and a representative from Indrachowk community and an engineer from Chhobhar community. During this period, the committee could not find a contractor. As per mutual understanding in the committee, informally, a supervisor was allocated from Chhobhar

community. The responsibility of the supervisor was to check the materials, keep control over the construction schedule, manage the labour and construction schedules and discuss with the design concerning construction. Further, the masonry labours were hired from Chhobhar community, while the roof (material + labour) was contracted to external skilled labours. During this period, the first author was also in extensive discussions within the technical subcommittee on materials and technical specifications and the committee members on design iterations, design-related expenses and progress.

After the completion of the project, the construction committee might dissolve and hand over the responsibility of maintenance and repairs of the rest house to Shri Adinath Community Forest Social Actor Group of Chhobhar community. The construction committee represented a form of collaboration that allowed space for shared group learning, deliberation among experts and, where integration was possible, with the dynamic role of the practitioner, whose cycle started and ended with the project initiation and termination.

7.4.2.1 Reflective practice on the TD process

The dynamic nature of the organisational structure in the collaboration creates a need to understand the dynamic nature of the collaboration on two aspects. First, the changing numbers of representatives reflect the requirement of different kinds of social actors as the process progressed. Second, the variations in the various stakeholders' interests during project execution reflects the role different actors played in achieving the objectives and goals.

In either aspect, the actors and the practitioner are collaborators in the process. The collaboration allocated the stakes to provide democratic decision-making. Furthermore, the collaboration allowed the stakeholders to learn about existing technologies, legal obligations, social and cultural constraints from actors and the designer's professional knowledge. The learning process would help the transition of the shade from its current status as a simple shade to the target one, i.e. meaningful rest house. The organisational structure had the transdisciplinary elements that allowed the shared space of dialogue and discourse on the learnings of different external factors in the decision-making process. In the transdisciplinary collaboration, it becomes necessary to interpret those learnings and integrate them into knowledge that is easily understandable to different worldviews.

Further, in collaboration, all stakeholders do not necessarily have equal stakes. Epistemologically, the transdisciplinary collaboration further hikes the stakes of a practitioner, because the practitioner transcends different worldviews to integrate diverse knowledge: as a researcher to unveil the complexity of the problem and as a designer to manifest the solutions physically. As such, in transdisciplinary collaboration, the organisational structure needs to be dynamic not only in the numbers of stakeholders but also in allocating variations in the stakes of different stakeholders. Crucially, the practitioner that requires transcending characteristics in knowledge co-production might have higher stakes because of the importance of integrating the knowledge under a common normative orientation.

Our case highlighted the organisational structure in the collaboration as situation-defined and dynamic. The dynamic and adaptable nature of the organisational structure allowed the actors to learn about the external factors that might influence the transition process. For instance, with the transition from the current status of the shade to the target status of the meaningful rest house, one might anticipate stronger relationships with redefined and varied stakes of different actors. Differentiation of stakes depends upon the knowledge and responsibility that different stakeholders had.

7.4.3 Bringing results to fruition

In this phase, the stakeholders tested the expected impact. The phase relies on the synthesis of knowledge and its contextual adaptation. It also considers collaborating stakeholders involved in transforming practices to promote the common good (Hirsch Hadorn et al., 2008). From a knowledge co-production perspective, this means developing new insights that may or may not alter the initial perception of a problem and consequently influence the problem-solving strategies, after translating the co-produced knowledge.

The strategies and the organisational structure in the collaboration need to be adaptive to the dynamic situations and changing objectives and visions. As such, the practitioner needs to develop competences for implementation and monitoring progress to be able to adapt strategies and objectives. One of the ways to develop the competences is to test the project in the social contexts before the actual execution of the project. During testing, the practitioner needs to observe the effects of the project and anticipate the unexpected impacts on the two levels of roles that a practitioner needs to perform. As a researcher, it is crucial to increase knowledge co-production that might explain surprises. As a designer, it is vital to transmitting knowledge that integrates the surprises into design elements. The assumptions, designs and explanations developed in the project brief are revised in such a way that they can explain the surprises.

In the case presented in the chapter, the design and the impact of the project was tested in context. One of the assumptions that the designer made was that the decision of installing the deity would increase the financial contributors. It happened, and consequently, the contributors also expected their contributions get honours. The committee had the responsibility of honouring their contributions. In response, the designer created three niches in the wall to honour financial contributors, members from the area management group and members from the executive committee of the shade-construction project. The new insight of the shade as a memorial, created by honouring different contributors, would not just strengthen the relationships, but also create a new narrative in the knowledge co-production. The memorial-narrative of the project helped to develop the design elements as well as iterated the goals and visions related to the strengthening of the relationship.

Another surprise came in form of a narrative developed after deciding to appoint a local supervisor and hiring local labours from Chhobhar community for the construction of the project. In particular, the people of Chhobhar community

developed a sense of ownership towards the shade. The shade was narrated as the symbol of the relationship between two communities, in addition to other targets. The new interpretations, in particular the development of ownership, supplemented the vision of the project, i.e. strengthening the relationship that both communities anticipated. The sense of ownership also influenced the formation of a rest-house maintenance and management committee after the termination of the construction committee. The committee institutionalized the collaboration between the two communities and at the same time also represented the governing body related to the shade. The strengthening relationship between two communities was institutionalised in the form of a committee that had stakes in making decisions related to the rest house and its surrounding. The institutionalized committee comprises representatives from both communities, and the practitioner remained as one of the advisors.

7.4.3.1 Reflective practice on output

The anticipation of the evolution and unveiling of objectives and visions in the project period creates a need to understand their dynamics and the duality in the practitioner's role. Irrespective of the role played by the practitioner, the strengths and weaknesses of problem-solving strategies needed to be learned because of the uncertainties in empirical knowledge, contested and conflicting objectives and diverse values. It influences the problem-solving strategies: from the implementation of technological solutions to social legitimacy about problem-solving strategies, including the design of the technologies and institutional shades as well as changing values, and consequently the roles of the practitioner as either a researcher or a designer depending upon the situations.

The dynamic situations of knowledge translation have both spatial and temporal aspects. Spatially, the knowledge is comprehended and translated by diverse actors based on their worldviews, objectives and vision. Different actors transform their practices according to their ideals. Temporally, the knowledge may transform their ideals and goals, which may comprise new insights, and redefine the problem and solutions, thus influencing their objectives and visions. As a result, epistemologically, knowledge is an iterative process, in which the knowledge gets supplemented with new insights as to the result of new narratives of objectives, goals and transforming practices. The collaboration needs to consider the dynamic changes in the knowledge observed and explained before the actual implementation of the project. The collaboration highlights the transdisciplinary elements of translated knowledge.

The practitioner should anticipate that surprises will occur and that exploring them may supplement the existing knowledge. As a designer, the practitioner needs to reshape the project and design elements in the output according to the revised knowledge and objectives. In either case, the challenge for the practitioner is to hold the shared vision that acts as regulating body, establishing the normative orientation to the knowledge co-production and translation.

Under such circumstances, the role of the practitioner becomes vital in explaining and directing different interpretations of knowledge. The practitioner's role as

a researcher is then to develop a normative orientation for different worldviews and make it comprehensible to the common norms. The collaboration needs to have a normative orientation that provides the baseline for making decisions and choices on the values and ideals, as well as influencing their evolution. The outcome of this is the integrated knowledge that best solves or mitigates the problems with concrete results. The normative framework for both technical solutions and their social understandings highlights the transdisciplinary elements of the collaboration.

In the case discussed in the chapter, the iterations made in the design elements have evolved their objectives. The normative framework is expressed in terms of the strengthening of relationships and is not implicitly assumed but instead reflected on explicitly. Irrespective of diverse objectives, it is implicit that translated knowledge and its manifestation strengthens the relationship between two communities. The outcome of this is that the integrated knowledge allows the designer to identify different values and actors' needs to be incorporated into the design, combined with the technology to manifest them and the consideration of financial constraints.

7.5 Conclusion

The following section summarizes knowledge generation and integration challenges relating to Pohl and Hagedorn's four types of aspirations, presented in the introduction:

> (a) to grasp the relevant complexity of a problem (b) to consider the diversity of life-world and scientific perceptions of problems, (c) to link abstract and case-specific knowledge, and (d) to develop knowledge and practices that promote what is perceived as the common good.
>
> (Pohl & Hirsch Hadorn, 2007)

7.5.1 Complexity of problems

A conventional understanding of a problem and solution stems from the technical relationality perspective, which focuses on instrumental challenges and possibilities. However, in the complexity of societal context, the problem interpretations are based on different views, which may or may not be in line with the professional's expertise. Acknowledging the complexity of a problem means, for example, addressing interrelations among different factors that constitute a problem and might influence the impact and acceptance of the proposed solutions. Even though a solution might appear technically sound and straightforward, the situational context for its implementation can be complicated, and factors and stakeholders' interactions within the context are dynamic and can change over time. 'Context' signifies here a fundament for interpreting a problem. It refers to the background and to conceptualizing and interpreting a problem to find the solutions. For instance, even though the technical solution for the shade construction is simple, getting acceptance for it was difficult because of contextual factors. This illustrates the significance of understanding the contextual situation and exploring hidden factors

that might determine decisions. Context-wise, it seems further important to capture dynamic interdependencies of various factors such as empirical insights, value orientations and decision-making mechanisms (Pohl & Hirsch Hadorn, 2008). The problem's complexity is generated by the dynamic interactions between different factors that affect the situation of the problem and its interpretations.

The transdisciplinary challenge associated with the complexity of the problems lies in developing an integrated understanding of the problem and solutions (Pohl & Hirsch Hadorn, 2008). In the project described in this chapter, the conceptualisation and development of the object (from shade to rest-house) were highly influenced by different interacting factors in the status quo of the relationship between the two communities. The time consumed for the final decision of the construction points to the importance of building trust and the dialectical discourse between the two communities for mutual acceptance. Development of an object as the shade and its evolution into a rest house symbolises the relationship between two communities rather than representing a mere solution for providing a shade. The case illustrates the multi-faceted ways of interpreting a problem considering the interacting factors. While developing systemic thinking in understanding factors within dynamic context through hermeneutic interpretations, a researcher needs further to co-produce knowledge and to transmit insights to stakeholders (Pohl & Hirsch Hadorn, 2008). How to comprehend situational roles within the complexity of context and explore intertwined factors is discussed in the next section.

7.5.2 Diversity of perspectives

The actors' diverse perception and interpretation of a problem often relate to their roles and stakes in the complexity of a context. As a result, each actor positions the problem in the context (a whole–part relationship) of their relevant worldviews, spatially and temporally. Each stakeholder holds specific perceptions, based on their relations to the problem, their roles in the context and specific social and natural conditions of the concrete situation. This results in a diversity of perspectives for the same entity, which requires considering in all phases of planning and designing a project. For instance, in our case, stakeholders have different perceptions of the object, as a shade and meaningful rest house.

It is demanding and time-consuming, however necessary, to clarify and relate different stakeholders' objectives and views in a common framework concerning what the problem is, what solutions could be and how to realize them. Integration of knowledge and different ways of exchanging, reflecting and critically assessing scientific and social views are to be explored by a designer or a researcher in facilitating participatory processes in TDC.

Facilitation further comprises helping involved stakeholders to understand the perspectives of others in different roles in different forms of collaboration. Perspectives are illustrated, and without qualifying them. This also highlights the dynamic role of the researcher/designer in creating possibilities for reflexive and democratic engagement in TDC process stages (Pohl & Hirsch Hadorn, 2008). In the project described in this chapter, the exchange of the diverse perspectives

was understood within the context of their shared common goal, i.e. strengthening the relationship between two communities. The stakeholders evaluated their role and the other's perception related to the project. The designer was primarily focused on aesthetics, strength and functionality of the object, while Indrachowk community wanted to incorporate their symbolic values and Chhobhar community intended economic pursuit. Despite the heterogeneity of these aspirations, all stakeholders had a shared vision of a concrete result in the form of shade and, later, the meaningful rest-house.

Hirsch Hadorn et al. (2008) present four means of integration and three forms of collaborations in a taxonomy of transdisciplinary research, as presented in Table 7.2. The table explains the dynamic role of the researcher in

Table 7.2 Forms of collaboration and means of integration in the project

Means of integration	*Forms of collaboration*		
	Common group learning (construction committee)	*Deliberation among experts (finance and technical sub-committee)*	*Integration by a subgroup or individual (researcher as a reflective practitioner)*
Mutual understanding (everyday language, glossary)	Discussion on possible functions of the structure through narratives	Anticipated budget (treasurer) Pros and cons of material/technology (engineer) Understanding labour skills	Developing a glossary of the requirements
Theoretical concept (transfer of concepts, a mutual adaptation of concepts, bridge concepts)	Discussion on different ideals of the object Assessing perceptions on already existing similar structures	Relevant construction material/technology according to the design concept Relevant budget allocation on the design concept	Manifesting symbolic representation, memorial and a multipurpose space through possible design concepts
Model (qualitative model, quantitative model)	Scenarios on material/ technology choices and their effect on functions and ideals	Scenarios on cost with a specification of materials Scenarios on materials/ technology choices and their effect on strength (engineer)	Correlating cost, functions, ideals and material/ technology
Product	On-site demonstration through the layout 3D visualisation	Bill of quantities of materials (treasurer) 2D drawing on paper to discuss (engineer/ labour)	Design narrative

Source: Based on Pohl and Hirsch Hadorn (2008, p. 115)

knowledge integration in different forms of collaboration. In our case, the first author acted as a community member while affiliated to the construction committee, a designer while in the technical sub-committee and a researcher while integrating knowledge. The table also illustrates different ways to translate the knowledge so that it was comprehensible for various stakeholders in different kinds of collaboration. This also demonstrates that the researcher's affiliation with societal actors is not exclusive and may vary. The table shows organisational structures that facilitate engagement and are responsive to the TDC process, for example, in considering a diversity of perceptions regardless of power constellations.

7.5.3 Abstract and case-specific knowledge

Knowledge in science often relates to idealized settings. Context conditions for problem-identifying and decision-making processes on selecting means and achieving ends provide little room in this type of knowledge. Contrarily, knowledge generation in TDC attempts to link abstract knowledge and knowledge in and of concrete situations in the life-world (Pohl & Hirsch Hadorn, 2008).

Bridging between the abstract and case-specific, nomothetic and ideocratic knowledge, and developing an interactive mutual exchange process between them seem feasible (Pohl & Hirsch Hadorn, 2008).

Process design should comprise a comparatively high degree of iterativity (the possibility of repeating with improved insights) of TDC knowledge and include feasibility for life-world criteria.

In our case, in hindsight analysis, the designer iterated the technicalities of the object according to the complexity of the problem and diverse perspectives (see sections 7.5.1 and 7.5.2, respectively). Different stakeholders assessed the design concept. The TDC process thereby facilitated an iterativity, where theory (here concept) was repeated by applying them to practice and the 'research product' (Odom et al., 2016), and where the underlying theoretical foundation was repeatedly modified and supplemented (Pohl & Hirsch Hadorn, 2008).

TD knowledge transgresses pragmatic application of disciplinary knowledge for problem-solving in a concrete world situation. It is integrated knowledge that, on the one hand, acknowledges disciplinary boundaries to describe a problem and, on the other hand, validates different types of disciplinary knowledge through its practical relevance for the context. Combining technical rationality and case-specific relevance meets the polyvalence and indeterminacy of real-life sustainability challenges. TD knowledge can also focus on forecasting an undetermined future, and exploring uncertainness in a non-prescriptive way of perceiving. Indeterminacy as a variable for beginning and end allows for the projection of possible future scenarios based on past and present conditions. Polyvalence as a variable allows post-reflection on scenarios and the development alternatives.

The polyvalent, inter-determinate qualities of TD knowledge allow for convergence of theory and practice – how theory can lead to practice, and how the practice may become a source for theory. For the last, narrating the object as a

boundary object (Keitsch, 2015) or research product (Odom et al., 2016) might facilitate engagement with material and meanings and direct the design.

By acknowledging polyvalence and indeterminacy as potentials of theory-practice connections, a knowledge facilitator acts then as a 'bricoleur':

> The bricoleur, says Levi-Strauss, is someone who uses 'the means at hand,' that is, the instruments he finds at his disposition around him, those which are already there, which had not been especially conceived with an eye to the operation for which they are to be used and to which one tries by trial and error to adapt them, not hesitating to change them whenever it appears necessary or to try several of them at once, even if their form and their origin are heterogeneous.
> (Derrida, 1970, p. 6)

In this chapter, the 'bricoleur' role is comprised of activities such as narratives, reflective hermeneutics and co-creative process applications, combined with scientific and professional architectural knowledge.

If 'bricolage' leads to neither random systems design nor orthodox neglect of (disciplinary) truth and validly claims (see Chapter 4), the bricolage approach can become a new epistemological feature to explore for TD. A challenge of bricolage is to transgress disciplinary and societal boundaries without losing sight of one's professional competence. It is, for example, important to balance social relevance and technical rigour without forsaking either (Pohl & Hirsch Hadorn, 2008). Achieving this might correspond with what Schön calls 'reflective practice' (Schön, 2017).

7.5.4 Common good

Any problem-solving strategy tends to achieve well-being by aligning the solutions to the ethical principles defined by social systems, institutions and environments. In transdisciplinary research, this refers to the 'common good' (Pohl & Hirsch Hadorn, 2008). The common good for a context enables the actors to achieve a consensus about solutions, irrespective of their heterogeneity (Pohl & Hirsch Hadorn, 2008).

The common good is interpreted in this chapter as a heuristic, connecting values of stakeholders involved in a TDC project. The common good stands contrary to 'grand narratives' (Lyotard, 1979) such as truth claims in sciences. It adapts the idea of cultural diversity depth (DePoy & Gilson, 2007) as conscious awareness that even if assumptions, expectations, attitudes, values and interests that influence decisions vary greatly in societies, consent is possible.

Specifying the concept of common good implies the development of a normative framework for the TDC process, where values and interests, instead of being implicitly assumed, are reflected upon openly and, if possible, in the plenum. Neither researchers nor scientists nor TDC actors possess a specific power of defining the common good or its realisation within a particular situation (Pohl & Hirsch Hadorn, 2008).

In the case discussed in this chapter, the stakeholders shared a common interest in strengthening the relationship between two communities, which is explicitly reflected in the decisions. The designer explored whether the object's design met this interest; the actors discussed how their aspirations towards the object might strengthen their relationship. The 'strengthening relationship' interest appeared autonomously. The interest, perceived as a 'common good', was seen as a regulating idea for exchanging reflecting, critically assessing and deliberating ideas in the myriad of diverse perspectives.

The common good seems bound neither to any disciplinary boundaries nor to any specific pathway to achieve it but depends upon all involved actors' reflection on roles, stakes and worldviews. The formulation and integration of the 'common good' rely partly on how well descriptive, normative and practice-oriented knowledge is presented and interrelated within a comprehensible 'design narrative'. The design narrative comprises different knowledge types: knowledge as systems knowledge, target knowledge and transformative knowledge (Hirsch Hadorn et al., 2008). These knowledge types regulate knowledge interpretations of different actors.

A researcher can interrelate the following aspects to connect the common good and the design narrative: aspects of different interpretations of the problem (what); normative aspects of clarifying and prioritizing, for example, when introducing new practices or transforming existing practices or both (why); and suggesting possible means for transforming existing practices and introducing desired ones (how).

Table 7.3 illustrates dynamic challenges, relating the design narrative to the typical good 'strengthening relationship'. The design narrative presented is based on post-reflection of the TDC process.

7.5.5 Reflective practice on sustainability

A key aspect of realizing TDC for sustainability is the involvement of non-scientific actors in planning, decision-making and design processes to integrate

Table 7.3 Interrelating different forms of knowledge in developing design narrative and consequent researcher's challenge

	Design narrative	*Challenge*
Systems knowledge (what) – descriptive	• A returned favour by Indrachowk community • An economic opportunity for Chhobhar community	• Unveiling uncertainties in object's interpretations
Target knowledge (why) – normative	• A symbolic representation of a strengthened relationship between the two communities	• Prioritizing different design ideals, values and objectives if they strengthen the relationship
Transformation knowledge (how) – practice-oriented	• A memorial by honouring various contributors • A symbolic representation of Indrachowk community • A multifunctional space	• Assessing possible design iterations based on possible design concepts, technologies, materials and regulations

Source: Adapted from Pohl and Hirsch Hadorn (2007, p. 39)

the best available knowledge, reconcile values and preferences and create ownership for problems and solutions options (Singh, Keitsch, & Shrestha, 2019). Elaborating and expressing normative orientations, example as a common good may contribute to increased consensus among diverse stakeholders. Methodologically, it allows researchers, planners and designers to oscillate between theory and practice. The emphasis on scaling up sustainability towards transdisciplinary collaboration also highlights the stakes and roles of the involved researcher or designer, transgressing disciplinary and professional boundaries and facilitating design narrative comprehensible for most stakeholders. This also relates to striving for consensus and mediating conflicts which can impede the output (Singh & Keitsch, 2016). In hindsight, the role of the reflective practitioner in TDC often relates to problem identification and problem-solving, and to anticipating systemic and prolonged impacts of solutions based on conditioning factors and the values governing them. However, this chapter has also revealed some so far unexplored questions such as: How to utilise hermeneutic interpretation in TDC knowledge generation with stakeholders; how to develop a design narrative commonly; and how to integrate indeterminacy in TDC processes and future prognoses. These questions should be addressed further in both TD theory and practice.

References

Corwin, E., Redeker, N. S., Richmond, T. S., Docherty, S. L., & Pickler, R. H. (2019). Ways of knowing in precision health. *Nursing Outlook*, *67*(4), 293–301. https://doi.org/10.1016/j.outlook.2019.05.011

DePoy, E., & Gilson, S. F. (2007). *The human experience: Description, explanation, and judgment*. Lanham, MD: Rowman & Littlefield.

Derrida, J. (1970). Structure, sign, and play in the discourse of the human sciences. *Writing and Difference*, *278*. Retrieved from www2.csudh.edu/ccauthen/576f13/DrrdaSSP.pdf

Harrington, A. (2006). Life-world. *Theory, Culture & Society*, *23*(2–3), 341–343.

Hirsch Hadorn, G., Biber-Klemm, S., Grossenbacher-Mansuy, W., Hoffmann-Riem, H., Joye, D., Pohl, C., . . . Zezmp, E. (2008). The emergence of transdisciplinarity as a form of research. In G. H. Hadorn, S. Biber-Klemm, W. Grossenbacher-Mansuy, H. Hoffmann-Riem, D. Joye, C. Pohl, U. Wiesmann, & E. Zemp (Eds.), *Handbook of transdisciplinary research* (Vol. 10, pp. 19–39). Dordrecht: Springer.

Høiseth, M., & Keitsch, M. (2015). Using phenomenological hermeneutics to gain an understanding of stakeholders in healthcare contexts. *International Journal of Design*, *9*(3), 33–45.

Keitsch, M. M. (2015). *Boundary Objects as Means for Knowledge Generation in Design Education*. Paper presented at the DS 82: Proceedings of the 17th International Conference on Engineering and Product Design Education (E&PDE15), Great Expectations: Design Teaching, Research & Enterprise, Loughborough, UK, 3–4 September.

Kleineberg, M. (2013). The blind men and the elephant: Towards an organisation of epistemic contexts. *Ko Knowledge Organisation*, *40*(5), 340–364.

Lyotard, J.-F. (1979). La condition postmoderne [The postmodern condition] (p. 979). Paris: Minuit.

Maguire, K., & Britten, N. (2017). 'You're there because you are unprofessional': Patient and public involvement as liminal knowledge spaces. *Sociology of Health & Illness*, *40*(3), 463–477. doi:10.1111/1467-9566.12655

McElroy, M. (Producer). (2018). Science-vs. context-based metrics: What's the difference? *Sustainable Brands*. Retrieved from https://sustainablebrands.com/read/defining-the-next-economy/sustainability-and-multicapitalism-together-at-last

Odom, W., Wakkary, R., Lim, Y.-K., Desjardins, A., Hengeveld, B., & Banks, R. (2016). *From research prototype to research product*. Paper presented at the Proceedings of the 2016 CHI Conference on Human Factors in Computing Systems, San Jose, CA.

Pohl, C., & Hirsch Hadorn, G. (2007). *Principles for designing transdisciplinary research* (A. B. Zimmermann, Trans.). Munich: oekom.

Pohl, C., & Hirsch Hadorn, G. (2008). Methodological challenges of transdisciplinary research. *Natures Sciences Sociétés*, *16*(2), 111–121.

Schön, D. A. (2017). *The reflective practitioner: How professionals think in action*. Abingdon, UK: Routledge.

Simon, H. A. (1996). *The sciences of the artificial*. Cambridge, MA: MIT press.

Singh, B., & Keitsch, M. M. (2016). Cultural sustainability and space: A comparison of two cases in Kathmandu, Nepal. *Sustainable Development*, *24*(5), 307–318.

Singh, B., Keitsch, M. M., & Shrestha, M. (2019). Scaling up sustainability: Concepts and practices of the ecovillage approach. *Sustainable Development*, *27*(2), 237–244.

Stefl-Mabry, J., Dequoy, E., & Stevens, S. (2012). Retrospective reflection: Insight into pre-service school librarians' competencies and skill development as revealed through field notes. *School Library Research*, *15*.

Verganti, R. (2003). Design as brokering of languages: The role of designers in the innovation strategy of Italian firms. *Design Management Journal,* (3)*,* 34–42.

8 Towards a transdisciplinary approach to entrepreneurship for sustainable development

Malin Gawell

8.1 Introduction

Entrepreneurship is often celebrated as a miracle for all sorts of reasons and has increasingly been lauded for its capacity to 'respond to needs' or to 'meet societal challenges' (Dees, 1998; Nicholls, 2006; Gawell et al., 2009; Berglund & Johannisson). It has also increasingly been associated with sustainable development through references to certain types of specialty entrepreneurship related to sustainability actions (Stål & Bonnedahl, 2016). However, 'classical' arguments in the entrepreneurship literature do not necessarily conform well with the framework of sustainable development. One such example is opportunity recognition, which is often highlighted as a key in the entrepreneurship literature, or, as Shane and Venkataraman (2000) argue, entrepreneurship is about the identification, evaluation and exploitation of business opportunities. Applied in a societal sphere, their statement needs to be problematized and approached from other perspectives to address real-world complex problems (Gawell, 2013). As argued in previous chapters in this anthology (e.g. Chapter 2), transdisciplinary approaches can contribute to addressing 'messy' societal problems and increase the capacity to address challenges across, between and beyond academic disciplines (cf. Nicolescu, 1994; Lang et al., 2012; Bernstein, 2015).

Transdisciplinary terminology has not been commonly applied in the field of entrepreneurship (McGregor, 2017). The development of the field has, in many ways, been influenced by what Mercader (2011) refers to as a transdisciplinary mindset with elements of intra-academic transdisciplinary as well as, at times, extensive stakeholder engagement on micro, meso and macro levels in society. However, these influences have been rather biased to certain groups of stakeholders and specific (primarily economic) aspects of development.

The field of entrepreneurship and the closely interrelated field of innovation have evolved through multidisciplinary and abductive approaches that to different degrees have been integrated into what is currently expressed as academic as well as more common knowledge about the phenomena and their role in society. Start-ups, small businesses and larger innovative enterprises have all been empirical objects, interlocutors and, at times, funders of research. The so-called *triple helix* highlighting the importance of collaboration between businesses, academia

and public authorities (Etzkowitz, 2002, 2008) has become a standard reference, especially in discussions on entrepreneurship and innovation policy development. The journey to contemporary state of the art has been completed and integrated with diverse interests, norms and values.

In this chapter, traces of the prior transdisciplinary mindset in the field of entrepreneurship will be reviewed and discussed in relation to different aspects of development in which entrepreneurship can align with inclusion and sustainable development rather than exploitation and fragmentation. The transdisciplinary approach can thus at least find the paths, if not pave the road, to address substantial challenges in society.

The chapter is based on a review of the field of entrepreneurship and recent collaborative studies of entrepreneurship initiatives aiming to improve living conditions and access to cultural activities in deprived suburbs in Stockholm, Sweden, which for decades have been considered problematic due to socio-economic status, alienation and violence.

8.2 Tracing transdisciplinary features in the field of entrepreneurship over time

The field of entrepreneurship consists of the academic literature as well as a broader discourse to which practitioners, media and policy makers also contribute arguments. In this review, the academic literature is the focus, but as there is an intense interaction between the groups of actors at times, the boundaries between the academic literature and other parts of the broader discourse are unclear. The following review, aiming to trace and highlight major transdisciplinary features in the field, is based on approximately 30 years of experience from working in the field in different capacities, including 20 years as an entrepreneurship scholar. The brief review presented in this chapter is therefore an illustration of three major types of transdisciplinary features of the field of entrepreneurship.

8.2.1 The field of entrepreneurship influenced by business logics and framed by economic growth

Entrepreneurship research stems from the study of specific dynamic activities framed in economic theory. Schumpeter (1934) argued that entrepreneurship was about businesses as they introduce new goods or new methods of production; open new markets or conquer new sources of raw material supply; or create a new organizational form of an industry (what today is referred to as a branch). He stressed the innovative aspect of entrepreneurship. The field of entrepreneurship has continued to develop, embedded in economic theory with a focus on growth and the exploitation of business opportunities (e.g. Kirzner, 1973; Shane & Venkataraman, 2000). With a continued focus on businesses and economic rationality, entrepreneurship has increasingly been examined not only by economists and business scholars but also by psychologists who have studied motivations,

geographers who have studied relations to regional contexts and anthropologists who have studied organizational cultures, etc. The field has transformed from a single discipline to one that is multidisciplinary and even interdisciplinary (see Landström, 1999).

Intertwined with the development of entrepreneurship as a research field, the empirical focus and collaboration with entrepreneurs and people involved in entrepreneurial endeavours within organizational structures, so-called intrapreneurship, have been characterized by a mutual aim to understand and improve conditions for entrepreneurial development. Looking closer at these arguments and frames of reference reveals better conditions for entrepreneurs and their businesses as well as better conditions for commercialization and thereby financial economic growth. Many of these studies rely on findings from research based on empirical interaction that – combined with an analysis of the field in a broader sense and close interaction between academics, practitioners and policy makers as respondents or experts or on conferences of different kinds – illustrates the transdisciplinary mindset 'of the time' in this particular analytical stream of the field. The economic embeddedness of entrepreneurship has been strengthened as policy makers embraced these phenomena as 'engines for economic growth' across the world (Acs et al., 2015).

8.2.2 The entrepreneurship framework expands into different spheres in society

Although Schumpeter elaborated on and has mostly been cited for his theory of economic development, in which he emphasized the role of entrepreneurship (Schumpeter, 1934), he gradually moved away from his economic framework and explored the relationships towards social sciences, particularly sociology, and argued that the dynamic process of entrepreneurship could be conceptualized in *all* spheres in society, such as art or politics (Swedberg, 2000). This move can be seen as an early step towards *social entrepreneurship*.

The spread of entrepreneurship into different spheres in society in recent decades is to a large extent characterized by the acclaimed characteristics of phenomena that have been nourished by decades of economic embeddedness. As the field of social entrepreneurship emerged, Nicholls (2010) identified key actors, such as the Ashoka and Skoll Foundation, that heavily influenced the preparadigmatic development of the field of social entrepreneurship, emphasizing individuals as heroes and business models as ideals for organizing. Influences from business logic are clear, and at times, this approach is referred to as a 'business school approach' (Defourny & Nyssens, 2010); during the last decade's increased interest in the emerging field of social entrepreneurship, social enterprise and social innovation, this approach has also met streams stemming from the tradition of cooperatives and social economy emphasizing co-ownership and the process of empowerment (Defourny & Nyssens, 2010).

As the field(s) of entrepreneurship and innovation expanded into societal spheres other than business, the portfolio of empirical examples and interlocuters

became more diverse. It has been suggested that the triple helix should be transformed into a quadruple helix (Holmberg et al., 2007; Gawell et al., 2009), including collaboration with the non-profit sector or civil society, depending on conceptual preferences. The expansion into the social sphere and emergence of concepts such as *social entrepreneurship*, *social enterprises* and *social innovation* have in many ways led to a renegotiation of meanings. On the one hand, these concepts have led the way for business ideals to 'invade' the social sphere (Berglund & Johannisson, 2012), and on the other hand, the established meanings of entrepreneurship and innovation have been challenged (Gawell, 2006, 2013).

This means that the field of entrepreneurship has evolved rather dynamically during recent decades. The primary focus in these fields has been on micro and meso levels, even though connections to macro levels through economic growth theories can be found in parts of the fields. At times, these connections are solidly addressed, but at other times, assumptions 'float', for example, to discussions on social entrepreneurship and social innovation without solid problematization. This evolution and status differ from other fields in which transdisciplinary approaches have been applied that, to a larger extent, are characterized by system approaches (Hirsch Hadorn et al., 2008), even though embedded primarily in economic theories and then gradually combined with references to other meso and macro schools of thoughts such as the human economy (Cattani et al., 2010), the solidarity economy (Laville, 2011) or a more multi-faceted context (Gawell, 2013; Young et al., 2016).

Epistemologically, the field of entrepreneurship can generally be characterized as rather pragmatic. In the stream where entrepreneurship is contextualized in different spheres of society, there is research explicitly adopting interactive methodological approaches such as action research (Johannisson et al., 2008) or even enactive research (Johannisson, 2018). These can be seen as additional expressions of a transdisciplinary mindset even though other terminology has been more common. These approaches are not, however, seen as dominating approaches in the field, but my argument is that much more than this research with explicit interactive approaches is influenced by a close interaction between academic and non-academic actors and thereby expressions of a transdisciplinary mindset.

8.2.3 Entrepreneurship under transformation towards a sustainable development framework

Apart from relating entrepreneurship to a more diverse context, there is an increased awareness of environmental as well as social challenges and the need for more sustainable approaches to development. The international policy initiative Agenda 2030, adopted by the UN in 2015, and the Sustainable Development Goals (SDGs) are set in this agenda. The SDGs, launched in 2015, call for framing of another kind of 'development' than the prior growth-oriented economic domination. It furthermore calls for a more holistic approach than the diversification into different spheres of society. It also calls for a number of sustainability considerations. This challenges not only politicians all over the world but also

citizens, businesses and other actors. It furthermore challenges academic institutions, including existing theoretical structures that tend to be focused on specific disciplinary topics and methodological approaches. The SDGs' challenge to the field of entrepreneurship is at least threefold. First, it challenges research to include sustainability as an explicit parameter. Second, it challenges the field to think across and beyond disciplinary boundaries and sets of stakeholders. Third, it challenges research to not only take the policy-driven Agenda 2030 for granted but also critically analyze its reach and limitations – for the sake of multi-faceted sustainable development.

In the field of entrepreneurship and innovation, there has been an obvious response to the call for sustainable development. Specific entrepreneurship initiatives related to sustainability have been highlighted (e.g. Stål & Bonnedahl, 2016), and policy measures have been adjusted to the new framework (e.g. the Swedish innovation policy). At times, the adjustments have been expressed in terms of *sustainable growth* rather than just *growth* (e.g. the Swedish innovation agency Vinnova). However, there are still strong tendencies to adopt traditional assumptions and knowledge, as well as gatekeeping regarding what has emerged during the last couple of decades within academia and policy agencies as well as among practitioners participating in what can be referred to as transdisciplinary collaboration at the meso level and/or policy making levels. New arguments for legitimization of financial exploitation, providing attractive business conditions through tax revenue or work supply, or academic performance assessments related to publication in established and many times disciplinary-based journals are just some examples of resistors. Therefore, despite explicit intentions to respond to the call for sustainable development through challenge-driven and many times transdisciplinary collaboration, there are several built-in obstacles impeding a successful transformation towards a sustainable development framework.

8.3 Experiences from initiatives seeking integration and prosperity in the (urban) periphery

Empirically, this chapter is based on two initiatives, both seeking to combat segregation in Swedish society and to lead to prosperity in its (urban) periphery. Both cases have a transdisciplinary design even though the term *transdisciplinary* has not been used. Instead, terms such as collaboration, co-production, research and development, etc., have been commonly used.

These initiatives address challenges of increased inequality and segregation in society that have been identified as prioritized challenges by the Swedish government, other public authorities and by many private for- and non-profit actors. These issues are especially related to urban periphery neighbourhoods with low socio-economic status and a high number of immigrants or children of immigrants. As seen in the presentations below, the initiatives have had quite different designs and cannot be compared in a strict manor. However, there are common denominators with regard to experiences from the transdisciplinary approach.

Both initiatives have a multi-stakeholder structure and have been funded by project grants from two significant actors in the field of research-and-development funding in Sweden: the Swedish Agency for Innovation (Vinnova) and the Swedish Knowledge Foundation (KK-stiftelsen) from 2017 to 2020.

8.3.1 Social innovation labs against segregation

This initiative is embedded in the Swedish Agency for Innovation (Vinnova) and works to promote and fund social innovations to meet challenges in society, which is part of their more general programme portfolio for innovation. As a specific response to the refugee influx in 2015, they launched a call for social innovation initiatives with a particular focus on the creation of social innovation labs to combat segregation with a requirement of participation from at least two sectors in society.

Ten projects from different parts of the country were granted two-year financial support. All of the projects had partners from the public and the non-profit sector. In many but not all projects, academic representatives also participated as coaches and/or evaluators. The same projects also had business partners. The innovation terminology was new to most of the project managers, even though many had considerable experience working with projects and/or change management (Gawell et al., 2020). Because Vinnova's experiences of working with innovations in the non-profit sector were limited, they funded coordinating overarching support for project managers that organized seven learning workshops during 2018–2019. The support group consisted of a representative from a non-profit umbrella organization focusing on leadership, two researchers with experiences in collaborative research and two consultants with experiences in design thinking and innovation management (Gawell et al., 2020). Approximately 50 people from the projects, the support group and Vinnova participated in some or all workshops.

The ten projects approached their task differently. Some created physical spaces for meetings, idea generation and testing. Others organized temporary activities aiming to play into established structures. In spite of the differences, the project managers highlighted three common challenges for themselves. First, they highlighted the lack of shared understanding of concepts and interpretations, ideas about what actions were feasible to engage in and the realistic impact of those activities. Second, they highlighted the challenges of collaboration due to the diversity of the projects. Third, they emphasized the challenge of the project as a format for development initiatives, especially given the rather short two-year timeframe of the endeavours. In spite of the challenges, they all argued that it was worth engaging in this type of transdisciplinary collaboration, as the issue of segregation and integration is crucial and urgent for individuals as well as for society. They all argued that they had learnt much about the complexity of these issues and that they had re-evaluated opportunities as well as obstacles for improvements towards inclusive, sustainable development. However, they needed more time to explore them properly and even more to bring them to fruition.

8.3.2 Reinventing the (urban) periphery

The other initiatives that this chapter draws on are funded by the Swedish Knowledge Foundation (KK-stiftelsen), which also specialized in funding research and competence development projects primarily involving academia and businesses with an overarching aim to improve 'competitive strength'. The focus on academia and businesses comes from the foundation's statutes, which were established in the mid-1990s.

The initiative is a large three-year project with a focus on Reinventing the (Urban) Periphery, which in the Swedish context means a focus on suburban areas that are characterized by socio-economic challenges, tensions and social alienation. In this project, 15 researchers from five disciplines collaborate with eight partners from private businesses. This project is funded by the Swedish Knowledge Foundation and co-funded by participating private business partners. To overcome the business bias in the project, it has been complemented with the creation of a centre at Södertörn University in which municipalities and civil society participate in the collaboration with the shared aim of exploring and developing interventions in urban planning that will contribute to positive and sustainable development.

The overarching logic of the projects is to generate knowledge that can support the most positive development possible by all the partners involved. Basically, there is a focus on private and public interventions combined with different expressions of entrepreneurship as well as citizens of the peripheral, sometimes marginalized areas or groups, with the aim of striving for a positive outcome, including empowerment and sustainable development (see Figure 8.1). The partners are in agreement about these frames, as well as the importance of all partners' participation in knowledge generation.

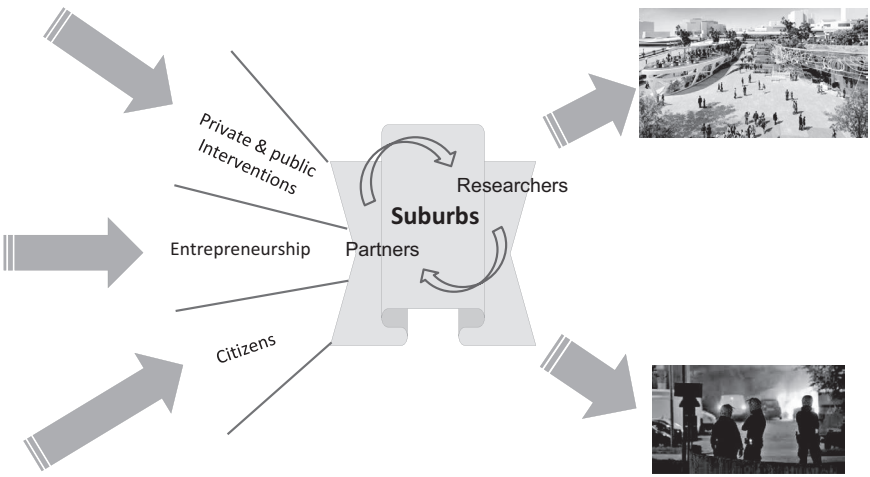


Figure 8.1 Transdisciplinary logic of the project Reinventing the (Urban) Periphery

The aim of the project is to strengthen the impact of more sustainable development through a transdisciplinary collaboration (symbolized by the circular arrows in the middle of Figure 8.1) in which different academic and non-academic actors participate by providing insights as well as learning from each other for the benefit of knowledge creation and implementation of this knowledge into practice.

In this project, it has been rather easy to agree on a common point of reference for starting it. The agreement about the issues at stake, the engagement to collaborate and a sense of common understanding of goals have been highlighted. However, as the project continued, it was obvious that the shared understanding might not have been as reliable, and ideas about how to integrate different actors' perspectives were not as developed as expected. In the project, this led to a relatively long phase of, at times, a rather frustrating search for definitions. Some tried to highlight goal-oriented project management tools or more design thinking-influenced methods, while others hesitated and even explicitly resisted conforming to a process despite impatience and doubts.

Gradually, at a rather late stage of the three-year project timeframe, a deeper understanding of the issues of interest and the different actors' interests, logics and specific aims were clarified – not necessarily in a way that coincided with what had been suggested earlier but rather in ways that included a higher degree of learning. This re-raises issues of how to work together, what specific deliveries are possible or desirable and, moreover, what synthesizing analysis can be made out of the somewhat varied materials produced, especially related so-called technical knowledge and transformative knowledge. This observation draws on Scholz et al. (2006), where experiences have been structured for *understanding*, *conceptualization* and in due time *analysis*.

The experiences from these projects, especially in combination with the continued analysis of cases studied over a longer time span, raise questions related to measurement of outcomes and the degree of impact within a fixed time span of two to three years. At the end of these projects, participants argued that the work had just started. The transdisciplinary approach seems to need more time and a format that gives these processes more space.

8.4 Towards a transdisciplinary approach to entrepreneurship for sustainable development – beyond individual projects

In a way, one can argue that these projects lacked effective integration processes and ought to be characterized as weak projects in need of stricter monitoring and/or focused activities to increase efficiency. Or that they could have been more structured according to the different types of knowledge that Hirsch Hadorn et al. (2008) identified and emphasized in transdisciplinary research: the system knowledge that recognizes the subjects of concerns and the identification of what needs to be changed; the target knowledge that recognizes the needs and interests of various stakeholders; and, finally, the transformation knowledge that recognizes the mechanisms of desired changes. However, based on the results that are currently

unfolding, this is not necessarily the case. Striving for efficiency in a rush can lead to underestimation of substantial problems and the complexity of issues of interest. It might lead to the underestimation of nuances and in-depth understanding of different stakeholders' interests, awareness and understanding of the different mechanisms in the field. These observations can, however, support reflection and the development of the process.

These arguments can of course be seen as nothing more than excuses for weak project management. However, again, as results are unfolding in these particular projects, the time factor to understand the problems to be addressed; to understand and at times develop a new adjusted conceptualization of the problems as well as the technical knowledge involved; and to understand the transitional aspects that influence the possibilities to change to what is perceived as a better position might be underestimated.

This adjustment might also involve collaboration with partners other than those already participating in activities. In the case of the project Reinventing the (Urban) Periphery, it was clear at an early stage that there was a need to complement the project with a centre open for more actors than the specific project format allowed. Even if the project is coming to an end, there remain needs to relate to other partners also involved in the complex and messy reality of communities and societies. There is furthermore a need to understand the more overarching interplay not necessarily represented by specific actors but rather related to the meaning of and relationship between different aspects of life and different notions of sustainable development. The figure of the transdisciplinary logic of the project Reinventing the (Urban) Periphery therefore needs an adjustment and an added set of arrows (see Figure 8.2).

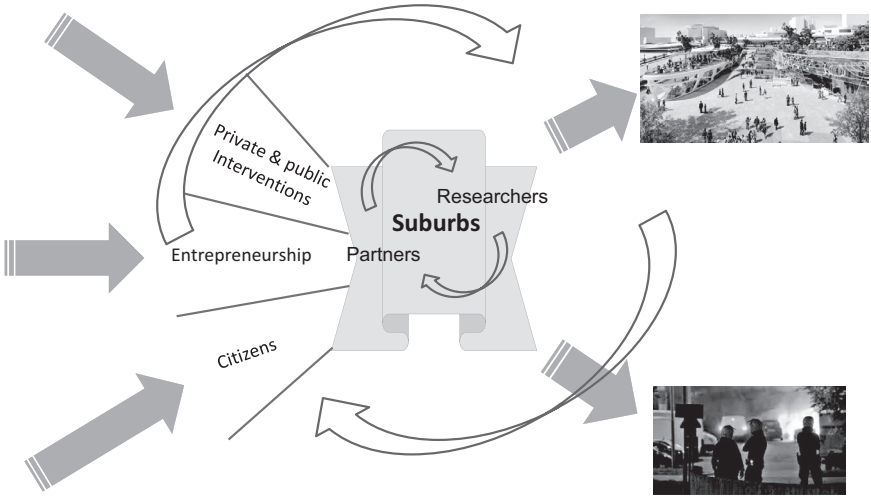


Figure 8.2 Transdisciplinary logic of the project Reinventing the (Urban) Periphery intertwined with the system level of transdisciplinary logic

Apart from the abovementioned factors, the understanding of transitional processes that often include multi-faceted aspects of social change are difficult to foresee. There might even be a need to view transdisciplinary processes beyond individual projects since substantial problems and complexity are beyond the scope of individual cases (see also Chapter 3). Based on studies of similar initiatives with a longer history (Westlund & Gawell, 2012; Gawell, 2020), signs of previous interaction can be found long after their conclusion. This indicates a time delay in which it seems as if knowledge matures prior to being transformed into conversations and the development of practices at a later stage. In addition, 'results' have at times appeared in ways that, from a project management perspective, have been unexpected. In these cases, a critique had been raised that the initiatives did not reach their set goals of integration beyond the specific projects with external funding. However, a decade or even two decades after evaluations of these specific initiatives, some young entrepreneurs refer to these organizations' initiatives, which somehow had reached them when they were children or youths. Somehow, these organizations had made an impression that contributed to a transformation – after a long and at times winding path.

Based on an analysis of the evolution of the field of entrepreneurship and innovation research, which still contains a bias towards business logics that continuously needs to be revealed and problematized, and the experiences from collaborative research processes analyzed in this chapter, arguments for a broader view of transdisciplinary approaches are raised. In line with Popa et al. (2014), this argues for a pragmatic approach to transdisciplinarity, including more reflexive science into the debate of transdisciplinary approaches, even though it also challenges ideas about a sense of common results and shared knowledge (McGregor, 2017).

The call for a need to broaden the view of transdisciplinary approaches, both in time and aspects of collaboration as well as in the understanding of processes of change, seeks to allow for a more holistic and nuanced understanding of development and, more specifically, sustainable development. It will furthermore allow the possibility of giving more recognition to the aspects of representation, power and empowerment that we know are crucial for development and a sustainable world. However, this calls for time and reflections from different perspectives. I realize, for example, that these arguments would be more difficult to make without many years of crossing over traditional boundaries between academia and practices of policy making, practices of consultancy and social work in civil society's daily practices. The processes of transdisciplinary approaches are by definition not smooth, and there are many different actors and aspects that need to be coordinated and integrated. The experiences from these transdisciplinary entrepreneurship and innovation initiatives reveal a continued need to develop working methods and mobilize resources for this work. It is at times strenuous and not necessarily in line with the evaluation criteria of any funder. However, the approach provides the hope of joint action for more sustainable development.

References

Acs, Z., Audretsch, D. & Strom, R. (2015) *Entrepreneurship, Growth and Public Policy*. Cambridge: Cambridge University Press.

Berglund, K. & Johannisson, B. (2012) In the Beginning Was Societal Entrepreneurship, in: Berglund, K., Johannisson, B. & Schwartz, B. (Eds.) *Societal Entrepreneurship: Positioning, Penetrating, Promoting*. Cheltenham: Edwards Elgar.

Bernstein, J. (2015) Transdisciplinarity: A Review of its Origins, Development and Current Issues. *Journal of Research Practice*, 11, 1, Article R1.

Cattani, A., Laville, J.-L. & Hart, K. (2010) *The Human Economy*. Cambridge: Polity Press.

Dees, G. (1998) The Meaning of 'Social Entrepreneurship'. Available at: www.redf.org/from-the-community/publications/262 (accessed 25 May 2013).

Defourny, J. & Nyssens, M. (2010) Conceptions of Social Enterprise and Social Entrepreneurship in Europe and the United States: Convergences and Divergences, *Journal of Social Entrepreneurship*, 1, 1, 32–53.

Etzkowitz, H. (2002) *MIT and the Rise of Entrepreneurial Science*. Abingdon, UK: Routledge.

Etzkowitz, M. (2008) *Triple Helix: University-Industry-Government Innovation in Action*. Abingdon, UK: Routledge.

Gawell, M. (2006) *Activist Entrepreneurship: Attac'ing Norms and Articulating Disclosive Stories*. Stockholm: Stockholm University.

Gawell, M. (2013) Social Entrepreneurship: Action Grounded in Needs, Opportunities and/or Perceived Necessities?, *VOLUNTAS: International Journal of Voluntary and Nonprofit Organizations*, 24, 4, 1071–1090.

Gawell, M. (2020) (För)ortens entreprenörskap – ett möte mellan mångas sökande efter utveckling, in: Gawell, M. & Papakostas, A. (Eds.), *Att göra stad i fragmenterade landskap*. Stockholm: Stockholmia.

Gawell, M., Johannisson, B. & Lundqvist, M. (2009) *Entrepreneurship in the Name of Society: A Reader's Digest of a Swedish Research Anthology*. Stockholm: KK-stiftelsen.

Gawell, M., Lindberg, M. & Neubeck, T. (2020) *Innovationslabb för social inkludering. Erfarenheter från Vinnova-finansierade projekt*. Stockholm: Ideell Arena. Available at: www.ideellarena.se/wp-content/uploads/2020/01/innovationslabb-foxxr-social-inkludering.pdf (accessed 16 March 2020).

Hirsch Hadorn, G., Biber-Klemm, S., Grossenbacher-Mansuy, W., Hoffmann-Riem, H., Joye, D., Pohl, C., Wiesmann, U. & Zemp, E. (2008) Idea of a Handbook, in: Hirsch Hadorn, G., Hoffmann-Riem, H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Wiesmann, U. & Zemp, E. (Eds.), *Handbook of Transdisciplinary Research*. Berlin: Springer.

Holmberg, L., Kovacs, H. & Lundqvist, M. (2007) *Samhällsentreprenör*. Göteborg: Chalmers.

Johannisson, B. (2018) *Disclosing Entrepreneurship as Practice: The Enactive Approach*. Cheltenham: Edward Elgar Publishing.

Johannisson, B., Gunnarsson, E. & Stjernberg, T. (2008) *Gemensamt kunskapande – den interaktiva forskningens praktik*. Växjö: Växjö University Press.

Kirzner, I. (1973) *Competition and Entrepreneurship*. Chicago: University of Chicago Press.

Landström, H. (1999) *Entreprenörskapets rötter*. Lund: Studentlitteratur. [Published in English 2012, Historical Foundations of Entrepreneurship Research].

Lang, D., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., Swilling, M. & Thomas, C. (2012) Transdisciplinary Research in Sustainability Science: Practice, Principles, and Challenges, *Sustainability Science*, 7, 1, 25–43.

Laville, J.-L. (2011) *What Is the Third Sector? From the Non-Profit Sector to the Social and Solidarity Economy: Theoretical Debate and European Reality*, EMES Working Papers No. 11/01. Available at: https://emes.net/content/uploads/publications/EMES-WP-11-01_Jean-Louis-Laville.pdf (accessed 25 May 2019).

Mercader, V. (2011) Inter-Transdisciplinarity, *Ethics and leadership in education*. Ibero-American Society and Technology Education. Available at: https://www.yumpu.com/en/document/read/46529243/inter-transdisciplinarity-istec (accessed 13 March 2020).

McGregor, S. (2017) Challenges of Transdisciplinary Collaboration: A Conceptual Literature Review, *Integral Leadership Review*. Available at: http://integralleadershipreview.com/15402-challenges-of-transdisciplinary-collaboration-a-conceptual-literature-review/ (accessed 25 May 2019).

Nicholls, A. (2006) *Social Entrepreneurship: New Models of Sustainable Social Change*. Oxford: Oxford University Press.

Nicholls, A. (2010) The Legitimacy of Social Entrepreneurship: Reflexive Isomorphism in a Pre-Paradigmatic Field, *Entrepreneurship Theory & Practice*, 34, 1, 1042–2587.

Nicolescu, B. (1994) *The Charter of Transdisciplinarity*. Available at: http://inters.org/Freitas-Morin-Nicolescu-Transdisciplinarity (accessed 16 March 2020).

Popa, F., Guillermin, M. & Debeurwaerdere, T. (2014) A Pragmatist Approach to Transdisciplinarity in Sustainability Research: From Complex Systems Theory to Reflexive Science, *Futures*, 65, 45–56.

Scholz, R., Lang, D., Wiek, A., Walter, A. & Stauffacher, M. (2006) Transdisciplinary Case Studies as a Means of Sustainable Learning: Historical Framework and Theory, *International Journal of Sustainability in Higher Education*, 7, 3, 226–251.

Schumpeter, J. (1934) *The Theory of Economic Development*. Cambridge, MA: Harvard University Press.

Shane, S. & Venkataraman, S. (2000) The Promise of Entrepreneurship as a Field of Research, *Academy of Management Review*, 25, 1, 217–226.

Stål, H. & Bonnedahl, K. J. (2016) Conceptualizing Strong Sustainable Entrepreneurship, *Small Enterprise Research: The Journal of SEAANZ*, 23, 1, 73–84.

Swedberg, R. (2000) *Entrepreneurship: The Social Science, View*. Oxford: Oxford University Press.

Westlund, H. & Gawell, M. (2012) Building Social Capital for Social Entrepreneurship, *Annals of Public and Cooperative Economics*, 83, 1, 101–116.

Young, D., Searing, E. & Brewer, C. (2016) *The Social Enterprise Zoo*. Cheltenham: Edward Elgar.

9 Context, problems and knowledge

A case study of an individual transdisciplinary PhD journey in Burundi, East Africa

Lauren Rosenberg

9.1 Introduction

The role of higher education institutions and the types of knowledge production supported by these institutions have come under scrutiny in terms of the transformative capabilities that are being developed within sustainability focused teaching and learning (Sipos, Battisti and Grimm, 2008; Brundiers, Wiek and Redman, 2010; Thomas, 2010; Wiek, Withycombe and Redman, 2011; Muhar, Visser and Van Breda, 2013; Bootsma et al., 2014; Keeler et al., 2015). Sustainability problems are complex and context-sensitive issues (Swilling and Anneke, 2012) and demand new ways of thinking and being that move away from the 'safe space' of descriptive–analytical (problem-focused) knowledge production towards solution-oriented research (Wiek et al., 2012). Transdisciplinary research (TDR) has emerged as a methodological response to this need and seeks to transcend disciplinary boundaries in order to solve problems in the real world (Pohl and Hirsch Hadorn, 2007; Hirsch Hadorn et al., 2008; Bergmann et al., 2012; Jahn, Bergmann and Keil, 2012; Brandt et al., 2013). Over and above working between disciplines, TDR seeks to bridge the divides between scientific and social knowledge systems in an integrative manner (see the 'three tastes' of TDR in Chapter 2). However, to date, the majority of TDR case studies and models have been specifically designed and evaluated within a developed world context (Hirsch Hadorn et al., 2008; Regeer and Bunders, 2009; Bergmann et al., 2012; Jahn, Bergmann and Keil, 2012; Brandt et al., 2013). Furthermore, well-known TDR approaches are also the outcome of large, multi-actor and multi-researcher projects (for example, Bergmann et al., 2005; Hall et al., 2008; Njoroge et al., 2015; Walter et al., 2007; Wiek et al., 2012). The literature on doing *individual transdisciplinary research* work within a developing world context is not well documented (van Breda, Musango and Brent, 2016). In a developing world context, individual researchers need a means of navigating contexts with low levels of social and educational equality. Such researchers have drawn on the methods from participatory action research to include weakly represented citizens and civil society groups to produce more fairness-driven transdisciplinarity (Chapter 2).[1] In developing world contexts, the logics of traditional TDR approaches – honed in more stable, equal societies – are simply inappropriate. Similarly, most handbooks on doing

fieldwork in the Global South often presume or assume a mono- or interdisciplinary perspective and offer little or no guidance to postgraduate students wishing to follow a TDR approach. In response to this need, a new approach to TDR has been theorized by researchers at the Centre for Complex Systems in Transition at Stellenbosch University, South Africa. This new approach is called Emergent Transdisciplinary Design Research (ETDR) and it is a context-relevant methodology to guide researchers undertaking TD research work (both collaborative and individual) within a developing country context (Van Breda and Swilling, 2018).

While ETDR maintains the integrative core of mainstream TDR approaches (see Chapter 3 of this book), it differs significantly in two core assumptions that it holds about the societal context in which the researcher is embedded, which in turn constantly reconfigures the three phases of a typical TDR journey (see Table 3.1). First, an ETDR approach assumes high levels of social fluidity (often characterized by high levels of social and educational inequality) where circumstances change *constantly* and in response the research process is *designed as it unfolds*. This is significantly different from the research planning processes involved in large, multi-institution TDR projects which – although acknowledging the inherent complexity and unpredictability of most societal issues – often require well-detailed project plans (that rely on linear processes and milestones) far in advance of the commencement of the research process (van Kerkhoff, 2014). In designing as the research process unfolds, ETDR places critical emphasis on moving away from extractive modes of knowledge production towards transformative knowledge that will primarily be evident through the emergence of bottom-up social change processes. Second, the ETDR approach differs significantly from traditional TDR in that it does not assume the transformative success of the third phase of a TDR project (bringing results to fruition). Rather, ETDR assumes the adaptive capacity and intuition of the individual researcher/research team and the co-researchers to create small-scale social experiments that *may* contribute towards transformation knowledge (Van Breda and Swilling, 2018). There is no guarantee that the research intervention will work; rather, interventions are seen as provisional, safe-to-fail social experiments that can be adapted to suit changes in the context. Another way to describe this assumption is as 'research-by-doing' (like learning by doing) where a researcher will quickly put into action knowledge rather than investing time in endless collaborative research to develop a meticulous plan of action that may or may not be implemented (Lang et al., 2012). Research-by-doing is a departure from the overly methods-driven approach to TD research often seen in TD research work from the Global North (van Breda, Musango and Brent, 2016). To be clear, ETDR does not contend that methods are unimportant or unnecessary; rather, an ETDR approach to doing TD research emphasizes the opportunities offered by context as a guide to selecting appropriate integrative methods (van Breda, Musango and Brent, 2016; van Breda and Swilling, 2018). Put another way, as the researcher develops relationships with societal actors and gains greater insight into what is socially robust target knowledge in that context, so too will there be greater insight into which integrative methods are appropriate.

As a guiding framework for understanding individual ETDR, I take the three questions posed by van Breda et al. (2016) in their study of individual TD research projects: 1) What type of complex societal problems can be tackled in an individual transdisciplinary research effort? 2) How does the individual transdisciplinary researcher go about doing this type of research? and 3) What types of outcomes can be expected? In this chapter, I reframe these three questions as the following three lenses: context, problems and knowledge. As all of the chapters in this book show, the diversity of practice within TD research approaches reflects the diversity of higher education institutional spaces and the social contexts within which these spaces operate. The common TD refrain of 'science *with* society' has always presumed a higher education institution in the Global North and a researcher operating under the logics and within the systems of a Global North society (even if 'the field' was in a Global South context). This was simply not the case with my PhD journey. I am an African scholar living and working in East Africa who has come to realize that the formal academic training I received in TD research was atypical and emergent because of the context of deep social inequality within which learning and teaching occurred. This chapter is a reflection on my experience of using the ETDR methodology (Van Breda and Swilling, 2018) and how I negotiated the unexpected collision between the social context of the research and the typical demands for knowledge creation placed on PhD researchers by higher education institutions. I want to forewarn the reader who is expecting an account of a PhD study that begins with a literature review, progresses to 'the field', continues with 'writing up the data' and concludes with the final submission of the thesis document and/or peer-reviewed articles. Unlike most PhD journeys, my research started from an experience of and curiosity for a particular context that then led to a literature review, not the other way around. A spontaneous, unplanned visit to rural Burundi in 2012 and exposure to its coffee sector sparked a curiosity around the intersection points between trade, development and social justice and the meanings of these intersections in a country like Burundi. This experience of context and the desire to create change within this context (what I later came to learn was termed 'transformation knowledge') was at the core of my PhD research journey.

9.2 Context: beyond 'fieldwork'

In an ETDR approach, *context* is the ultimate guide to designing the research process and is the medium through which research questions are distilled. However, the emphasis is usually on the social world of the research. What I came to realize in my own experience of using ETDR is that I, along with my classmates, received very little instruction on how to relate to the contextual demands of the academy and hold these in tension with demands of the social context of the research. I will return to this tension in the following section ('problems') but wish to flag it upfront as equally important as the social context of the 'real world'. In ETDR immersion in the social context of the research (see section 3.4.1), there is a non-negotiable first step to setting in motion a research process

that will be designed as it unfolds. It was thus essential to my research to insert myself into an actual coffee supply chain in Burundi. My hope was to gain an in situ, bottom-up perspective of the coffee industry and (through embedded learning) learn about sustainability issues through interaction with societal actors. I began working with a Burundian coffee producer, Long Miles Coffee Project (LMCP) in 2013. LMCP was chosen as a suitable producer organization within which to embed the overall research aim because of its business model, which has a dual focus on high quality coffee production and community development. Immersion into the context of LMCP meant relating to individuals working for LMCP as colleagues and co-researchers, not as key informants. Similarly, both coffee farmers and coffee buyers related to me as someone who worked with LMCP, not as an external researcher doing research on or for LMCP. Living and working in Burundi afforded the space to interact with coffee sector actors on a regular basis. These interactions varied in form: some were set up as official meetings to discuss the overall research aim while other discussions were less formal meetings where I was introduced as a researcher and coffee professional working in Burundi. Meetings between different stakeholders in the industry were also intentionally initiated to facilitate conversation around current challenges in the sector.[2] The formal literature review (usually the first step in the PhD process) was only done after 15 months of immersion in context. Whereas in most TD research processes, the established literature exerts a strong influence on the direction of the research through deductive or inductive reasoning, in ETDR emphasis is placed on abductive logic: making connections between things based on intuitive reasoning despite the extremely fallible insight of the researcher. Abductive logic is the logic of hunches. ETDR encourages researchers to abduce (follow through on a hunch) to push the research forward (see also section 3.4), rather than relying on the formal laws of deductive and inductive logic to provide guidance. During the 15 months of living and working in Burundi during which I learnt how to produce and export coffee, two hunches emerged that provided the guiding framework for the research going forward. The first was that 'sustainable coffee' is non-standard and context sensitive (and, furthermore, possibly meaningless unless rooted in place). The second hunch was that 'the producer' in Burundi is not the individual coffee farmer, nor is it the washing station.[3] 'The producer' in Burundi is the relationship between a coffee washing station and the farmers it works with. Reliability of supply and quality of supply can only be ensured if there is a synergistic relationship between the washing station and the farming communities it works with. If this relationship is ignored, the potential for creating long-term change (through stabilizing yields, improving production and accessing new markets, etc.) is limited to the production capabilities of either the washing station or the farming community. Thus, rather than deference to the literature, which argues for the efficacy of sustainability certifications for improving the sustainability of coffee production systems (Ponte, 2004; Giovannucci and Ponte, 2005; Raynolds, Murray and Heller, 2007; Vermeulen and Kok, 2012; Vermeulen, 2015), I read the literature in light of the emergent hunches gleaned from immersion in context.

Time spent *away* from Burundi allowed me to re-examine Burundi through more formal academic resources and, unfortunately, brought a 'hard numbers' perspective to the desperate poverty that I experienced as part and parcel of everyday life in Burundi. I discovered that Burundi is a very poor country, with an undiversified economy relying almost exclusively on foreign aid and export earnings determined by the volatility of the world coffee market. In the section below, I summarize the literature review created for the PhD *after* immersion in context. I want to emphasize that although the literature review was extremely relevant and necessary for the research to progress, it ultimately did not guide the research process. Burundi's position in the global coffee market is best described as high potential yet low performing. Coffee is the primary export crop and main source of foreign exchange earnings. Between 2000 and 2015, revenues from coffee exports generated between 70% and 80% of total foreign exchange earnings (Oketch and Polzer, 2002; World Bank, 2012; USAID, 2013). Roughly a third of the population depends on coffee production for their livelihoods (USAID, 2013). Unlike other East African nations, Burundi has a narrow export base and has failed to diversify its economy away from coffee into services and manufactured goods (World Bank, 2012). At a household level, coffee is the only cash crop that provides a relatively large sum of money in a single payment. Most households have somewhere between 80 and 300 trees and struggle with highly cyclical and unpredictable yields.[4] Lower, unpredictable yields inevitably mean lower, unpredictable household incomes. The historical–political economy of coffee cultivation in Burundi has resulted in a lack of incentive and lack of means to invest in new trees and inputs needed to stabilize production. Farmers have simply never seen coffee as their own crop or as a crop from which they can derive a profit (Oketch and Polzer, 2002). While this sentiment is slowly changing in a handful of communities where exporters are taking the initiative to help farmers access inputs and new markets, in general there is little incentive for farmers to invest in their coffee farms themselves. Current average yields (red cherry) in Burundi are estimated at around 1.34 kg/tree (Kamwenubusa and Guilleminault, 2013), which is low for Arabica Bourbon that is capable of yields of 10 kg/tree. I regard these estimates as optimistic, and my ongoing research in Burundi has indicated that a more realistic range of average yield/tree is 0.5–0.8 kg. It is important to recognize too that behind the many tangible manifestations of underinvestment and neglect at the farm level are the mostly invisible vicissitudes caused by decades of war and unrest. It is beyond the scope of this chapter to discuss the episodes of ethnic-based violence in 1965, 1972 and 1988 and the civil war from 1994 to 2005 (Rosenberg, 2017). However, the gruesome overtones of senseless killing, political instability and internal and external displacement of farmers must be acknowledged as major contributing factors to the sustainability challenges that the coffee sector currently faces at farm level. Livestock, forest areas and coffee trees were ravaged during the war (Lemarchand, 1995; Oketch and Polzer, 2002; Daley, 2006; Watt, 2008; Uvin, 2009). Ecological disconnect, as a result of violence and displacement, is painfully evident in Burundi: farmers have lost much of the knowledge they need to work the land they depend on. A painful legacy of

bloodshed, exploitation and coffee lie in Burundi's soil and much work remains for the sector to regain the trust of the farmers it depends on and to restore the land to greater productivity. The current population is estimated at 10.8 million people – with two-thirds of the population living below the national poverty line ($1.90/day) and Burundi sitting at 180 out of 187 on the Human Development Index (UNDP, 2014; World Bank, 2014). Unfortunately, although foreign aid continues to pour into Burundi, it is severely limited in its effectiveness due to current governance structures, which remain non-developmental, neo-patrimonial and fragile (Desrosiers and Muringa, 2012; Daley, 2013; Curtis, 2015). Burundi's socio-political and agro-economic conditions render it one of the world's smallest, near inconsequential, coffee-producing nations, yet at both national and household level coffee is a literal lifeline to the Burundian economy. Unfortunately, Burundi has little to offer sustainable coffee buyers, as reliability and guarantee of supply is essential to participating in this market.[5] This is part and parcel of the inevitable tension that exists between the trade potential of standardizing the sustainability of coffee production and the realities of the context of production (Rosenberg, 2017). The brief snapshot of Burundi presented earlier should clearly show that there are significant challenges to Burundian coffee producers wanting to enter the sustainable coffee market. Furthermore, within a context of long-standing political instability, unpredictability and weak institutions, there is unfortunately very little that a small agribusiness (like LMCP) can do to create transformative change without policy influence or the support of a large development organization. While transdisciplinarity is defined as a research approach that is problem-solving oriented (Pohl and Hirsch Hadorn, 2007; Hirsch Hadorn et al., 2008; Bergmann et al., 2012; Jahn, Bergmann and Keil, 2012; Brandt et al., 2013), very rarely does literature on transdisciplinary research approaches assume a societal context of instability, inequality, extreme poverty and political volatility where the fairness-driven 'taste' of TDR is the most appropriate. However, in my view, it is precisely these sorts of circumstances that often give rise to the best sorts of problem solving. What will be evident in the next section is that the types of problem solving I needed to do in the 'real world' of my research collided violently with the type of problem solving I needed to do in order to satisfy the formal academic requirements of the PhD.

9.3 Problems: the 'real world' versus the PhD

After formally registering for my PhD, I was acutely aware that I needed to complete a PhD document in a fixed amount of time but was relying on a methodology that insists on allowing emergence to guide problem solving in the 'real world'. In the previous section, I described how I spent 15 months in Burundi immersed in context. What I did not describe is that I *had* to come to the decision to leave Burundi as I was in jeopardy of losing my funding because I had not produced a literature review within the first year of study. The fact that the research process had led to the creation of a farmer support programme that had created 17 jobs within Long Miles Coffee (15 of which were employing rural youth) was

negligible. Despite being in a department that has pioneered ETDR, the university's formal requirements for a PhD took precedence over the emergence happening in the real world. Retrospectively, I have come to see that there were three problems that constantly defined my research process:

Problem 1: 'Make farmers' problems roasters' problems, and make roasters' problems farmers' problems'.
Problem 2: Satisfy the requirements for completing a PhD as per my academic institution's rules.
Problem 3: Solving Problem 1 cannot be done in the usual way that Problem 2 is solved.

This succinct description of the research problems has only been formed in retrospection as the entire research journey was informed by abductive logic and emergence that resulted from immersion in context.

9.3.1 Problem 1: 'make farmers' problems roasters' problems, and make roasters' problems farmers' problems'

In an ETDR approach, boundary objects are typically informed by hunches, interactions and experiences generated by informal relationships and unplanned events and circumstances (emergence). Boundary objects are essential for generating transformation knowledge, as they translate complex real-world problems into knowledge structures (epistemic objects) that are immersed in context (Becker, 2012). A boundary object can exist as almost anything (a concept, an action/experience, a plan), but it must be meaningful to all actors in order for it to be a successful boundary object (Bergmann et al., 2005). The concept of 'quality coffee' emerged as a boundary object in early 2013 as LMCP expressed that this was a strategic goal for the company in order to maintain its market position and, most significantly, fetch a higher price to pay a premium to farmers – a significant contributing factor in community engagement. I asked how my research could serve this goal and in response a challenge was thrown out to me by LMCP to 'make farmers' problems buyers' problems and make buyers' problems farmers' problems'. Buyers' problems revolved around a reliable supply of high-quality Burundian coffee, while farmers' problems revolved around limited access to the inputs and knowledge to stabilize and improve production. At this point it was unclear as to *how* exactly to respond to this challenge given the constraints of an individual PhD research project and with the limited financial and human resources of LMCP. Sober reflection on Burundi's position in the global coffee market (i.e. that the total volume of national production is so small it is effectively inconsequential to the global market) confirmed that pursuing a 'quality over quantity' approach may be one way of creating transformative change. The question of *how* exactly to do this remained unclear. However, at this point in my research journey (early 2013) it had become increasingly clear that I did not have the required skillsets – both in terms of academic background and work experience – to design a research

intervention to help farmers improve the quality of their coffee that they would deliver to LMCP.[6] It is at this point that a decision needed to be made about what type of knowledge would be produced as a result of the research process. There are several considerations that an individual TD researcher needs to account for when deciding which type of knowledge should be produced by their research (van Breda, Musango and Brent, 2016). One of these considerations is the nature of the boundary object and what type of knowledge is needed for an integrative solution. Sufficient systems and target knowledge were available to LMCP in terms of what constituted 'quality coffee'.[7] I made an intuitive decision to pursue transformation knowledge despite not having the requisite skillset or the budget to hire anyone who did. The decision involved a commitment to learning by doing in order to improve the quality of LMCP's coffee (through a yet to be designed intervention) and simultaneously building trust with farmer communities through a commitment to listening to their needs through regular community meetings.

9.3.2 Problem 2: satisfy the requirements for completing a PhD as per my academic institution's rules

> Hi everyone,
>
> As you know I'm leaving this year to finish my PhD and I am leaving next Tuesday March 3rd. Things got a bit serious between my Professor and I and he has completely changed his attitude towards me and last week he was about to take legal action against me together with the University (yikes! see email thread below). This has now been resolved and I had to write a letter promising that I would spend 6 days a week, 6 hours a day working exclusively on my PhD. I'm sad to be leaving, but leaving to finish this degree is important because the degree itself allowed me to be in Burundi in the first place. I am very much looking forward to returning to Burundi next January to focus only on LMCP work:)
>
> Thank you all for the support this year- it's meant the world.
>
> Best, Lauren
>
> (Email sent to Long Miles Coffee colleagues on February 23, 2015)

ETDR is high-risk research that collides violently with the established norms of *doing* postgraduate research. In allowing abductive logic to guide the research process, I effectively was choosing to put the formal academic outputs of this research process as a second priority. I naively assumed that if I made the first priority of the research journey to contribute towards solving problems in the real world of the research, the necessary academic outputs would automatically be generated. Part of this was due to what was modelled to me as 'normal' TD practice, namely transformation knowledge practised in a particular social context with the aim of long-term engagement. Thus, I perceived ETDR less as a way to follow a research methodology and more as a means to enable connection to a

social context long after the formal research activity (in this case, my PhD) had concluded. In other words, I assumed it was normal to use the PhD as a means of creating a vocation for oneself outside of the university. When I think back on the research methodology classes that I attended, I cannot remember a single class dedicated to creating the written document/publications that are required to obtain a PhD. Rather, the training in ETDR methodology classes that my classmates and I received involved practice-oriented lessons and case studies that exclusively prepared and equipped us to engage in real-world problem solving in a manner where context is foregrounded as being supremely important. It was only three years after I began my PhD that I realized that this differs from typical expressions of TD, where real-world problems are often only drawn in to stress the societal relevance of the research project (Wuelser and Pohl, 2016). It was an extremely risky decision to prioritize problem solving in the real world above academic outputs, as currently TD doctoral research is not evaluated on the quality of the real-world intervention but on the quality of a specific type of written documentation (publications and dissertations) of the real-world intervention (Willetts et al., 2012; Wuelser and Pohl, 2016).

9.3.3 Problem 3: solving Problem 1 cannot be done in the usual way that Problem 2 is solved

In 2013, when it emerged that it would be critically important that any and all research activity from my part needed to have an equal contribution towards building trust between LMCP and the farmers it worked with *as well as* improving the quality of production, I did not realize that this would be a direct challenge to what I needed to produce as a student registered for a PhD. Evidence of authentic community trust cannot necessarily be produced within the same time frame afforded to complete a PhD. This emergent tension demanded a renegotiation of the rationale and motivation for the research work. I decided that a short-term, project-based motivation for the research (i.e. research that would not outlast the duration of the PhD project) would be utterly unhelpful for the societal actors involved. The new motivation was a focus on real-world solutions, through learning by doing, with the non-negotiable goal of long-term community engagement that builds trust.[8] However, what was not clear was *how* to build community trust (beyond the payment of a premium for quality coffee) within the parameters of operating as a for-profit business. Giving away free inputs for the sake of helping poor farmers improve the quality of their production in the hope that they would in turn trust LMCP could never be integrated into LMCP's business model or their long-term vision for community development. Although my research methodology classes were practice-oriented, in retrospect I realized I received little preparation for the fact that the real-world problem solving may be entirely consuming because it makes demands on you that your formal academic training has not prepared you for in terms of disciplinary knowledge and skills. Apart from the abductive reasoning that guided the research, I want to briefly mention here the deductive/literature-informed reasons for not deferring to certification (voluntary

sustainability standards). Sustainable coffee research faces the same challenges as other sustainability initiatives with other commodities in that it is yet to show how generating systems knowledge can enable and contribute to sustainable transformation (Miller et al., 2014; Seijger et al., 2015). Recent landmark studies about the impacts of voluntary sustainability standards (VSS) at origin clearly show that VSS have by and large failed to produce transformative change at origin (Blackman and Rivera, 2011; ITC, 2011; RESOLVE, 2012; COSA, 2013; Potts et al., 2014). Two themes were apparent in the analyses of these studies:

1 Context is highly influential, if not determinable, of the potential impacts a VSS could have;
2 The knowledge base of actual impacts of VSS remains thin and much more case/place/origin-specific ('field-level') knowledge is needed.

Further to these two themes, coffee producer authors or co-authors are almost non-existent in the scientific canon of sustainable coffee research. I realized this as there is complete silence in the literature regarding the constant gap between sustainable coffee production and sustainable coffee sales, i.e. there is constant oversupply of 'sustainable coffee' in the global coffee market (Potts, Meer and Daitchman, 2010; Potts et al., 2014). It is surprising that this scenario of chronic oversupply has not provoked a greater sense of unease or inquiry in the literature beyond brief mention. While certain VSS may offer market access to producers, they should not be mistaken as business models or a guarantee of sales. For example, in 2012 less than a third of certified production in Kenya was actually sold as certified coffee (van Rijsbergen et al., 2016). It is worth remembering that producers solely bear the losses incurred with unsold certified production (Cycon, 2007; Rueda and Lambin, 2013; Dragusanu, Giovannucci and Nunn, 2014; Vellema et al., 2015). Lastly, it is important to note that while implementation of a sustainability certification *may* contribute to improving the quality of coffee, none of the available mainstream sustainability standards are able to certify the quality attributes that high-quality coffee buyers require (Rosenberg, Swilling and Vermeulen, 2018).

9.4 Knowledge: unexpected outcomes in rural Burundi

ETDR sees the research process as 'a discovery of the evolutionary potential of the present and experimental explorations in the in-between spaces adjacent to what already exists in the present' (Van Breda and Swilling, 2018:13). When I embarked on my PhD research journey, I had a strong understanding of the 'in-betweenness' of ETDR: the assumption that an ideal end-scenario will never arrive and, if it did, not to assume that it would last because of the volatility of the societal context. However, what I could not anticipate were the implications (time, energy, money) of working across disciplinary boundary lines to sustain the exploration in the in-between spaces *away* from the safety of the university. Unlike my classmates, for whom the societal context of their research was a

ten-minute drive away from campus, the context of my research was thousands of kilometres away and entirely foreign. This section reflects on how I solved Problem 3 described earlier and the emergent knowledge production that resulted. Again, I wish to emphasize that what follows is a *retrospective* reflection of a research journey that did not have a clear plan marked out ahead of time.

In order to learn more about working with coffee farmers and how best to improve quality at farm level (Problem 1), I travelled to Rwanda in February 2014 to meet with a coffee exporter whom I had met in 2013 who seemed to have had innovative solutions to improve coffee quality using his background as a plant pathologist. Rwanda and Burundi share similar agro-ecological features for coffee production, and it made more sense to learn from a practitioner who had been in the coffee business for several years rather than consulting a text book. Throughout the research journey, it was an extreme challenge to find literature that could connect to the social realities I found in rural Burundi simply because it barely existed apart from project reports from USAID or other development organizations.[9] The Rwandan exporter had developed an Integrated Pest Management (IPM) programme that trained and employed out-of-school, unemployed youths as 'coffee scouts' who trained farmers on good agricultural practices using IPM together with a locally produced organic insecticide called Pyrethrum. The coffee scouts are named as such because they scouted for the Antestia bug (*Antestiopsis* spp.), a pest commonly associated with spreading the Potato Taste Defect (Jackels et al., 2014).[10] The IPM coffee scout programme seemed a highly appropriate response to the challenges that LMCP was facing as it would directly contribute towards improving quality by improving farmers' capacity for coffee farming. I, however, had no agronomical or farming formal education and thus did not have the scientific capabilities to initiate the programme. I spent the three weeks motivating the founders of LMCP that a local agronomist needed to be hired, sent to Rwanda to receive training on the coffee scout programme and returned to Burundi to set up the programme for the company. This took some work as at the time LMCP was a young start-up with only four employees and the additional proposed cost to the company was significant.

The LMCP coffee scout programme began in April 2014 by hiring six young Burundians as coffee scouts to work in the communities immediately surrounding one of LMCP's washing stations. Formal employment opportunities in rural Burundi are hard to come by and it was not difficult to find interested candidates for the job. The newly hired LMCP agronomist worked through informal networks and community leaders to find suitable candidates for the work. All applicants needed to be able to read and write as the ability to collect and record data about on-farm management practices is a core component of the IPM programme. The coffee scouts' applicants were trained in IPM theory and practice by the LMCP agronomist and then had to complete a written test in order to demonstrate that they had sufficient grasp of the IPM content. However, most of the training for the IPM coffee scout programme happens on the job when coffee scouts interact with farmers. Trainings were intentionally designed to be highly interactive, humorous and easy to understand so that farmers can pass

on the information to others. Farmers' trainings occurred on a monthly basis in the communities closest to LMCP's washing station. The work of the coffee scouts was co-designed by the agronomist, and I had to introduce farmers to the IPM approach by focusing on an easy and low/no tech tangible experience: scouting and 'hunting' the Antestia bug. The scouts were aware of exactly when the Antestia bug appears and feeds on the coffee trees (Umuhire, 2013), and trainings are arranged during this time to show farmers how they themselves can simply wait (at the appropriate times) for the Antestia bugs to appear and simply catch them with their hands to remove them from their trees. The highly participatory approach to training farmers was a stark departure from what farmers are accustomed to in Burundi – free inputs given by the state to a select number of farmers in each community. After seven months of operation, the LMCP coffee scout programme had attracted the attention of one of LMCP's buyers, who wished to invest in the programme for one year. This investment began in November 2014 and expanded the programme to a total of 14 coffee scouts. Prior to this investment, the coffee scout programme had been funded by ad hoc donations to LMCP from interested onlookers and supporters outside of Burundi who wanted to contribute to a young agribusiness start-up. The ad hoc financing during this period was a challenge that periodically delayed trainings and frequently caused concern as to whether there would be sufficient finances to pay the scouts' salaries on time. In 2015, the LMCP agronomist decided to move away from centralized farmer trainings towards a decentralized model of training that he termed 'IPM-Friends'. The decentralized training approach of LMCP's IPM-Friends model resembled elements of the traditional Farmer Field School (FFS) approach in terms of its emphasis on decentralized, learner-centred experiential learning (Braun et al., 2006; Anandajayasekeram, Davis and Workneh, 2007; Chuluunbaatar and Yoo, 2015). However, it differs from traditional expressions of FFS in that it does use formal lecturing to deliver information on new topics to farmers. Thus, unlike FFS where those leading farmer groups are only facilitators, the LMCP coffee scouts were both facilitators of group learning and teachers. Van den Berg and Jiggins (2007) have argued that it is important to see IPM FFS as both an extension instrument as well as an educational investment in order to perceive both the immediate (productivity) impacts as well as the developmental impacts.[11] I see their argument as being particularly relevant to the Burundian coffee sector given its history. The table below (Table 9.1) details the immediate impacts of the LMCP coffee scout programme for 2014 and 2015. At the end of 2016, the coffee scout programme became an integrated part of LMCP's operations and a part of the company's operating costs because of its value added in creating quality coffee. At the time of writing (December 2019), LMCP employs 26 full-time coffee scouts and two agronomists.

At the time of completion of writing the PhD (December 2016), three developmental outcomes of the LMCP coffee scout programme were observed. I wish to stress, again, that none of these outcomes could possibly have been planned at the beginning of the research journey given that there was never any intention to develop an IPM programme.

Table 9.1 Immediate impacts of the LMCP coffee scout programme for 2014 and 2015

Year	*Outcomes*
2014	711 farmers trained
	15 full-time jobs created (1 agronomist, 14 coffee scouts)
	9706 coffee trees pruned
	Agro-economic status of four communities mapped to individual farm level (320,000 coffee trees)
	93 farms mulched during post-harvest training
	Experimentation: growing mushrooms from coffee pulp
	Research collaborations with an international NGO and the national Burundian agronomic research institute
	13 LMCP farmers decide to rejuvenate their coffee farms
	More than 1100 Antestia bugs killed
	First LMCP farmer survey to evaluate coffee scout programme (n=57). Positive appreciation from farmers who requested that the coffee scout programme be continued in 2015
2015	Release of LMCP's first Kirundi language agronomist report for distribution to community leaders detailing the impacts of the 2014 coffee scout programme
	687 farmers trained in centralized community trainings
	120 farmers trained as part of the decentralized 'IPM-Friends' (FFS) strategy
	Development of an LMCP IPM sketch called 'Margarita's Coffee Farm' played in five communities to promote production practices that improve quality, over 500 farmers in attendance in total. An 'IPM Hymn' titled 'IPM shingimizi' ('IPM make your roots strong') is written and performed at the end of the skit and is sung at other community gatherings organized by the coffee scouts
	Two Antestia hand catching competitions with cash prizes for adults and school books as prizes for school age youth
	30 visits to coffee cooperatives to train leaders on selective handpicking to improve quality
	52,818 coffee trees pruned
	Updated agro-economic status of four communities mapped to individual farm level (320,000 coffee trees)
	273 farms mulched during post-harvest training
	Experimentation: Perennial Peanut (*Arachis pintoi*) and Tephrosia (*Tephrosia vogelii*) as ground cover
	Introduction of Brix Meter refractometer to LMCP farmers. The Brix Meter measures sugar levels in coffee cherry as a measure of ripeness to guide selective handpicking
	Conclusion of research collaboration with national Burundian agronomic research institute recommending Pyrethrum for use in the Burundi coffee sector
	Eight 'IPM-Friends' groups commit to securing resources to build their own worm farms to produce organic compost for community use
	Noticeable improvements in cupping scores for all communities involved in coffee scout programme
	611 LMCP farmers decide to rejuvenate their coffee farms
	More than 30,300 Antestia bugs killed
	Baseline study on average yield/tree. Results show that LMCP farmers involved in coffee scout training programme recorded less than 10% losses in production due to underripe/Antestia infected cherries compared to 30% losses of farmers not part of the coffee scout programme

9.4.1 Short, live, community data feedback loops

What became apparent in the very beginning of the IPM programme was the inherent research component built into the training modules. In order to plan trainings, it was essential to maintain a good database of agro-economic indicators to assess the level of productivity in communities where training would occur. The grassroots modality of the IPM coffee scout programme resulted in both a quick and effective means of reaching farmers as well as a continuous feedback loop of information coming in from farmers who attended the IPM trainings. Prior to the launch of the IPM programme, LMCP had to work through other community structures (local churches, cooperative leaders) to disseminate important information relating to production practices at the washing station. Relying on these third-party intermediaries was often not effective and had a time delay (e.g. churches only meet on Sunday). Likewise, prior to the IPM programme LMCP had limited agro-economic information for the farmers they worked with. At the end of 2014, LMCP had detailed information about the state of farms in the communities it worked with. These indicators include which farms have been mulched, pruned and intercropped as well as the age of the farm.

9.4.2 Non-seasonal agricultural jobs in Burundi's coffee sector

Often, the problem with agricultural jobs in developing nations is that they create seasonal employment that is generally not supported or protected by any form of institutional or legal framework (Gresser and Tickell, 2002; Cramer et al., 2014). This is the reality for most employment opportunities in the coffee sector in Burundi (Bamber, Gereffi and Guinn, 2014). Fundamental to the design of IPM programmes is year-round farm maintenance, and this has meant year-round employment for the LMCP coffee scouts. The economic impact of the LMCP IPM programme should not be overlooked: none of the 14 scouts hired in 2014 could find work in the fields in which they were qualified for prior to being employed by LMCP.[12]

9.4.3 Trust as a platform for farm rejuvenation and innovation

The critical issue of soil fertility in Burundi (Cochet, 1995, 2004) is nearly always compounded by the fact that there are simply too many old, unproductive coffee trees in Burundi (World Bank, 2012; USAID, 2013; Nkurunziza, 2014). Apart from a lack of means to access or purchase new coffee trees and the fact that pruning will result in a loss of yield the following harvest, many farmers have simply not seen any real incentive to invest in enhancing/expanding their coffee farms. Until the recent opportunities offered by the privatization of the sector in 2009, coffee had never been a means by which the rural majority of Burundi could farm as entrepreneurs. Coffee farming is still widely perceived as having to deal with a crop that has the sole purpose of meeting burdensome obligations imposed on rural farmers by urban government elites. It was thus incredibly surprising that

at the end of 2014, 13 LMCP farmers decided to rejuvenate their coffee farms and began the process of de-weeding, -pruning and -stumping their coffee farms, knowing that these activities would reduce their harvest for the following year but greatly improve it the next. Although LMCP always encouraged farmers to rejuvenate their farms, it has never forced any farmer to rejuvenate their farm nor has it provided free coffee saplings, trees or tools to rejuvenate a farm. Rather, the LMCP coffee scouts have diligently communicated the overall benefits of rejuvenating one's farm as being worth the effort when compared to the costs involved. At the end of November 2015, a further 611 farms had been rejuvenated across four communities closest to LMCP's first washing station.

Several innovations emerged from the scout programme during 2015 that were not part of the initial design of the IPM programme but have emerged as entirely complementary as they contribute to improving quality and stabilizing yields. One of these revolves around finding an appropriate crop to intercrop with coffee for the purposes of growing in situ mulch. These include Perennial Peanut (*Arachis pintoi*) and Tephrosia (*Tephrosia vogelii*) to act as nitrogen fixing companion crops. Both crops are being grown in an attempt to find a solution to the challenge that farmers face in terms of finding mulch for their fields. The innovation does not lie in the (technical) experimentation with growing the crops but rather in the fact that LMCP farmers have allowed LMCP to experiment with these crops on their land. Arable land is scarce in Burundi (van Leeuwen, 2010; Niragira et al., 2015), and it remains surprising that farmers would offer their land as experimentation plots to LMCP with no financial compensation and no guarantee that the intercropping would be successful.

At the beginning of March 2015, I began to formally describe in writing my research journey in Burundi that had begun in May 2013. Like other TD researchers, I encountered the difficulty and unresolved challenge of knowledge integration in transdisciplinary research (Thompson Klein, 2004; Wickson, Carew and Russell, 2006; Pohl et al., 2010). I navigated this by writing myself *into* my research as opposed to writing up my fieldwork (like most postgraduate handbooks instructed me to do). What we know about our research is constituted by how we write ourselves in (Mansvelt and Berg, 2010). Writing-up implies a distanced position from the context of the research to achieve the production of impartial knowledge; writing-in highlights the situated partiality of the knowledge being represented. Writing-in calls for reflexivity and rigour (Mansvelt and Berg, 2010) and for the researcher to provide sufficient insight into the complex emotional processing that comes with working in difficult situations (Vorrath, 2013). Although I should have anticipated that the writing-in phase of this research would be challenging because I was not bound to any disciplinary formats, I was completely surprised and frequently overwhelmed by the task of integrating knowledge in a reflexive manner that honours the research process and the research context. At the beginning of the writing-in phase, I found it extremely difficult to translate the small, everyday moments of change that occurred in the hills where LMCP worked into a language that was appropriate for an academic audience. When I presented my work to colleagues or when I read the most relevant authors in the

field of sustainable coffee, my evidence seemed far too anecdotal to matter to anyone apart from LMCP farmers, LMCP and the community of coffee buyers it works with. Similarly, it was challenging to find peer-reviewed articles written by practitioners who focus on both the business mechanisms of sustainable coffee and the struggles involved in community development. As a result, I supplemented my literature review with 'grey literature' from practitioners and coffee professionals – which has been criticized by some academics that have reviewed my work when I have submitted it for publication.

During the writing-in phase, I realized that I had experienced a dual learning journey: I was simultaneously learning about the Burundian coffee sector while learning about a research methodology that is not yet well documented in academic literature. In the first instance, the learning journey seemed justified: it is expected that it would take time to generate the new knowledge expected of doctoral research. The second instance, however, was far more difficult to justify to other academics and practitioners. For example, how was it possible that I did not have specific research questions and specific means of collecting information to respond to the various questions of other academics before entering 'the field'? In 2016, there was no body of written, peer-reviewed work that I could explain myself with (yet), and the only other work I could reference was occurring at an institution (Stellenbosch University) with which most were unfamiliar. This often had the effect of rendering my approach to research as highly interesting (mostly because of the difficulty of the research context) but anecdotal and, to some, untrustworthy. It took several months to get comfortable in my own 'language' of writing. Throughout the writing-in phase, I felt that my discomfort was unique to my situation: perhaps if I had invested significantly more time in understanding transdisciplinarity, then I might have been better equipped to handle the knowledge integration task required of me to complete my PhD. It was only at the very end of the research journey that I discovered that a transdisciplinary doctoral pedagogy is yet to emerge and that I had been holding my writing to standards of evaluation that are yet to be agreed upon (Willetts et al., 2012; Belcher et al., 2016; Willetts and Mitchell, 2017). This discovery resulted in a turning point in the research journey. My research question eventually became: as an individual, transdisciplinary researcher, working in a context of high levels of educational and social inequality and with political instability, how do you construct the research process? As a result of this turning point, the written component of my PhD journey became more about a methodology than about the sustainability of coffee production. The fact that transformative knowledge was generated through the IPM programme was an unexpected outcome.

9.5 Conclusion

This chapter has reflected on an intuitive research process that did not have a predetermined research agenda and intentionally allowed the immediacy of context to shape the research process. ETDR is a move away from ex situ decision-making processes to embedded, in situ and contextual decision-making and problem

solving. For doctoral research students, unless there is buy-in from key stakeholders at their home university, their research will not be recognized as legitimate because of ETDR's extreme reliance on abductive logic to drive the research process. Of the eight essential principles of TD research (Chapter 3), abductive logic and reasoning is critical to operationalizing ETDR because it allows researchers to respond to socially dynamic and volatile contexts where deductive and inductive reasoning would simply be insufficient. ETDR thus provides a more authentic means of allowing African researchers to engage with their context; however, at the same time it exposes them to much higher levels of risk and uncertainty as this approach is not appealing to the majority of Global North funders, who expect clear deliverables from North–South research collaborations. Despite being a student of an institution that pioneered ETDR, there were several points in my research journey where I simply felt unprepared for what I was experiencing, and I often felt unable to respond to the demands of my home university and the demands of the societal actors in the research context. ETDR prioritizes transformation knowledge, making it high-risk research precisely because it depends on contextual dynamics. Unlike large, multi-stakeholder TD projects where outputs are decided upon in advance, the individual researcher has a choice to make about how they will prioritize time and energy between generating the written formal academic outputs (journal articles, research reports, etc.) and the multimodal contributions they will make towards real-world problem solving the social context of their research. In my own PhD journey, I continuously chose to put the formal academic outputs of the research process as a second priority as I was working off the hunch that if the first priority was to contribute towards solving problems in the real world of the research, the necessary academic outputs would automatically be generated. I was only partially correct in this hunch. It was, and remains, an extremely risky decision to prioritize problem solving in the real world above academic outputs, as currently TD doctoral research is not evaluated on the quality of real-world intervention but on the quality of a specific type of written documentation (publications and dissertations) of the real-world intervention (Willetts et al., 2012; Wuelser and Pohl, 2016). The practical challenges associated with following an ETDR approach suggests that ETDR may not be suitable or appropriate in all research contexts. As a new, emergent praxis, ETDR has promising results but is yet to be tested in multiple social contexts. More case study knowledge is needed in this regard, to provide deeper insight for individuals wishing to undertake TD research in a developing world context using this approach.

Notes

1 Although I use the signifier 'developing world context' to refer to a range of contexts found predominantly in the Global South, this should not be mistaken as a formulaic description of place or reduction of context. Rather, I use this signifier as a caveat to point to a multiplicity of possibilities that are simply not present in a 'developed world' context.

2 Apart from the learning generated from everyday experiences and ongoing interactions with Burundian coffee sector actors, supplementary learning was generated from 22

semi-structured interviews conducted between November 2013 and September 2015 with green coffee buyers and other coffee researchers who have working experience and insight into production dynamics in Burundi's coffee sector.

3 Coffee washing stations are processing units where coffee cherry is mechanically depulped. Once removed from its skin, the coffee seeds are literally washed with water for several hours in tanks and grading channels. The aim of wet processing coffee is to improve quality by differentiating bean sizes based on density. Higher quality beans are denser, whereas poor quality beans are not and will reveal themselves by floating to the top of water. After washing, the coffee seeds need to be dried (parchment), a process that also takes place at the washing station.

4 Arabica trees characteristically do have cyclical production, but cyclicity has been exacerbated by decades of inappropriate land use programmes for state-controlled coffee production that have resulted in acute losses of soil fertility. Recently climate change (in particular, irregular rainy seasons) has further aggravated this problem. Added to this is the fact that most soils in Burundi are highly acidic and reduce the availability of essential nutrients, in particular nitrogen, for healthy coffee growth (Snoeck, Zapata and Domenach, 2000; Nduwimana et al., 2013; Nzeyimana, Hartemink and de Graaff, 2013).

5 Large corporations (including supermarket chains) constitute the majority of purchases in the sustainable coffee trade (Jaffee and Howard, 2010; Johannessen and Wilhite, 2010; Jaffee, 2012; Elder, Lister and Dauvergne, 2014).

6 My undergraduate studies were in media and urban studies and my master's research had focused on the sustainable cities literature in an African context.

7 These are industry standards and protocols on sensory analysis of coffee and the price discovery mechanisms associated with these protocols (Rhinehart, 2009; Di Donfrancesco, Gutierrez Guzman and Chambers, 2014; SCAA, 2014; Wilson and Wilson, 2014).

8 Interestingly, in comparison to the research motivation expressed in the formal research proposal at the beginning of my PhD research, the new emergent motivation was more preoccupied with sustaining a development process rather than extracting information about a development intervention.

9 This is linked to the narrow geographic dispersion of certified coffee production; 77% of certified sustainable coffee is produced in Latin America and only 10% originates from Africa (Potts et al., 2014).

10 Brewed coffee beans with PTD taste like a raw potato – an unpleasant taste defect that does little to improve Burundi's reputation on the international market. It is common knowledge that traditional commercial buyers will easily reject entire containers of coffee if one incidence of PTD were found in their order.

11 Examples of immediate impacts include yield increases, profit increases, pesticide reduction and improved communication skills. Examples of developmental impacts include poverty reduction, collaboration between farmers, innovation and improved marketability of produce (Van den Berg and Jiggins, 2007).

12 See also Berckmoes and White (2014).

References

Anandajayasekeram, P., Davis, K. E. and Workneh, S. (2007) 'Farmer Field Schools: An Alternative to Existing Extension Systems? Experience from Eastern and Southern Africa', *Journal of International Agricultural and Extension Education*, 14(1), p. 13. doi: 10.5191/jiaee.2007.14107.

Bamber, P., Gereffi, G. and Guinn, A. (2014) *Burundi in the Coffee Global Value Chain: Skills for Private Sector Development*. Durham, NC: Duke University, Center on Globalization Governance and Competitiveness.

Becker, E. (2012) 'Social-Ecological Systems as Epistemic Objects', in Glaser, M. et al. (eds.) *Human-Nature Interactions in the Anthropocene: Potential of Social-Ecological Systems Analysis*. New York: Routledge, pp. 37–59. doi: 10.4324/9780203123195.

Belcher, B. M. et al. (2016) 'Defining and Assessing Research Quality in a Transdisciplinary Context', 25(November 2015), pp. 1–17. doi: 10.1093/reseval/rvv025.

Berckmoes, L. and White, B. (2014) 'Original Article Youth, Farming and Precarity in Rural Burundi', *Nature Publishing Group*, 26(2), pp. 190–203. doi: 10.1057/ejdr.2013.53.

Bergmann, M. et al. (2005) *Quality criteria of transdisciplinary research: A guide for the formative evaluation of research projects*. 13. Frankfurt.

Bergmann, M. et al. (2012) *Methods for Transdisciplinary Research: A Primer for Practice*. Frankfurt/Main, Germany: Campus Verlag.

Blackman, A. and Rivera, J. (2011) 'Producer-Level Benefits of Sustainability Certification', *Conservation Biology*, 25(6), pp. 1176–1185. doi: 10.1111/j.1523-1739.2011.01774.x.

Bootsma, M. C. et al. (2014) 'Added Value and Constraints of Transdisciplinary Case Studies in Environmental Science Curricula', *Corporate Social Responsibility and Environmental Management*, 21(3), pp. 155–166.

Brandt, P. et al. (2013) 'A Review of Transdisciplinary Research in Sustainability Science', *Ecological Economics*, 92, pp. 1–15. doi: 10.1016/j.ecolecon.2013.04.008.

Braun, A. et al. (2006) *A Global Survey and Review of Farmer Field School Experiences*. Wageningen, The Netherlands: International Livestock Research Institute.

Brundiers, K., Wiek, A. and Redman, C. L. (2010) 'Real-World Learning Opportunities in Sustainability: From Classroom Into the Real World', *International Journal of Sustainability in Higher Education*, 11(4), pp. 308–324. doi: 10.1108/14676371011077540.

Chuluunbaatar, D. and Yoo, J. (2015) *A Shift in Global Perspective: Institutionalizing Farmer Field School*. FAO: Rome.

Cochet, H. (1995) *Etude sur la stratégie des producteurs de café au Burundi*. Paris: Office du café -OCIBU/INAPG.

Cochet, H. (2004) 'Agrarian Dynamics, Population Growth and Resource Management: The Case of Burundi', *GeoJournal*, 60, pp. 111–120. doi: 10.1023/B:GEJO.00000335 93.29549.3b.

COSA (2013) *The COSA Measuring Sustainability Report: Coffee and Cocoa in 12 Countries*. Philadelphia, PA.

Cramer, C. et al. (2014) 'How to Do (and How Not to Do) Fieldwork on Fair Trade and Rural Poverty', *Canadian Journal of Development Studies/Revue canadienne d'études du développement*, 35(April), pp. 170–185. doi: 10.1080/02255189.2014.873022.

Curtis, D. E. A. (2015) 'Development Assistance and the Lasting Legacies of Rebellion in Burundi and Rwanda', *Third World Quarterly*, 36(August), pp. 1365–1381. doi: 10.1080/01436597.2015.1041103.

Cycon, D. (2007) *Javatrekker: Dispatches from the World of Fair Trade Coffee*. White River Junction, Vermont: Chelsea Green Publishing.

Daley, P. (2006) 'Ethnicity and Political Violence in Africa: The Challenge to the Burundi State', *Political Geography*, 25(6), pp. 657–679. doi: 10.1016/j.polgeo.2006.05.007.

Daley, P. (2013) 'The Burundi Peace Negotiations: An African Experience of Peace-Making in the Era of Neo-Liberalism', in Abrahamsen, R. (ed.) *Conflict and Security in Africa*. Woodbridge: James Currey, pp. 108–126. doi: 10.1080/03056240701449729.

Desrosiers, M.-E. and Muringa, G. (2012) 'Effectiveness under Fragile Conditions?: Socio-political Challenges to Aid and Development Cooperation in Burundi', *Conflict, Security & Development*, 12(March 2015), pp. 501–536. doi: 10.1080/14678802.2012.744183.

Di Donfrancesco, B., Gutierrez Guzman, N. and Chambers, E. (2014) 'Comparison of Results from Cupping and Descriptive Sensory Analysis of Colombian Brewed Coffee', *Journal of Sensory Studies*. Blackwell Publishing Ltd, 29(4), pp. 301–311. doi: 10.1111/joss.12104.

Dragusanu, R., Giovannucci, D. and Nunn, N. (2014) 'The Economics of Fair Trade', *Journal of Economic Perspectives*, 28(3), pp. 217–236.

Elder, S. D., Lister, J. and Dauvergne, P. (2014) 'Big Retail and Sustainable Coffee: A New Development Studies Research Agenda', *Progress in Development Studies*, 14, pp. 77–90. doi: 10.1177/1464993413504354.

Giovannucci, D. and Ponte, S. (2005) 'Standards as a New Form of Social Contract? Sustainability Initiatives in the Coffee Industry', *Food Policy*, 30, pp. 284–301. doi: 10.1016/j.foodpol.2005.05.007.

Gresser, C. and Tickell, S. (2002) *Mugged: Poverty in Your coffee cup*. London: Oxfam.

Hall, K. L. et al. (2008) 'The Collaboration Readiness of Transdisciplinary Research Teams and Centers Findings from the National Cancer Institute's TREC Year-One Evaluation Study', *American Journal of Preventive Medicine*, 35(2 Suppl.), pp. S161–S172. doi: 10.1016/j.amepre.2008.03.035.

Hirsch Hadorn, G. et al. (2008) *Handbook of Transdisciplinary Research*. Dordrecht, Netherlands: Springer. doi: 10.1007/978-1-4020-6699-3.

ITC (2011) *The Impacts of Private Standards on Producers in Developing Countries*. 2. Geneva. doi: 42117.

Jackels, S. C. et al. (2014) 'GCMS Investigation of Volatile Compounds in Green Coffee Affected by Potato Taste Defect and the Antestia Bug', *Journal of Agricultural and Food Chemistry*, 62(42), pp. 10222–10229. doi: 10.1021/jf5034416.

Jaffee, D. (2012) 'Weak Coffee: Certification and Co-Optation in the Fair Trade Movement', *Social Problems*, 59(1), pp. 94–116. doi: 10.1525/sp.2012.59.1.94.

Jaffee, D. and Howard, P. H. (2010) 'Corporate Cooptation of Organic and Fair Trade Standards', *Agriculture and Human Values*, 27(May 2009), pp. 387–399. doi: 10.1007/s10460-009-9231-8.

Jahn, T., Bergmann, M. and Keil, F. (2012) 'Transdisciplinarity: Between Mainstreaming and Marginalization', *Ecological Economics*. Elsevier B.V., 79, pp. 1–10. doi: 10.1016/j.ecolecon.2012.04.017.

Johannessen, S. and Wilhite, H. (2010) 'Who Really Benefits from Fairtrade? An Analysis of Value Distribution in Fairtrade Coffee', *Globalizations*, 7(4), pp. 525–544. doi: 10.1080/14747731.2010.505018.

Kamwenubusa, E. and Guilleminault, D. (2013) *Rapport sur les revenus et les coûts de productions des acteurs de la filière café au Burundi*. London.

Keeler, L. W. et al. (2015) 'Utilizing International Networks for Accelerating Research and Learning in Transformational Sustainability Science', *Sustainability Science*. doi: 10.1007/s11625-016-0364-6.

Lang, D. J. et al. (2012) 'Transdisciplinary Research in Sustainability Science: Practice, Principles, and Challenges', *Sustainability Science*, 7, pp. 25–43. doi: 10.1007/s11625-011-0149-x.

Lemarchand, R. (1995) *Burundi: Ethnic Conflict and Genocide*. 2nd ed. Cambridge: Woodrow Wilson Center Press and Cambridge University Press.

Mansvelt, J. and Berg, L. D. (2010) 'Writing Qualitative Geographies, Constructing Meaningful Geographical Knowledges', in Hay, I. (ed.) *Qualitative Research Methods in Human Geography*. 3rd ed. Oxford: Oxford University Press, pp. 333–355.

Miller, T. R. et al. (2014) 'The Future of Sustainability Science: A Solutions-Oriented Research Agenda', *Sustainability Science*, 9(2), pp. 239–246. doi: 10.1007/s11625-013-0224-6.

Muhar, A., Visser, J. and Van Breda, J. (2013) 'Experiences from Establishing Structured Inter- and Transdisciplinary Doctoral Programs in Sustainability: A Comparison of Two Cases in South Africa and Austria', *Journal of Cleaner Production*. Elsevier Ltd, 61, pp. 122–129. doi: 10.1016/j.jclepro.2013.07.031.

Nduwimana, O. et al. (2013) *Cartographie de la fertilite des sols du Burundi et des besoins des principales cultures vivrieres en elements nutritifs*. Bujumbura.

Niragira, S. et al. (2015) 'Food for Survival: Diagnosing Crop Patterns to Secure Lower Threshold Food Security Levels in Farm Households of Burundi', *Food and Nutrition Bulletin*, 36(2), pp. 196–210. doi: 10.1177/0379572115587491.

Njoroge, R. et al. (2015) 'Transdisciplinary Processes of Developing, Applying, and Evaluating a Method for Improving Smallholder Farmers' Access to (Phosphorus) Fertilizers: The SMAP Method', *Sustainability Science*. Springer Japan, 10(4), pp. 601–619. doi: 10.1007/s11625-015-0333-5.

Nkurunziza, F. (2014) 'The Burundi Coffee Subsector Sustainability Challenges and Opportunities', *11th African Fine Coffees Association (AFCA) Conference*. Bujumbura.

Nzeyimana, I., Hartemink, A. E. and de Graaff, J. (2013) 'Coffee Farming and Soil Management in Rwanda', *Outlook on Agriculture*, 42(1), pp. 47–52. doi: 10.5367/oa.2013.0118.

Oketch, J. S. and Polzer, T. (2002) 'Conflict and Coffee in Burundi', in Lind, J. and Sturman, K. (eds.) *Scarcity and Surfeit: The Ecology of Africa's Conflicts*. Pretoria: Institute for Security Studies, pp. 84–156.

Pohl, C. and Hirsch Hadorn, G. (2007) 'The Principles in Brief', in Pohl, C. and Hirsch Hadorn, G. (eds.) *Principles for Designing Transdisciplinary Research*, Munich: Oekom, pp. 19–23.

Pohl, C. et al. (2010) 'Researchers' Roles in Knowledge Co-Production: Experience from Sustainability Research in Kenya, Switzerland, Bolivia and Nepal', *Science and Public Policy*, 37(4), pp. 267–281. doi: 10.3152/030234210X496628.

Ponte, S. (2004) *Standards and Sustainability in the Coffee Sector: A Global Value Chain Approach*. Winnipeg and Manitoba: International Institute for Sustainable Development (IISD), United Nations Conference on Trade and Development (UNCTAD).

Potts, J., Meer, J. Van Der and Daitchman, J. (2010) *The State of Sustainability Initiatives Review 2010: Sustainability and Transparency*. Winnipeg, Manitoba and London: International Institute for Sustainable Development (IISD) and International Institute for Environment and Development (IIED).

Potts, J. et al. (2014) *The State of Sustainability Initiatives Review 2014: Standards and the Green Economy*. Winnipeg, Manitoba and London: International Institute of Sustainable Development.

Raynolds, L. T., Murray, D. and Heller, A. (2007) 'Regulating Sustainability in the Coffee Sector: A Comparative Analysis of Third-Party Environmental and Social Certification Initiatives', *Agriculture and Human Values*, 24, pp. 147–163. doi: 10.1007/s10460-006-9047-8.

Regeer, B. J. and Bunders, J. F. G. (2009) *Knowledge Co-Creation: Interaction between Science and Society*. Den Haag: Advisory Council for Spatial Planning, Nature and the Environment (RMNO), pp. 1–131.

RESOLVE (2012) *Toward Sustainability: The Roles and Limitations of Certification*. Washington, DC.

Rhinehart, R. (2009) *What Is Specialty Coffee?* http://scaa.org/?page=RicArtp1, last visited 08-07-2015.

Rosenberg, L. (2017) *Turi kumwe (We Are Together): A Transdisciplinary Exploration of the Burundian Coffee Sector and Its Sustainability Challenges*. Stellenbosch University. http://hdl.handle.net/10019.1/103243

Rosenberg, L., Swilling, M. and Vermeulen, W. J. V. (2018) 'Practices of Third Wave Coffee: A Burundian Producer's Perspective', *Business Strategy and the Environment*, 27(2), pp. 199–214.

Rueda, X. and Lambin, E. F. (2013) 'Linking Globalization to Local Land Uses: How Eco-Consumers and Gourmands are Changing the Colombian Coffee Landscapes', *World Development*, 41(1), pp. 286–301. doi: 10.1016/j.worlddev.2012.05.018.

SCAA (2014) *SCAA Protocols: Cupping Specialty Coffee*. Santa Ana, CA: Specialty Coffee Association of America (SCAA).

Seijger, C. et al. (2015) 'Towards Practitioner-Initiated Interactive Knowledge Development for Sustainable Development: A Cross-Case Analysis of Three Coastal Projects', *Global Environmental Change*, 34, pp. 227–236. doi: 10.1016/j.gloenvcha.2015.07.004.

Sipos, Y., Battisti, B. and Grimm, K. (2008) 'Achieving Transformative Sustainability Learning: Engaging Head, Hands and Heart', *International Journal of Sustainability in Higher Education*, 9(1), pp. 68–86. doi: 10.1108/14676370810842193.

Snoeck, D., Zapata, F. and Domenach, A. (2000) 'Isotopic Evidence of the Transfer of Nitrogen Fixed by Legumes to Coffee Trees', *Biotechnology, Agronomy, Society and Environment*, 4(2), pp. 95–100.

Swilling, M. and Anneke, E. (2012) *Just Transitions: Explorations of Sustainability in an Unfair World*. Cape Town and Tokyo: UCT Press and United Nations University Press.

Thomas, I. (2010) 'Critical Thinking, Transformative Learning, Sustainable Education, and Problem-Based Learning in Universities', *Journal of Transformative Education*, 7(3), pp. 245–264. doi: 10.1177/1541344610385753.

Thompson Klein, J. (2004) 'Prospects for Transdisciplinarity', *Futures*, 36(4), pp. 515–526. doi: 10.1016/j.futures.2003.10.007.

Umuhire, I. B. (2013) *Daily Habits of Antestia Bur (Antestiopsis Spp.) in Caged Coffee Trees in Huye District, Rwanda*. National University of Rwanda, Huye, Rwanda.

UNDP (2014) *Human Development Report 2014: Sustaining Human Progress: Reducing Vulnerabilities and Building Resilience*. New York. ISBN: 978-92-1-126340-4.

USAID (2013) *Burundi Agribusiness Project: Final Report*. Maryland.

Uvin, P. (2009) *Life after Violence: A People's History of Burundi*. London and New York: Zed Books.

van Breda, J., Musango, J. and Brent, A. (2016) 'Undertaking Individual Transdisciplinary PhD Research for Sustainable Development', *International Journal of Sustainability in Higher Education*, 17(2), pp. 150–166. doi: 10.1108/IJSHE-07–2014-0107.

van Breda, J. and Swilling, M. (2018) 'The Guiding Logics and Principles for Designing Emergent Transdisciplinary Research Processes: Learning Experiences and Reflections from a Transdisciplinary Urban Case Study in Enkanini Informal Settlement, South Africa', *Sustainability Science*, 13(42), pp. 1–19.

van den Berg, H. and Jiggins, J. (2007) 'Investing in Farmers: The Impacts of Farmer Field Schools in Relation to Integrated Pest Management', *World Development*, 35(4), pp. 663–686.

van Kerkhoff, L. (2014) 'Developing Integrative Research for Sustainability Science through a Complexity Principles-Based Approach', *Sustainability Science*, 9(2), pp. 143–155. doi: 10.1007/s11625-013-0203-y.

van Leeuwen, M. (2010) 'Crisis or Continuity? Framing Land Disputes and Local Conflict Resolution in Burundi', *Land Use Policy*, 27(3), pp. 753–762. doi: 10.1016/j.landusepol.2009.10.006.

van Rijsbergen, B. et al. (2016) 'The Ambivalent Impact of Coffee Certification on Farmers' Welfare: A Matched Panel Approach for Cooperatives in Central Kenya', *World Development*. Elsevier Ltd, 77, pp. 277–292. doi: 10.1016/j.worlddev.2015.08.021.

Vellema, W. et al. (2015) 'The Effect of Specialty Coffee Certification on Household Livelihood Strategies and Specialisation', *Food Policy*. Elsevier Ltd, 57, pp. 13–25. doi: 10.1016/j.foodpol.2015.07.003.

Vermeulen, W. J. V. (2015) 'Self-Governance for Sustainable Global Supply Chains: Can It Deliver the Impacts Needed?', *Business Strategy and the Environment*, 24(2), pp. 73–85. doi: 10.1002/bse.1804.

Vermeulen, W. J. V. and Kok, M. T. J. (2012) 'Government Interventions in Sustainable Supply Chain Governance: Experience in Dutch Front-Running Cases', *Ecological Economics*, 83, pp. 183–196. doi: 10.1016/j.ecolecon.2012.04.006.

Vorrath, J. (2013) 'Challenges of Interviewing Political Elites: A View from the Top in Post-War Burundi', in Thomson, S., Ansoms, A. and Murison, J. (eds.) *Emotional and Ethical Challenges for Field Research in Africa: The Story Behind the Findings*. London: Palgrave Macmillan, pp. 57–69.

Walter, A. I. et al. (2007) 'Measuring Societal Effects of Transdisciplinary Research Projects: Design and Application of an Evaluation Method', *Evaluation and Program Planning*, 30(4), pp. 325–38. doi: 10.1016/j.evalprogplan.2007.08.002.

Watt, N. (2008) *Burundi: Biography of a Small African Country*. London: HURST Publishers Ltd.

Wickson, F., Carew, A. L. and Russell, A. W. (2006) 'Transdisciplinary Research: Characteristics, Quandaries and Quality', *Futures*, 38(9), pp. 1046–1059. doi: 10.1016/j.futures.2006.02.011.

Wiek, A., Withycombe, L. and Redman, C. L. (2011) 'Key Competencies in Sustainability: A Reference Framework for Academic Program Development', *Sustainability Science*, 6(2), pp. 203–218. doi: 10.1007/s11625-011-0132-6.

Wiek, A. et al. (2012) 'From Complex Systems Analysis to Transformational Change: A Comparative Appraisal of Sustainability Science Projects', *Sustainability Science*, 7, pp. 5–24. doi: 10.1007/s11625-011-0148-y.

Willetts, J. and Mitchell, C. (2017) 'Assessing Transdisciplinary Doctoral Research: Quality Criteria and Implications for the Examination Process', in Fam, D. et al. (eds.) *Transdisciplinary Research and Practice for Sustainability Outcomes*. New York: Routledge, pp. 121–136.

Willetts, J. et al. (2012) 'Creative Tensions: Negotiating the Multiple Dimensions of a Transdisciplinary Doctorate', in Lee, A. and Danby, S. (eds.) *Reshaping Doctoral Pedagogies*. London: Routledge, pp. 128–143.

Wilson, A. P. and Wilson, N. L. W. (2014) 'The Economics of Quality in the Specialty Coffee Industry: Insights from the Cup of Excellence Auction Programs', *Agricultural Economics*. Blackwell Publishing Ltd, 45, pp. 91–105. doi: 10.1111/agec.12132.

World Bank (2012) *Burundi: Diagnostic Trade Integration Study (DTIS) Update*. Washington, DC.

World Bank (2014) *Burundi*. http://data.worldbank.org/country/burundi, last visited 01-01-2015.

Wuelser, G. and Pohl, C. (2016) 'How Researchers Frame Scientific Contributions to Sustainable Development: A Typology Based on Grounded Theory', *Sustainability Science*. Springer Japan, 11(5), pp. 789–800. doi: 10.1007/s11625-016-0363-7.

10 Embracing transdisciplinary tensions on the road to 2030

Thomas Macintyre, Sjors Witjes, Sigurd Vildåsen, and Mónica Ramos-Mejía

10.1 Introduction

This chapter explores transdisciplinary (TD) research from the context of sustainability in social sciences, with the United Nations Sustainable Development Goals (SDGs) as a backdrop. We consider this contribution to come at an important time. As we write these words, reports are streaming in as to the state of the world: humanity has wiped out 60% of animal populations since 1970 (Grooten & Almond, 2018); inequality is increasing in almost all regions of the world (Alvaredo, Chancel, Piketty, Saez, & Zucman, 2018); and 'rapid, far reaching and unprecedented changes in all aspects of society' are needed to limit global warming to 1.5°C (IPCC, 2018). Although there is an increasing realization that both personal and collective transformation must take place for such change to happen (O'Brien, 2012), the question of our time is *how* such transformations will take place.

In light of the 'wicked' nature of ever changing and complex sustainability challenges (Andersson & Törnberg, 2018; Rittel & Webber, 1973), there is an increasing recognition of the importance of encouraging the participation of non-academic actors in TD research. This enables actors who are not part of the dominant (Western) knowledge systems to contribute to the outcome of the sustainability-oriented research process, i.e. TD research enables them 'to be deliberately included in the future' (Arnstein, 1969, p. 216). This connects to the ambition of 'fairness-driven transdisciplinarity', as outlined in Chapter 2 of this book.

Yet such fairness-driven transdisciplinarity, characterized by focusing on the empowerment of often marginalized actors, is situated in environments with strong structural and systemic barriers to realizing more sustainable outcomes through participatory research. At the root of such barriers are unequal power relations between actors, which bring about a 'ladder' of varying degrees of stakeholder participation (Arnstein, 1969), whereby different relationships between actors result in different levels of participation. The main argument of this chapter is that there is a need to surface and address underlying tensions in conducting sustainability-oriented TD research, brought about by the underlying power differences inherent in multi-stakeholder environments. Confronting such tensions is a means to recognize the diverse perspectives, values and knowledge systems in society, contributing to TD as a more reflexive practice for sustainability.

In the following section, we begin by exploring TD research tensions through individual co-author narratives, answering the question of how underlying assumptions involved in TD research can affect the research process. In section 10.3, co-authors compare these approaches, with a specific focus on how such TD approaches can lead to enhanced sustainability outcomes in the context of the SDGs. Throughout these sections, the co-author narratives interact with one another in a dialogical way, signifying a conversation between authors on their differing experiences and points of view in TD research, balancing their personal experiences with generalizable observations. These sections represent more of a discussion forum at a conference than conventional paper, but the style mirrors what we as researchers and authors consider to be the multi-stranded and diverse approaches to TD research. In section 10.4, we collectively analyze our narratives through the conceptual lens of paradox theory, highlighting the nature of the tensions in knowledge co-production between academic and non-academic actors, as well as challenges of bridging the gap between theory and practice in addressing the 2030 agenda for sustainable development put forward by the United Nations. We hope that the conversational style and multiple voices in the chapter encourage the reader to critically engage with the issues raised, while keeping in mind that the questions have no final answers, and that this is an ongoing and evolving conversation.

10.2 Carrying out transdisciplinary research in the field

10.2.1 Thomas Macintyre, community-based research in Colombia, South America

Situated in the discipline of education for sustainable development, my research is focused on the role of *learning* in addressing climate change and sustainability. I am inspired by decolonial approaches to education (Grosfoguel, 2011; Le Grange, 2016) and how the generation of learning ecologies within the framework of TD emphasizes the multiple forms of learning across different sectors of society (Maina & González, 2016; Siemens, 2007; Wals, 2019; Westberg & Polk, 2016). As a TD researcher who is sceptical of mainstream higher education, I am particularly interested in how to co-produce knowledge *together* with grassroots initiatives and communities, contributing to epistemological justice (Hall & Tandon, 2017). My research is part of, now completed, an international project called T-Learning, which focussed on reframing dominant narratives in education and learning (Lotz-Sisitka et al., 2016).[1] Specifically, I was the lead researcher in the Colombian case study, based on participatory action research (PAR), where our team employed Transformation Labs to generate action-based change (see Macintyre et al., 2019).

A characteristic of this PAR methodology is the close collaboration with members of grassroots initiatives in Colombia who are acting in the capacity of co-researchers in the T-Learning project. From my perspective, TD research encourages the transgression of dominant paradigms and the exploration of novel collaborations between researchers and society. In line with fairness-driven

transdisciplinarity, I see an underlying assumption of TD research to be the validity of different knowledge systems, while at the same time appreciating that knowledge is unstable, contested and only ever scratching the surface of how we understand the world (de Sousa Santos, 2016). Confronting such uncertainty requires creativity and innovation, with a strong focus on working together with people, communities and ideas that often seem foreign to us. Below I present an anecdote from fieldwork which highlights the tensions involved in putting these lofty aspirations into practice.

Textbox 10.1 Personal narrative by Thomas Macintyre

It was a cold morning in the Ecovillage of Aldeafeliz, situated one hour from the Colombian capital of Bogota. After three days of participatory methodology workshops, with few hours of sleep, I was exhausted. But I was also excited. As part of a Transformation Lab we were conducting with co-researchers, Andres from the initiative Colectivo Talanquera was sharing with us an 'Indigenous technology' of energetic cleansing. In the damp morning dew, sitting on big stone overlooking the eco-village, Andres explained the ancestral practice of rubbing small balls of organic cotton between our fingers, concentrating on imparting our negative energy into the cotton which was then 'planted' into the earth as an offering to Mother Earth. Despite having participated in such rituals before, I was still struggling to move away from the cognitive level of these exercises, to really give myself up to the 'silent knowledge', as Tatiana Monroy from Aldeafeliz calls the connection with the non-rational and emotional world. Put simply, I felt disconnected to this 'umbilical cord' to Mother Earth. As I sat on the stone, feeling cold and tired, I looked around at the co-researchers, all with eyes closed and looks of contentment. Many of them are leaders in their communities, navigating complex community dynamics in the search for social and ecological justice. 'How are they able to connect?' I wondered to myself. 'What have they experienced that I have not?' How can academics like myself engage in research contexts which we do not understand?

The above anecdote shows how working with people across different sectors of society has the power to disrupt our comfort zone, helping sustainability academics and practitioners to reflect critically on who we are and our roles in society. The anecdote also demonstrates that TD research in practice is often challenging. On the one hand is the perennial challenge in action research of bridging the institutional requirements of a scientific investigation with the realities of community co-researchers in terms of time, motivation and economic resources (Herr & Anderson, 2014). On the other hand is the ethical dilemma of whether the underlying knowledge constructions of many grassroots communities have more to teach higher education institutions than the other way around. In my narrative

earlier, as I sat on that rock twirling the cotton balls, trying to move beyond the cognitive so as to understand and learn this ancestral technique, no number of lectures or books could have prepared me for this situation. I was left wondering: what really was my role as a researcher?

10.2.2 Sigurd Vildåsen: corporate sustainability in Norway

Positioned in the field of corporate sustainability (CS), I have a particular interest in tensions and paradoxes stemming from conflicting requirements between social, economic and environmental demands (Hahn, Figge, Pinkse, & Preuss, 2018; Van der Byl & Slawinski, 2015). The role of tensions is an interesting topic for discussion in the TD field in general, as exemplified by Thomas Macintyre's account earlier of how TD insights challenge the classical perception of societal actors, and especially the role of higher education. As a way to embrace tensions emerging in real-life projects, and inspired by the work of Lang et al. (2012), I ground my TD research on the assumption that companies must be involved in both designing the research questions introduced by academia and providing inputs to the knowledge creation process. This connects well with the ambition of solution-oriented transdisciplinarity (as presented in Chapter 2), whereby stakeholder involvement is extended, in this case, to include industry representatives.

In the period of May 2014–May 2018, I was involved in a TD research process involving academia, the business sector, governmental organizations and NGOs. This was anchored in the project Sustainable Innovation and Shared Value Creation in Norwegian Industry (SISVI).[2] My research activities were performed in close dialogue with representatives from the company Plasto – a small manufacturer of plastic components – that contributed approximately 5% of the total funding of the SISVI project. In the period of September 2016–May 2017, Plasto's representative attended a workshop series with the title 'SDGs – Learning by Doing', organized by the Polytechnic Society of Norway. Moreover, Plasto committed to discussing the SDGs in its management group, with the purpose of identifying the most relevant goals as seen from the company's perspective. Below I present an anecdote from this collaborative process.

Textbox 10.2 Personal narrative by Sigurd Vildåsen

In June 2016, I became involved with the board of the Polytechnic Society, a non-profit organization working to promote the SDGs in Norwegian industry. For me, this was an interesting opportunity to link my collaborative research with the company Plasto to a broader network of actors. Plasto's representative found the initiative promising, but he emphasized the company had to evaluate every extra activity critically due to a challenging market situation. However, to my surprise, he was able to commit the top management group and ran two internal workshops to draw on their viewpoints and experiences in applying the SDGs framework.

In December 2016, the Plato representative presented their lessons learnt at a meeting at the Polytechnic Society, where other companies also shared their experiences. Plasto's main message was that a company, in principle, affects and is affected by all 17 goals, but this insight is challenging to apply in a practical context. For this reason, Plasto had decided to prioritize goals nr. 9 (industry, innovation and infrastructure), 12 (responsible consumption and production), 14 (life below water) and 17 (partnerships for the goals) in their further work. Moreover, they had established concrete targets, for example, with regard to using recycled materials in their production process.

After this interesting meeting, I started to ponder the following paradox: the SDGs are meant to represent a holistic framework, but companies state that it is impractical to work with all the goals at the same time. Is it feasible for companies to work on all SDGs in an integrated manner? How can a company combine the practical need to focus on a few goals while at the same time ensuring credibility in their efforts by adopting a holistic perspective?

One of my underlying assumptions in the collaboration with Plasto was that my role as a researcher was to observe and analyze the activities of the company, acknowledging that this process will always influence decisions and perceptions of company representatives. Indeed, it is evident that I have influenced organizational actors since they were previously unaware of the SDG framework. However, 'objectivity' is not possible, nor is it an ideal, when conducting TD research (e.g. Lang et al., 2012). The researcher and practitioner interact and are active contributors in a relationship, in this case co-developing research questions, which in turn shapes concrete activities and the decisions undertaken in the project.

I acknowledge the risk that my role as a 'critical' researcher could be blurred because of my close collaboration with the company. An example is a dilemma which developed for me, concerning the SDG prioritizations by Plasto. The company Plato chose to focus on a subset of the goals, which many would argue is a limitation since the framework is based on holistic considerations of all the 17 goals. However, my emphasis was to introduce them to a step-by-step approach based on gradual learning on how to work with the framework. This is in line with my TD assumption that my role as a researcher is not to provide the 'right' answers, but to encourage learning and experimentation. Although my research covers all three main TD ambitions, the limited scope of the contribution of one organization on the sustainable development of society means that my research should be seen as small-range TD (as presented in Chapter 2).

10.2.3 Mónica Ramos-Mejía: community-based research and corporate sustainability in Colombia, South America

Situated in the field of corporate sustainability (CS), I am interested in understanding the role of entrepreneurs in fostering sustainability transitions (Grin,

Rotmans, & Schot, 2010; Witkamp, Raven, & Royakkers, 2011). In this context, grassroots entrepreneurs act as niche innovators capable of transforming production–consumption systems into more sustainable assemblages from the bottom-up (Seyfang & Smith, 2007). Sustainability transitions researchers have frequently engaged in collaborative experiments with communities and local governments, aiming for novel socio-technical solutions (Luederitz et al., 2017). These experiments are usually solution-oriented and entail TD research.

As mentioned by Sigurd Vildåsen earlier, non-academic actors are interested in finding solutions to their own contexts when getting involved in TD research. This contrasts with conventional explanatory academia whereby research findings should either contribute to, or challenge, current debates in the literature. Conventional research requires rigorous data collection and analysis and is often understood as a well-defined linear process driven by a research question that originated from a research gap (Creswell & Creswell, 2017). This difference can be seen in the following anecdote taken from my fieldwork in Colombia.

Textbox 10.3 Personal narrative by Mónica Ramos-Mejía

'Everything you've said sounds very beautiful, but it's a world away from what works here'. This is what an ecopreneur[3] told my colleague who was 'teaching' environmental management strategy at a training course aimed at developing business models for sustainability in rural Colombia. My colleague has had a brilliant academic career in corporate sustainability; however, despite her knowledge and experience, her points were considered out of context and thus irrelevant.

The opening remark was an eye-opener for the research group I am part of, and invited a discussion into what knowledge is and who it is for: if knowledge is not useful for a group of people in specific circumstances, does it mean that this knowledge is not valid? Or does it mean the knowledge is not being appreciated? How can we co-produce knowledge that is scientifically valid and contextually relevant and useful?

The questioning attitude of the ecopreneur mentioned earlier inspired a two-year process aimed at co-creating ecopreneurial ventures,[4] in which an interdisciplinary team from the University of Twente (UT), the Netherlands (in which I was involved as doctoral researcher), worked together with grassroots innovators in Colombia to understand the local dynamics, resources and values underlying the innovation process.

The co-creation process that unfolded was characterized by a knowledge dialogue in which grassroots innovators and academic researchers entered a reflection process that created room for translation between different realities and expectations. For instance, the rural energy enterprise on which one of the ecopreneurs was working developed a business model that reflects a combination of context-specific knowledge related to community-based

organizational management and academic knowledge related to solar energy technologies for storage and distribution.

Throughout the process, ecopreneurs used the concepts and tools they learned as resources to bring new technologies and social practices into the local landscape, with the deliberate intention of igniting changes towards sustainability. Similarly, the UT team experimented with innovative academic methods, strengthening its capacity to carry out transdisciplinary research.

From my experience working with grassroots innovators, conventional research was indeed 'a world away' from their daily lives. Grassroots innovators were not interested in sustainable business model literature, but rather in how to develop business models that corresponded to their environmental and social concerns, while being feasible in the marketplace. As scholars, we were well informed about the debate but lacked the experience of facing the everyday challenges that an ecopreneur has to deal with. The ecopreneurs working with us, on the other hand, were too busy sorting out everyday challenges to have the opportunity to adopt available knowledge to solve their problems.

To address this research disjunction, the Dutch and the Colombian teams decided to engage in a co-creation process, facilitated by design science research methods. This design process is experimental in nature, whereby the purpose is not to design one single solution, but many alternatives for action (Ramos-Mejia, 2018). This process highlights the insider's perspective rather than the observer's on the problem-solving process, meaning that the knowledge that seemed very distant for the ecopreneurs was translated and reinterpreted by them into local realities. This highly participatory process is also iterative, making room for cycles of action and reflection, which is a key aspect of the process (Ramos-Mejía & Balanzo, 2018). Sitting together to reflect on what happens throughout the project loosens the tension related to the outcome of the research process. Furthermore, as mentioned in Textbox 10.3, both academic and non-academic researchers contributed to creating novel business models responding to context-specific sustainability challenges. We can, therefore, understand this form of TD research to combine a solution-oriented process as well as a fairness-driven ambition to transform the forms of collaboration between the different academic and non-academic stakeholders.

10.2.4 Sjors Witjes, corporate sustainability researcher in Europe and Latin America

Situated in the discipline of corporate sustainability (CS), my research is focused on reflexive learning concerning the integration of sustainability in organizational systems. As organizations are accountable for their sustainability performance, I am motivated by accompanying the process of reflecting on interventions in

the organizational system aimed at enhancing sustainability performance (see, for example, Jansen, Tempelaar, van den Bosch, & Volberda, 2009; O'Reilly & Tushman, 2013). Inspired by the engaged scholarship of Van de Ven and Johnson (2006), I reflect on sustainable practices with organizational members, bringing together their practical knowledge with my academic knowledge and aiming for enhanced awareness and knowledge on how to improve the organization's sustainability performance (Eccles, Ioannou, & Serafeim, 2014; Maletič, Maletič, Dahlgaard, Dahlgaard-Park, & Gomišček, 2016).

As a teacher dedicated to preparing future generations for their role in society, I am particularly motivated to integrate students from different academic levels in the CS reflection process (Schulz, Finstad-Milion, & Janczak, 2018). Below, I present an anecdote from my research which highlights the tensions involved in putting this into practice.

Textbox 10.4 Personal narrative by Sjors Witjes

I have just received an email from a dairy company requesting academic reflections on the integration of sustainability into their organizational system by offering an internship for a master's thesis student. The development and supervision of participatory action research on corporate sustainability at a master's level enables me to build bridges between the corporate and academic worlds. Although companies should take responsibility for their (un)sustainable actions, or pay for it by hiring additional staff or external consultants, I see a huge opportunity of combining the preparation of students for their future role in society with participation in a research project that aims at generating meaningful outcomes for the company as well as the production of knowledge contributing to debates on corporate sustainability. Furthermore, small-scale research projects based on master's theses have the potential to enhance a company's understanding of the added value of scientific research for improving corporate sustainability performance that could lead to bigger research projects in the future. Although academic–corporate research collaboration could create alternative funding schemes in a Dutch academic world experiencing reduced governmental funding for scientific research, it does generate tensions between knowledge production and the need for financial support. Although the outcome of the research project is used to reflect on improving corporate sustainability performance, there is the disconcerting risk of the research being used for corporate 'greenwashing': in exchange for a company accepting academic research, the collaboration with a university can be used to show that the company is dealing with sustainability. Although I have signed many non-disclosure agreements to ensure that I do not pass on company data, I have never requested a company sign an agreement to ensure ethical use of research outcomes. How can I be assured that the collaboration

between business and academia leads to meaningful change, and not just window dressing for both actors? Although I trust my experiences with previous projects, and the positive appraisals from my company contacts as well as my academic counterparts, increasing academic/non-academic research collaborations raise ethical as well as practical tensions which must be addressed.

My research is based on a practical question from an organization wanting to improve its contribution to the sustainable development of society. Faced with complex and wicked problems in society, companies must decide whether or not to embed their contribution to these problems into their organizational system. I aim at understanding and facilitating the integration process of CS into business activities that can lead to CS becoming an added value with respect to corporate goals (see Witjes, 2017; Witjes, Vermeulen, & Cramer, 2017). By applying participatory action research (PAR), the data gathering process is combined with supporting the company in making CS an integral part of their daily business activities and, simultaneously, enabling the feedback of research outcomes between researchers and the company (Lang et al., 2012). This continuous reflection process is used to validate the research outcomes, as well as to encourage corporate self-reflection on CS as an added value to a corporation's future goals.

The collaboration between the researcher and the company in preparing and executing the research process is based on two assumptions (Schaltegger & Beckmann, 2013): first, the company understanding and accepting the scientific method and research process as an added value resulting in corporate self-reflection. Second, the researcher understanding the day-to-day life in a company as a source of data. As illustrated in Textbox 10.4, however, this collaboration can result in undesired outcomes: students carrying out menial jobs like cleaning floors for the company, or companies enlarging research outcomes for marketing purposes. With these undesired outcomes being an inevitable part of working in a diverse team of actors with pluralistic views on specific situations, a TD team of academic and non-academic actors guarantees the existence of conflict (Stokols, 2006). During my TD research, creative conflict management has been a central challenge through the acknowledgement that suppressing situations of conflict does not enable the freedom needed for exchanging knowledge between the different actors in the process of reflection (Cundill et al., 2019; Van de Ven & Johnson, 2006).

Although corporate–academic collaboration can enable the CS scholar to be actively involved in transforming corporate society, the dilemma is that it can reduce the need for companies to take full responsibility for their potentially unsustainable behaviour. From a methodological perspective, my TD research also contributes to the challenges of scientific knowledge creation, exploring how a reflection process between academic and non-academic actors can lead to decision-making on the integration of CS into organizational systems. As is the

case with the research of Sigurd Vildåsen, my research covers all three main TD ambitions; the limited scope of the contribution of one organization on the sustainable development of society means that my research should be seen as small-range TD (as presented in Chapter 2).

10.3 Comparing TD concepts and approaches in the context of the SDG framework

In this section, we will compare our TD approaches and assumptions in the context of the SDGs. The agenda 2030 SDGs provide an ambitious global agenda aiming to 'free the human race from the tyranny of poverty and . . . to heal and secure our planet' (United Nations, 2018). With 17 goals aimed at transforming society in the fields of poverty, inequality, climate, environmental degradation, prosperity and peace and justice, the SDGs provide a shared framework for addressing global sustainability challenges. While Sigurd Vildåsen and Thomas Macintyre discuss the relative versus more critical perspective to approaching the goals individually, highlighting a few goals for focus, Sjors Witjes and Mónica Ramos-Mejía focus on the goals as a framework, reflecting on their use from a wider perspective.

10.3.1 Sigurd Vildåsen: the SDGs help link local challenges to global challenges

The SDGs and the Agenda 2030 framework address a broad array of societal issues, giving space for a large set of actors to converse, collaborate and disagree. Thus, the role of the TD researcher in such a context is especially interesting. Interactions between academia and SDG practice entail a special role for the researcher, for example, by actively critiquing the behaviour of industrial companies based on their sustainability performance. That being said, such critical distance must be balanced with the TD principle of treating stakeholders' worldviews as knowledge inputs (e.g. Lang et al., 2012). We do not own the truth as researchers and scientists when operating in the TD domain: we are legitimate actors in an ongoing knowledge debate.

In practice, actors in a decision-making setting framed by the SDGs typically represent different interests. In a workshop I co-organized in October 2017, as part of the Polytechnic Society, I observed a representative from the organization Transparency International promoting goal number 16, which deals with accountable institutions, as a way to counteract corruption. In the same meeting, several business representatives talked about goal number 12, focusing on the issue of responsible production and consumption. What I learned is that actors tend to promote a few goals linked to their own organizational interests. This creates a setting defined by negotiations, with each participant arguing their viewpoints.

Interestingly, even though actors promote different interests, it is possible to link their lines of reasoning. This can be accomplished, for example, if a workshop facilitator emphasizes a holistic understanding of the framework during

discussions. Indeed, the role of actors collaborating based on a common platform is reflected in SDG number 17, which focuses on the partnerships between governments, the private sector and civil society to reach sustainability outcomes. In my research, SDG number 17 was used actively by companies and other actors in the private sector, to facilitate collaborative projects. I have experienced the framework as a means for myself to ease the communication with Plasto's representatives through linking the local activities of Plasto to global societal challenges.

10.3.2 Thomas Macintyre: the SDGs are meant to be critiqued and reframed according to local contexts

Negotiating worldviews and visions of future activities is one of the biggest challenges for reaching the SDGs, and top priority for TD research and researchers. Despite the usefulness of the SDG framework in concentrating the world challenges in concrete themes, as Sigurd Vildåsen mentions earlier, it is important to note that the SDGs are built on certain underlying assumptions. For example, goal number 8 states 'decent work and *economic growth*', which is a contentious assumption given finite global resources (Jackson, 2009). With my own interest in more radical forms of learning which transgress inbuilt sustainability barriers, I therefore see fairness-driven TD research as a means to bring together different people and perspectives to discuss, critique and reframe the SDGs according to local contexts and needs. Alongside a systems approach in implementing the SDGs (Reynolds, Blackmore, Ison, Shah, & Wedlock, 2018), there is a need for a decolonial approach to sustainable development and transdisciplinary research (Chilisa, 2017).

This differs to Sigurd Vildåsen's approach in which actors connect their interests to specific SDGs and argue their own interests, rather than taking a critical look at the power relations and assumptions inherent to the different actors. Rather than a relativist approach where everyone holds the truth, I think it is important to take a more disruptive and critical approach, generating discussion about the extent to which, for example, a company's focus on only a few SDGs can address underlying structural barriers to addressing sustainability, in line with fairness-driven transdisciplinarity.

However, as my own experience on that rock on the eco-village demonstrates (see Textbox 10.1), although we may want to understand and experience other realities, we each hold entrenched values and ways of understanding the world which are difficult to transgress. To move effectively towards the SDGs, I believe we need to negotiate differing interests while attempting to disrupt our own ways of thinking so as to better empathize with those we find it difficult to connect with.

10.3.3 Sjors Witjes: the SDGs require the continuous feedback between actors

I see the dominant paradigm of growth as a rooted belief in the corporate world. With corporate growth mainly reflected by key performance indicators representing quantifiable corporate processes impacting the SDGs, it distracts attention from

qualitative social outcomes of informal processes, such as those represented by SDG 17. This relates to the tension of research 'greenwashing' based on quantifiable results, without considering qualitative outcomes. To avoid the potential abuse of outcomes, the aim of my research is to accompany companies in reflecting on their past and current sustainability performance from a quantitative and qualitative perspective in order to establish a more realistic strategy for improved future performance. In this way, my TD research approach can also be seen as corporate support, as the research outcomes can also be used to improve corporate performance and, therefore, to contribute to SDG 12 on sustainable consumption and production. From a TD ambition perspective (see Chapter 2), I work from a problem orientation through an inter-academic solution orientation towards enhanced fairness within a limited, organization-oriented scope. The contribution to knowledge creation in the integration of CS in organizational systems, as well as the organization of reflection between academic and non-academic actors on strategic decision-making processes for CS integration enables me to generalize outcomes and upscale my research scope from an organization focus. This is achieved via a sector or supply chain focus (see for example Witjes & Lozano, 2016), linked to a societal scope on the regional, national (see Sartori, Witjes, & Campos, 2017) or international level.

To ensure legitimacy of my research within the academic world, the participatory action research method I apply includes continuous feedback between meaningful outcomes for practice, and knowledge created by a continuous collaboration between academics and non-academics for a broader perspective such as for science. By providing tools for companies to reflect on their sustainability performance, my research aims at changing the dominant paradigm in organizations from corporate growth towards a new development paradigm prioritizing the environment of which we all are part (Nobre et al., 2016). I also see an important role for academia to enhance critical reflections in collaboration with non-academics aiming for the SDGs, and support companies to improve their contribution to a more sustainable society while being attentive to the possibilities of companies abusing research outcomes for 'greenwashing'.

10.3.4 Mónica Ramos-Mejía: the SDGs must be translated and contextualized to co-create knowledge

Although there is general agreement on the desirability of the SDGs and their specific targets, there is little agreement on the means of achieving them. One of the reasons for this is the disconnection between dominant forms of knowledge and local realities. As I mentioned in Textbox 10.3, mainstream Western knowledge may be alien for local realities in the Global South. When single knowledge systems prevail, solutions are usually neither relevant nor feasible for local contexts. In this particular case, the assumptions and values that shaped the contents of the environmental management workshop did not match the context of our co-researchers. The contents had been developed for wealthier and more formal economies, operating under formal rules. The context of our co-researchers was characterized by informality and insecurity.

Like Sjors Witjes mentions here, TD research helps surface these differences through continuous and reflexive dialogue, where knowledge is not being 'transferred' from the academic to the practitioner team, but translated and contextualized between actor groups. Following Sjors' argument about organizations working towards inclusiveness towards contributing to the development of society, I would argue that something similar happens with communities when they engage in a TD research process. TD research creates spaces for knowledge forms to interact, even if this can be disruptive and confusing, like Thomas Macintyre emphasizes in his section.

In my case, the example of the rural solar-energy community-owned company demonstrated that despite the inefficiencies according to conventional key performance indicators in the sector, the cycles of action and reflection that emerged throughout the TD process made possible the translation between different knowledges, realities and expectations, resulting in solutions that were feasible according to local resources and capacities. This solution-driven and co-created knowledge is what could enhance sustainability outcomes in the context of the SDGs.

10.4 Discussion: TD approaches in knowledge co-production and action

In the previous section, we compared different approaches to conducting TD research among the co-authors, and the assumptions these approaches are based on. The common thread between the previous narratives is the inherent tensions involved in integrating knowledge from various scientific and societal groups, and translating this knowledge into meaningful action. This has been explored from the perspective of community-based learning in Colombia, and corporate sustainability in Northern Europe. In this section, we carry out a collective discussion on how our disciplinary TD approaches can inform a more reflexive form of research through highlighting and addressing unequal power relations between actors, thus generating meaningful societal outcomes through embracing TD tensions.

To do this, we will employ a paradox lens to explore how surfacing and addressing tensions are generative of new ways of understanding wicked sustainability challenges. Rather than juxtaposing opposite views, which can be weighed against each other, paradox theory takes a holistic approach, acknowledging that contradictory elements are interrelated and can be dealt with through cyclical responses (Smith & Lewis, 2011). In line with earlier work on paradox theory by sustainability-oriented scholars (Hahn et al., 2018; Van der Byl & Slawinski, 2015), the following three sections each present a discussion of paradox having arisen in the previous sections.

10.4.1 Trying to be participatory risks replicating inbuilt unsustainable structures

Academic education is considered a key contributor in shifting the mindsets of individuals and society towards more sustainable forms of living (Wiek, Farioli,

Fukushi, & Yarime, 2012). At its best it promotes critical thinking and reflection. Yet in an age of climate change scepsis, of which the extent of human-induced global warming is illustrative, science as a bedrock of progress is in question. As Sjors Witjes mentions in section 10.2.4, academic institutions are receiving less government money and having to forge alliances with the private sector, which is problematic in terms of negotiating competing interests. From a higher education perspective, Thomas also critically reflects on the limits of what is taught at the university, in comparison to life skills learnt out in the field. With decreasing funding and legitimacy concerns, academia is in desperate need of reinventing itself as a useful actor in society.

As transdisciplinary scholars, we as co-authors have shared the methodology of participatory action research as a means to actively engage *with* stakeholders and promote the co-creation of knowledge and action-based change at the local level. Yet a paradox evident in the narratives here is the extent to which our research really is *participatory*. The underlying assumption is that knowledge is a co-production process, relevant to both academia and non-academic partners. But what do we give back to our non-academic partners through our investigation? And how much are they actually participating in the research process? Participation, both as a concept and as practice, addresses a broad range of actor involvement aiming at the redistribution of power. It goes from 'the empty ritual of participation' where power-holders are enabled to 'educate' or 'cure' the participants to having the real power to affect the outcome of the process by way of high degrees of decision-making (Arnstein, 1969, p. 217). As Thomas Macintyre's anecdote illustrates, rather than a co-production of knowledge, the researcher was the one left confused, wondering what his role was in the community setting. Ignoring such unsettling encounters and only writing in academic journals about what experts know and understand risks replicating inbuilt unsustainable societal structures, with less tangible and unknown phenomena marginalized in favour of dominant sustainability discourses. Much like the 'greenwashing' Sjors Witjes writes about in section 10.3.3, reflecting on such paradoxes encourages us to question our own assumptions and worldviews. This is highlighted by Mónica Ramos-Mejía's anecdote, which shows how projects which bring academia and grassroots communities together have the potential for an intervention to be contextualized, and required skills and technical tools provided by outside actors (see Lantz, Viruell-Fuentes, Israel, Softley, & Guzman, 2001).

10.4.2 By trying to be contextually relevant we question the scientific validity of TD research

The experiences brought by the co-authors here show the tension between scientific validity and contextual relevance. The former refers to robust methodologies and fluent dialogue with existing literature. The latter refers to practice-related challenges in specific contexts. Often, they do not match, which results, for example, in the practice-component being either overlooked or oversimplified by scientific approaches and conceptualizations.

The paradox arises when focusing on both the goals of scientific validity and contextual relevance. On the one hand, when a research project is transdisciplinary in terms of people, disciplines and fields, and directly related to the local context, there are more perspectives and, therefore, a more precise look into reality. However, the more diverse the group, the more difficult it is to agree on the process of co-designing, co-implementing or co-analyzing the results in a scientific way (Akpo, Crane, Vissoh, & Tossou, 2015). On the other hand, although non-academic actors often feel more comfortable with simple and easy-to-picture models, complex theoretical frameworks are better suited to embrace more detailed data: the simpler the model, the more variables it overlooks or keeps as constants. This is particularly relevant to contextualizing research, where looking at spaces, scales and places (Truffer et al., 2015) or at the institutional diversity (Ramos-Mejía & Balanzo, 2018).

The generative aspect of this paradox lies in the fact that it is precisely this tension that nurtures TD research. If a TD group manages to deal with such difficulty, it is more likely that innovative methodological approaches are developed, as well as more comprehensive results achieved. For example, in the research project mentioned by Mónica Ramos-Mejía in section 10.2.3, the process became more relevant to the community involved when the academic members of the team stopped analyzing each case separately from their own perspective, and started having meetings together to carry out the analysis collaboratively, creating a dialogue that transcended disciplinary boundaries.

10.4.3 By trying to be collaborative, we risk not being credible in TD research

The SDGs framework has become popular in societal discourse, and most people would agree that it helps focus attention on global sustainability challenges. However, critics such as Spangenberg (2017) argue that the lack of formal obligations leaves too much navigational space for individual companies to take full responsibility for their actions. As Sigurd Vildåsen's narrative illustrates, the application of the SDGs among companies tends to be at a high level of abstraction without clear linkages to daily operations. Along the lines of Sjors' reasoning, it is questionable whether the popularity of the SDG framework in the business sector is something that benefits society as a whole through actual results, or whether it is a means of avoiding stricter legislation by signalling future actions in a collaborative though uncommitted manner.

Within this issue is the paradox between *creatively* bringing diverse actors together to address shared challenges, and the *credibility* of such collaboration resulting in action-based change. On the one hand, the SDG framework provides a common frame of reference upon which diverse actors can agree upon, in line with a pluralist epistemology (Vildåsen, Keitsch, & Fet, 2017). As Sigurd Vildåsen argues, this enables creative learning processes, where for example business representatives can meet with NGOs to share social and environmental issues in a constructive manner. In many cases, companies do not have the competencies and

motivation to evaluate SDG issues from a societal perspective, which places an important role on researchers to facilitate learning in TD contexts. On the other hand, discussing the SDGs in themselves does not lead to actual change, and the related multi-actor debate can result in superficial statements without committed agreements. Thomas shares his scepticism of companies only choosing a few SDGs to focus on, instead of focusing on the deeper systemic change to which he feels the SDGs aspire, and which are needed in society. The related knowledge stemming from such processes risks a lack of credibility whereby actions and measures signalled by companies are difficult to verify.

This paradox can be seen as an invitation to both academic and non-academic actors to be bolder in exploring innovative solutions to societal challenges. As all authors have stressed, tensions are natural to all collaborations between academic and non-academic actors. Beyond limited time and resources (Schaltegger & Beckmann, 2013), sources of tension include conflicting assumptions and worldviews. The important aspect is to promote critical and reflective thinking through engaging in learning and feedback between diverse actors (Cash et al., 2003). This involves challenging company representatives in how they understand the relationship between SDGs and corporate goals, and to challenge the TD researcher to explore creative research methods, which capture the collaborative spirit but are also scientifically credible and meaningful to society. In this way, in the words of Sjors Witjes, we can promote a paradigm shift from business-as-usual towards more inclusive and creative approaches towards developing more sustainable societies.

10.5 Reflecting on how to embrace TD tensions on the road to 2030

The four co-authors of this chapter have embarked on an experiment in collaborative writing in which we have seen messy sustainability challenges as an opportunity to contribute to the TD debates around the need for more inclusive and reflective societies (Smith & Lewis, 2011).

Through the multiple voices of the co-authors, we have explored how underlying assumptions involved in TD research affect the research process. The authors are in general agreement about highlighting the plurality of epistemologies present in society, highlighted by Sigurd Vildåsen noting that 'nobody owns the truth'. For this reason, it is important to accept the knowledge domains of other actors (Wiek, Withycombe, & Redman, 2011), as highlighted by Sjors Witjes in the need for companies and researchers to accept each other as valuable sources of information.

The narratives here, however, show that in practice this is complicated. Thomas Macintyre struggles with understanding the 'silent knowledge' being explored with co-researchers, questioning his own contribution to the community he is studying, while Sigurd Vildåsen is left to consider the extent to which the company he is collaborating with will put the SDGs into actionable change. Sjors Witjes feels a tension with how student research(ers) will be utilized by companies.

Taking the disconnection between academic and non-academic actors as a starting point, Mónica Ramos-Mejía's narrative emphasizes the TD assumption that research should be solution-based, and shows how this assumption drives a desire for participatory action research, a methodology shared by all co-authors, which can address local contextual problems.

The question as to *how* such TD research can lead to enhanced sustainability outcomes produced more nuanced narratives among the authors. Sigurd Vildåsen stresses that although the SDG framework can result in only some of the targets being emphasized by actors, resulting in a negotiation between divergent interests, the framework can unite competing interests around a common language. This places an important role on academics to be facilitators and take the role of raising critical questions as to how the goals are interpreted. Sjors Witjes takes this a step further by arguing that the role of academia to generate corporate reflexibility around the SDGs can lead to a paradigm shift away from an economic paradigm of economic growth, towards a paradigm of inclusivity. More critical to how this works in practice, both Thomas Macintyre and Mónica Ramos-Mejía question the extent to which our roles as academics is really benefiting the realities and local contexts of non-academic actors. Thomas Macintyre questions whether it is enough to just bring actors together in inclusive collaboration, or if a deeper transformative process is needed.

Underlying these different perspectives is an important assumption in employing a TD framework: that bringing together academic and non-academic, in a process of collaborative and reflexive learning, will lead to a new shared consensus. As the narratives here show, this is not a given outcome. At display is the lack of ability or opportunity to address the issue of unequal power in stakeholder relations. This begs questions as to the TD research conditions which make multi-stakeholder projects productive, and importantly, address the source of these power imbalances, thus ultimately leading to socio-ecological transformations. Exploring these questions proves an important avenue for further TD research in the sustainability sciences.

To conclude, the SDGs are without doubt a highly ambitious project. With its focus on its impacts 'for all', through its universal applicability, it represents, in theory at least, a disruptive break with the status quo. TD research is an apt approach to moving towards these goals through its ambitions to bring together various stakeholders in a participatory context which addresses complex issues in a reflexive manner. Yet as the narratives here show, transformations across sectors of society are not easy, with context specific realities contributing to complex socio-ecological challenges. It implies academic and non-academic researchers and practitioners must embrace the inherent tensions of working collaboratively with others who think and understand the world in a different way. This requires, on the one hand, understanding that opening up room for participation implies a redistribution of power along the research process. And, on the other hand, it requires TD research to be a reflexive practice so as to shake up our mindsets, contributing innovative approaches to tackling these challenges. Its success will ultimately depend on learning to embrace inherent transdisciplinary tensions on the road to 2030.

Notes

1 'T-Learning' is an acronym for the international multi-case study project Transgressive Social Learning for Social-Ecological Sustainability in Times of Climate Change. See http://transgressivelearning.org/ for more information.
2 See details about the project here: https://sisvi.no/
3 *Grassroots ecopreneurs* can be defined as 'grassroots entrepreneurs moved by social and environmental concerns, coming up with simple and eco-friendly solutions in their quest to resolve everyday life problems' (Sarkar & Pansera, 2017, p. 327)
4 Ventures that deliver social and environmental value, besides the economic one.

References

Akpo, E., Crane, T. A., Vissoh, P. V., & Tossou, R. C. (2015). Co-Production of Knowledge in Multi-Stakeholder Processes: Analyzing Joint Experimentation as Social Learning. *The Journal of Agricultural Education and Extension*, *21*(4), 369–388.

Alvaredo, F., Chancel, L., Piketty, T., Saez, E., & Zucman, G. (2018). *World inequality report 2018*. Cambridge, MA: Harvard University Press.

Andersson, C., & Törnberg, P. (2018). Wickedness and the Anatomy of Complexity. *Futures*, *95*, 118–138.

Arnstein, S. R. (1969). A Ladder of Citizen Participation. *Journal of the American Institute of Planners*, *35*(4), 216–224. https://doi.org/10.1080/01944366908977225.

Cash, D. W., Clark, W. C., Alcock, F., Dickson, N. M., Eckley, N., Guston, D. H., . . . Mitchell, R. B. (2003). Knowledge Systems for Sustainable Development. *Proceedings of the National Academy of Sciences of the United States of America*, *100*(14), 8086–8091.

Chilisa, B. (2017). Decolonising Transdisciplinary Research Approaches: An African Perspective for Enhancing Knowledge Integration in Sustainability Science. *Sustainability Science*, *12*(5), 813–827.

Creswell, J. W., & Creswell, J. D. (2017). *Research design: Qualitative, quantitative, and mixed methods approaches*. Thousand Oaks, CA: SAGE Publications.

Cundill, G., Harvey, B., Tebboth, M., Cochrane, L., Currie-Alder, B., Vincent, K., . . . Landry, M.-E. (2019). Large-Scale Transdisciplinary Collaboration for Adaptation Research: Challenges and Insights. *Global Challenges*. Hoboken, NJ, *3*(4), 1700132.

de Sousa Santos, B. (2016). *Epistemologies of the South: Justice against epistemicide*. London and New York: Routledge.

Eccles, R. G., Ioannou, I., & Serafeim, G. (2014). The Impact of Corporate Sustainability on Organizational Processes and Performance. *Management Science*, *60*(11), 2835–2857.

Grin, J., Rotmans, J., & Schot, J. (2010). *Transitions to sustainable development: New directions in the study of long term transformative change*. Abingdon, UK: Routledge.

Grooten, M., & Almond, R. E. A. (2018). *Living planet report-2018: Aiming higher*. Gland, Switzerland: WWF International.

Grosfoguel, R. (2011). Decolonizing Post-Colonial Studies and Paradigms of Political Economy: Transmodernity, Decolonial Thinking, and Global Coloniality. *Transmodernity Journal of Peripheral Cultural Production of the Luso-Hispanic World*, *1*(1), 1–36.

Hahn, T., Figge, F., Pinkse, J., & Preuss, L. (2018). A Paradox Perspective on Corporate Sustainability: Descriptive, Instrumental, and Normative Aspects. *Journal of Business Ethics*, *148*(2), 235–248.

Hall, B. L., & Tandon, R. (2017). Decolonization of Knowledge, Epistemicide, Participatory Research and Higher Education. *Research for All*, *1*(1), 6–19.

Herr, K., & Anderson, G. L. (2014). *The action research dissertation: A guide for students and faculty* (K. Herr & G. L. Anderson, eds.). London, UK: SAGE Publications.

IPCC. (2018). *Global Warming of 1.5°C*. In Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, and T. Waterfield (Eds.), An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty. In Press.

Jackson, T. (2009). *Prosperity without growth: Economics for a finite planet*. Abingdon, UK: Routledge.

Jansen, J. J. P., Tempelaar, M. P., van den Bosch, F. A. J., & Volberda, H. W. (2009). Structural Differentiation and Ambidexterity: The Mediating Role of Integration Mechanisms. *Organization Science*, *20*(4), 797–811.

Lang, D. J., Wiek, A., Bergmann, M., Stauffacher, M., Martens, P., Moll, P., . . . Thomas, C. J. (2012). Transdisciplinary Research in Sustainability Science: Practice, Principles, and Challenges. *Sustainability Science*, *7*(1), 25–43.

Lantz, P. M., Viruell-Fuentes, E., Israel, B. A., Softley, D., & Guzman, R. (2001). Can Communities and Academia Work Together on Public Health Research? Evaluation Results from a Community-Based Participatory Research Partnership in Detroit. *Journal of Urban Health: Bulletin of the New York Academy of Medicine*, *78*(3), 495–507.

Le Grange, L. (2016). Decolonising the University Curriculum: Leading Article. *South African Journal of Higher Education*. Retrieved from https://journals.co.za/content/high/30/2/EJC191701

Lotz-Sisitka, H., Ali, M. B., Mphepo, G., Chaves, M., Macintyre, T., Pesanayi, T., . . . McGarry, D. (2016). Co-Designing Research on Transgressive Learning in Times of Climate Change. *Current Opinion in Environmental Sustainability*, *20*, 50–55.

Luederitz, C., Schäpke, N., Wiek, A., Lang, D. J., Bergmann, M., Bos, J. J., . . . Others. (2017). Learning through Evaluation: A Tentative Evaluative Scheme for Sustainability Transition Experiments. *Journal of Cleaner Production*, *169*, 61–76.

Macintyre, T., Monroy, T., Coral, D., Zethelius, M., Tassone, V., & Wals, A. E. J. (2019). T-Labs and Climate Change Narratives: Co-Researcher Qualities in Transgressive Action-Research. *Action Research*, *17*(1), 63–86.

Maina, M. F., & González, I. G. (2016). Articulating Personal Pedagogies through Learning Ecologies. In B. Gros, Kinshuk, & M. Maina (Eds.), *The future of ubiquitous learning: Learning designs for emerging pedagogies* (pp. 73–94). Berlin, Heidelberg: Springer Berlin Heidelberg.

Maletič, M., Maletič, D., Dahlgaard, J. J., Dahlgaard-Park, S. M., & Gomišček, B. (2015). Effect of Sustainability-Oriented Innovation Practices on the Overall Organisational Performance: An Empirical Examination. *Total Quality Management & Business Excellence, 27*(9–10), 1171–1190. doi: 10.1080/14783363.2015.1064767.

Nobre, C. A., Sampaio, G., Borma, L. S., Castilla-Rubio, J. C., Silva, J. S., & Cardoso, M. (2016). Land-Use and Climate Change Risks in the Amazon and the Need of a Novel Sustainable Development Paradigm. *Proceedings of the National Academy of Sciences*, *113*(39), 10759–10768.

O'Brien, K. (2012). Global Environmental Change II: From Adaptation to Deliberate Transformation. *Progress in Human Geography*, *36*(5), 667–676.

O'Reilly, C. A., III, & Tushman, M. L. (2013). Organizational Ambidexterity: Past, Present, and Future. *Of Management Perspectives*. Retrieved from https://journals.aom.org/doi/abs/10.5465/amp.2013.0025

Ramos-Mejia, M. (2018). *Transitions to sustainability at the bottom: The role of grassroots ecopreneurs* (Doctoral Dissertation). University of Twente, The Netherlands.

Ramos-Mejía, M., & Balanzo, A. (2018). What It Takes to Lead Sustainability Transitions from the Bottom-Up: Strategic Interactions of Grassroots Ecopreneurs. *Sustainability: Science Practice and Policy*, *10*(7), 2294.

Ramos-Mejía, M., Franco-Garcia, M. L., Jauregui-Becker, J. M. (2018). Sustainability Transitions in the Developing World: Challenges of Socio-Technical Transformations Unfolding in Contexts of Poverty. *Environmental Science & Policy, 84*, 217–223. https://doi.org/10.1016/j.envsci.2017.03.010.

Reynolds, M., Blackmore, C., Ison, R., Shah, R., & Wedlock, E. (2018). The Role of Systems Thinking in the Practice of Implementing Sustainable Development Goals. In W. Leal Filho (Ed.), *Handbook of sustainability science and research* (pp. 677–698). Cham: Springer International Publishing.

Rittel, H. W. J., & Webber, M. M. (1973). Dilemmas in a General Theory of Planning. *Policy Sciences*, *4*(2), 155–169.

Sarkar, S., & Pansera, M. (2017). Sustainability-Driven Innovation at the Bottom: Insights from Grassroots Ecopreneurs. *Technological Forecasting and Social Change*, *114*, 327–338.

Sartori, S., Witjes, S., & Campos, L. M. S. (2017). Sustainability Performance for Brazilian Electricity Power Industry: An Assessment Integrating Social, Economic and Environmental Issues. *Energy Policy*, *111*, 41–51.

Schaltegger, S., & Beckmann, M. (2013). Transdisciplinarity in Corporate Sustainability: Mapping the Field. *Business Strategy and the Environment*, *22*(4), 219–229.

Schulz, K.-P., Finstad-Milion, K., & Janczak, S. (2018). Educating Corporate Sustainability: A Multidisciplinary and Practice-Based Approach to Facilitate Students' Learning. *Journal of Cleaner Production*, *198*, 996–1006.

Seyfang, G., & Smith, A. (2007). Grassroots Innovations for Sustainable Development: Towards a New Research and Policy Agenda. *Environmental Politics*, *16*(4), 584–603.

Siemens, G. (2007). Connectivism: Creating a Learning Ecology in Distributed Environments. *Didactics of Microlearning: Concepts, Discourses and Examples*, 53–68.

Smith, W. K., & Lewis, M. W. (2011). Toward a Theory of Paradox: A Dynamic Equilibrium Model of Organizing. *Academy of Management Review: Academy of Management*, *36*(2), 381–403.

Spangenberg, J. H. (2017). Hot Air or Comprehensive Progress? A Critical Assessment of the SDGs. *Sustainable Development*, *25*(4), 311–321.

Stokols, D. (2006). Toward a Science of Transdisciplinary Action Research. *American Journal of Community Psychology*, *38*(1–2), 63–77.

Truffer, B., Murphy, J. T., & Raven, R. (2015). The Geography of Sustainability Transitions. Contours of an Emerging Theme. *Environmental Innovation and Societal Transitions*, *17*, 63–72. https://doi.org/10.1016/j.eist.2015.07.004.

United Nations. (2018). *Sustainable development goals*. United Nations Sustainable Development. Retrieved April 16, 2018, from www.un.org/sustainabledevelopment/sustainable-development-goals/

Van der Byl, C. A., & Slawinski, N. (2015). Embracing Tensions in Corporate Sustainability: A Review of Research from Win-Wins and Trade-Offs to Paradoxes and Beyond. *Organization & Environment*, *28*(1), 54–79.

Van de Ven, A. H., & Johnson, P. E. (2006). Knowledge for Theory and Practice. *Academy of Management Review: Academy of Management*. Retrieved from https://journals.aom.org/doi/abs/10.5465/amr.2006.22527385

Vildåsen, S. S., Keitsch, M., & Fet, A. M. (2017). Clarifying the Epistemology of Corporate Sustainability. *Ecological Economics: The Journal of the International Society for Ecological Economics*, *138*, 40–46.

Wals, A. E. J. (2019). Sustainability-Oriented Ecologies of Learning as a Response to Systemic Global Dysfunction. In R. Barnett & N. Jackson (Eds.), *Learning ecologies: Sightings, possibilities, and emerging practices*. London: Routledge.

Westberg, L., & Polk, M. (2016). The Role of Learning in Transdisciplinary Research: Moving from a Normative Concept to an Analytical Tool through a Practice-Based Approach. *Sustainability Science*, *11*(3), 385–397.

Wiek, A., Farioli, F., Fukushi, K., & Yarime, M. (2012). Sustainability Science: Bridging the Gap between Science and Society. *Sustainability Science*, *7*(1), 1–4.

Wiek, A., Withycombe, L., & Redman, C. L. (2011). Key Competencies in Sustainability: A Reference Framework for Academic Program Development. *Sustainability Science*, *6*(2), 203–218.

Witjes, S. (2017). *Leapfrogging through retrospection: Ferreting out sustainability integration within organisations* (Doctoral Dissertation). University Utrecht, the Netherlands. Retrieved from https://dspace.library.uu.nl/handle/1874/347990

Witjes, S., & Lozano, R. (2016). Towards a More Circular Economy: Proposing a Framework Linking Sustainable Public Procurement and Sustainable Business Models. *Resources, Conservation and Recycling*, *112*, 37–44.

Witjes, S., Vermeulen, W. J. V., & Cramer, J. M. (2017). Assessing Corporate Sustainability Integration for Corporate Self-Reflection. *Resources, Conservation and Recycling*, *127*, 132–147.

Witkamp, M. J., Raven, R. P. J. M., & Royakkers, L. M. M. (2011). Strategic Niche Management of Social Innovations: The Case of Social Entrepreneurship. *Technology Analysis & Strategic Management*, *23*(6), 667–681.

11 Challenges of transdisciplinary research collaboration for sustainable development

Walter J.V. Vermeulen and Martina M. Keitsch

The starting point of this book was to synthesize ideas, methods and applications from different academic disciplines in transdisciplinary research and their approaches to transdisciplinary collaboration (TDC). Our intention has been to map shared and diverging concepts and tools applied by scholars in various disciplines addressing sustainability issues. The contributions in this book comprise concepts, methods and case studies in a wide span of transdisciplinary collaboration with different societal stakeholders, such as companies, political decision-makers and local people.

The writing and editing of this book have been a joint journey, navigating through numerous examples of research projects and contributions to theoretical foundations of transdisciplinary it, and its methodological and ethical implications. The various chapters illustrate that in practice a fair level of pragmatism guides the collaboration of academics with non-academics in a wide variety of cases.

In this final chapter we reflect on what the journey has delivered.

The concept of transdisciplinarity is rooted in the social change ambitions of the 1960/1970s, with Jantsch calling for adapting universities 'as a means of increasing the capability of society for continuous self-renewal' (Jantsch, 1972, p. 12; see section 2.1), and is still mostly focused on intra-academic collaboration. Yet, in the new millennium TD has been increasingly taken up in varying fields of sustainability research as a form of outreach beyond the fences of universities. This adaptation seems essential for creating the transformations needed (section 2.2), thus making sustainability and transdisciplinarity natural allies and agents of change.

Sustainability requires the analysis of place and context-specific phenomena, which is challenging, especially in a wider socio-ecological systems context. Transdisciplinarity, on the other hand, enables the feeding of such analysis by connecting to more sources of knowledge and information than the 'mode 1' type of science relies on (section 2.3), while also enabling shared learning and application of this new knowledge by the actors connected to the phenomena studied.

How and to what extent academic and non-academic actors manage to engage in open and responsive discourses is a key factor for success, both for sustainability scientists and for societal transition processes. This deviates from the image of the anthropologist, who investigates in splendid isolation among his research

subjects, as described by Lévi-Strauss at the start of the first chapter of this book. The essence of TD is to team up with stakeholders and commonly become agents of transformative change for sustainability.

This implies that transdisciplinary research requires fundamentally redefined roles for researchers, and for their academic institutions (section 3.1), enabling them to go beyond disciplinary knowledge generation. The book shows many examples of scholars who, embarking from diverse disciplinary 'harbours', have been navigating their specific societal research fields, collaborating with people and organizations in society.

We see scholars starting from the discipline of *industrial design*, designing a solar streetlamp in Jhong Village, Nepal (Chapter 4); or developing a new shade on the path between the Indrachowk and Chhobhar communities in Nepal (Chapter 7). Other scholars started from the field of *sustainability management*, setting up an international project supporting universities and their industrial partners in applying corporate sustainability concepts and tools in lower income countries like Uganda, India and Nepal (Chapter 6) or collaborating with the Norwegian fishing industry on applying the UN sustainability goals (Chapter 10). In Chapter 8, examples of projects in the field of *entrepreneurship* engaging with social entrepreneurs in the Swedish cities were presented, while one of the scholars in Chapter 10 worked with grassroots innovators in Colombia. In the fields of *sustainability science* and *sustainable agriculture*, scholars have been the departure points for a project on sustainable coffee in Burundi (Chapter 9), or on land management in Germany (Chapter 5).

These examples illustrate the growing attention in many scientific communities (partly in specific disciplines, but also in interdisciplinary academic settings, like sustainability science groups) for new forms of collaborative knowledge creation and application. In Chapter 2, three different 'tastes' of transdisciplinary research were identified (shown in Figure 2.5), which are illustrated in the various chapters: intra-academic transdisciplinarity (Chapters 5, 10), solution-oriented transdisciplinarity (Chapters 4, 5, 10), fairness-driven transdisciplinarity (Chapters 8, 9, 10) and small-range transdisciplinarity (Chapters 6, 7, 10).

The chapters also illustrate the various stages in the academic career of researchers applying transdisciplinary research, with the authors reflecting from the perspectives of their different roles. Some have been project leaders or partners in (multiple) larger scale projects (Gawell, Keitsch, Spangenberg, Vermeulen), or were applying TD in the context of higher education programmes and projects (Fet, Keitsch, Knudson, Vermeulen, Witjes), while in some cases TD is part of PhD research projects (Ramos-Mejía, Macintyre, Rosenberg, Witjes, Vildåsen). The cases presented further comprise a great variety of collaboration with non-academic actors in various geographic contexts: with industries and SMEs (in Burundi, Colombia, Nepal, Norway, Uganda), with local communities (in Burundi, Colombia, Nepal) and with local authorities (in Germany, Nepal, Sweden).

The forms of collaboration and communication in the chapters are in some cases organized in a structured way, referring to some of the methodological

literature shown in Table 3.3, but in many cases an ad hoc project- and context-specific approach is applied. Several projects had transdisciplinary ambitions and implications, while being organized in a pragmatic way, leading to stakeholder involvement in later stages. Chapter 6 gives an example where transfer of academic knowledge to universities in low income countries was first needed, before outreach to local companies could be established.

Some examples in other chapters refer to individual PhD research projects, where single researchers with limited time and budgets as well as additional procedural PhD-requirements had to balance their academic output with the time needed for the required iterativeness and multi-actor engagement in the research design and implementation (section 3.3). Allowing for stakeholders' knowledge inputs, multi-level learning may be easier to implement in post-docs' and senior researchers' projects than in individual PhD research, relating to their levels of experience and authority. The more so for sharing the role of defining the research questions with non-academic actors. The formulation of research questions is in academic traditions seen as a core responsibility for the PhD, while both real-world needs and scientific requirements are addressed in TD contexts. In some cases, this results in obstacles for co-construction of research questions (see also Lang et al., 2012, p. 33; Herrero, Dedeurwaerdere and Osinski, 2019, p. 18).

Chapter 3 suggests distinguishing between the three levels of individual researchers' projects, research institutes' research portfolios and the research strategies of the research institutes. Some of the ambitions of TD collaboration may be better linked to the last two levels than to individual projects, especially for early stage researchers. The literature on methods for TD hardly addresses this so far.

One of the red threads in the chapters is the diversity of roles to be taken by TD researchers.

Chapter 3 discusses the triple process focus of TD researchers, as facilitating collaboration (initiation and continuation of the process), as ensuring meaningful knowledge creation (content of the process) and as warranting feasible and applicable outcomes (implementation and validation of the process). Chapter 8 describes the TD researcher's role as a threefold combination of practitioner, scholar and designer/professional by applying Schön's concept of the 'reflective practitioner' to TDC. In a dynamic time and space relation, these roles often comprise the process steps mentioned earlier plus anticipating systemic and prolonged impacts of co-produced solutions-based conditioning factors and the values governing them.

Chapter 6 adds to this a set of skills and capabilities of TD researchers, including the availability and development of personal traits, like open-mindedness and willingness to revise one's views to integrate insights from other disciplines. This requirement transcends not only the boundaries of science but claims that scientists should also be open to viewpoints from non-academic actors.

This point has far-reaching consequences, for example that scientists give up their alleged knowledge monopoly. However, while doing so, methodologies needed to attain safeguarded construct and field validity and reliability, going beyond traditional scientific evidence and justifiable arguments (section 3.2.3).

This has been further elaborated in Chapter 4, linking proof and reasoning to the validity claims of Habermas' discourse ethics: truth; normative rightness; and truthfulness (section 4.2). Acknowledging that dialogues between stakeholders in different positions and with different values and interests are exposed to the dialectics of power relations requires an awareness that TDC syntheses and solutions presuppose (the heuristics of) an environment of hierarchy-free discourses. This is where the further development and application of TD methodologies and research principles, as described in Chapters 3 and 4, are essential but may be de facto very challenging (section 5.4). Spangenberg observes that if such conditions cannot be created, one should also seriously consider not applying the TD approach, or employing an exit strategy during the collaboration process.

The various presented cases in this volume shed light on essential conditions for TD and TDC success and for key challenges. As a first condition, methodological rigor may be essential. However, this is not a straightforward condition. The TD research principles also include flexibility and adaptivity as crucial elements. Various chapters exemplify some level of application of a standard set-up for TD projects (the six steps, derived from various authors in section 3.2, and further supplemented in section 5.4, including the ideas of Pohl and Hirsch Hadorn in Chapter 8). Yet, in other chapters the research set-up includes assigning different roles to researchers and stakeholders, which links to the institutional context that is addressed by a multi-level perspective of research organizations (as discussed in Chapters 3 and 5), like the capacity building project discussed in Chapter 7. Instead of pursuing methodological rigor with a fixed multi-step methodology, the articulation and institutional facilitation of the core principles and ethics of TD (sections 3.4 and 4.2) would probably be more essential than a strict steps-wise approach.

Another essential feature for TD/TDC success, highlighted in various chapters, is the joint activity of connecting integration of ideographic and nomothetic ways of knowing (sections 3.4.5, 5.3.2 and 8.3). Academic and non-academic stakeholders should jointly engage in this. This includes linking contextual and case-specific with abstract understanding in a holistic, yet not acquisitive manner. Co-producing knowledge will then enable multi-level learning across stakeholder groups and transform communities to curricula developers (sections 4.4 and 5.4.3).

This emphasizes the human resources angle in TD projects as a condition for success. Some chapters already referred to the different roles and required skills of researchers and TD facilitators. For the researcher, this means, among others things, reconciling to a certain degree with the role of a 'bricoleur' rather than insisting on being an expert in a specific field or discipline: 'the scientist creating events (changing the world) by means of structures and the "bricoleur" creating structures by means of events' (Lévi-Strauss, 1966, p. 22). Methodologically and normatively, a TD bricoleur challenges the supposed link of science with reality as ideological by allowing non-academic worldviews and values (signs) to gain weight in problem solving.

> Concepts open possibilities while signs recycle previously available meanings. One way in which signs can be opposed to concepts is that whereas

> concepts aim to be wholly transparent with respect to reality, signs allow and even require the interposing and incorporation of a certain amount of human culture into reality.
>
> (ibid., p. 20)

Yet co-production comprises not only academic researchers in TD projects, but also, as Chapters 5 and 6 point out, non-academic stakeholders who are involved as either problem-owners, agents for change or funders and enablers of TD processes. Human resources skill development includes cultivating a 'TD attitude', which is in Chapter 10 also described as 'willingness to get out of one's comfort zone' and as 'willingness to change'. This goes for both scientists and non-academic stakeholders, while the first should see themselves as an initiator of change in TD projects.

In an educational setting, academic teaching programmes need revision and adjustment to foster this attitude (Chapter 5, Chapter 6). TD scholars need to be able to initiate and coordinate processes of mutual acceptance of each other's position (Chapter 4), and all participants in TD collaboration projects need to be willing and able to move towards co-producing common knowledge, identifying common good and perceiving common solutions (Chapter 8).

Several chapters in this volume illustrated institutional contextual conditions as a success factor. Creating an enabling environment by providing sufficient and adequately conditioned funding is e.g. essential for TD projects success (Chapters 5, 6 and 8). Funding requirements can cause administrative and organizational hindrances, which in the worst case leads to frustration and termination of projects for researchers active in remote research fields (Chapter 9). Another element connected to TD support and prospects is the management of expectations. The ambition of TD researchers is often to create impact in the real world through their projects. Some cases show clear evidence of this, like job creation and reduced environmental pollution (Chapter 9). However, in many cases, project results may merely be the start of a change in stakeholder groups (Chapters 6, 7 and 8) as well as in academia (Chapter 6). TD projects can be first steps for e.g. policy makers developing new approaches (Chapter 8), yet the slow pace of structural societal transformations has to be accepted. This can pose a dilemma in a world where TD approaches have been developed to meet current and pressing major persistent environmental challenges (section 2.3).

Yet, accepting the premise that multiple sources of knowledge contribute to a better understanding of the complexities of sustainability challenges raises many questions to be addressed, such as: can we consider all knowledge inputs as equally valuable, as well as when diverse conflict interest groups are included? The authors of Chapter 10 formulate this even more generically: 'Who now holds the truth?'

This implies epistemological queries such as: what is the fundament on which TD researchers and non-academic stakeholders determine truth validity and how to maintain scientific authority? What are ideals and ideologies of different groups

of participants, e.g. the perception of TD as 'wicked problems', and how far are they projected to a team?

Further, from an ethical perspective: are all stakeholders evenly willing to adjust their views and beliefs? Section 5.4 mentions the risk that for powerful stakeholders, participation in TD projects can be a mere means to achieve traditional, patriarchal values that construct, mediate and maintain hegemonic forms of domination.

Current TD literature does not provide clear answers to these questions, and this volume cannot give ultimate responses, either. However, we have tried to trace an alternative way of approaching the questions. Currently, many TD concepts are fundamentally built on arborescent ('tree-like') thinking (Deleuze and Guattari, 1987), which is a common way for developing logical reasoning through linear, sequential reflection. Yet from the perspective of TD, this also implies that knowledge converges not along a pragmatic trajectory of common problem-solving space, but rather on a path of 'true' knowledge generation, thereby often remaining in splendid academic isolation. This is for example the case when presuming and applying classical binary opposites – true–false, normal–abnormal, useful–useless. Even if these dichotomies exist in real life, they do not necessarily mean the same for each stakeholder in a TDC team. Since academics tend to forget that discourses are based on negotiation with all its implications, rather than epistemic affordances, one recommendation for TD is to exercise arborescent thinking consciously and with care.

According to Deleuze and Guattari (1987), arborescent knowledge is methodologically generated through delineation:

> All of tree logic is a logic of tracing and reproduction. . . . Its goal is to describe a de facto state, to maintain balance in intersubjective relations. . . . It consists of tracing,[1] on the basis of an overcoding structure or supporting axis, something that comes ready-made. The tree articulates and hierarchizes tracings; hierarchizes tracings; tracings are like the leaves of a tree). . . . The tree and root inspire a sad image of thought that is forever imitating the multiple on the basis of a centred or segmented higher unity.
>
> (ibid., pp. 12, 16)

In their opinion, a main weakness of the tree-like model is that when diversity meets structure, it is diminished by categories and laws of combination (ibid., p. 6).

Deleuze and Guattari (1987) introduce the rhizome (literally: 'rootstalk', from Greek rhízōma 'mass of roots') as a counter model to traditional 'empiricist' or 'rationalist' arborescent worldviews by responding to the fact that non-scientific, lifeworldly views are essential to meaning creation. In the TD context, the rhizome can illustrate research that allows for various, scientific and non-scientific entry and exit points regarding interpretation, planning, development and evaluation. It also symbolizes the networking and connecting to stakeholders in the 'real world', where the search for useful knowledge requires digging into the

ground and getting dirty boots, as well as the need for an iterative approach (Chapter 3).

The rhizomatic principles of connection and heterogeneity (ibid., 7) state that every point (here: meaning, things, policies etc.), as dissimilar as it might be, can be connected with every other point: 'a rhizome ceaselessly establishes connections between semiotic chains, organizations of power, and circumstances relative to the arts, sciences, and social struggles' (ibid., 7).

The SDGs illustrate a rhizomatic network of such dynamic connections (lines) between entry and exit points comprising environments, citizens, governments, information and natural and artificial objects.

The multiplicity principle of the rhizome emphasizes the real-world nature of the multiple when creating connection-lines. As lines expand or shrink, the multiple gets new dimensions. Connections can get 'interrupted or broken': 'a rhizome may be broken, shattered at a given spot, but it will start up again on one of its old lines, or on new lines' (ibid., 9). For example, in TDC projects, goals might change, and projects might even turn out to be a 'failure'. From a rhizome perspective, this could invite researchers and stakeholders to follow up along one of the remaining 'lines' (see e.g. Chapter 8). Projects that by themselves may seem to have a small impact can lead to follow-ups and new initiatives at a different time and place and still yield results.

The map is a representation of the rhizome per se. It is open, connectable and performance-oriented, can be perpetually modified, reversed and reworked, and it has multiple entryways: '[The map . . .] coordinates are determined not by theoretical analyses implying universals but by a pragmatics composing multiplicities or aggregates of intensities' (ibid., p. 15).

Deleuze and Guattari introduced the rhizome as an alternative way of thinking which allows pragmatically approaching alliances: 'the rhizome is alliance, uniquely alliance. The tree imposes the verb "to be" but the fabric of the rhizome is the conjunction, "and . . . and . . . and . . ."' (ibid., 25). The rhizome connects any point to any other point; it allows the introduction and alignment of heterogeneous signs within various dimensions. It is a multiplicity with no beginning or end, made only of lines which can be disrupted as dimensions change in nature, which in the context of TD research illustrates the iterative approach.

For TD, the concept of the rhizome symbolizes that acknowledging epistemological otherness, rather than trying to fit the 'savage mind' (Lévi-Strauss, 1966) in purposive rationality schemes (see Chapter 1), is a necessary condition for co-producing future knowledge. Academic thinking is seen as a powerful source for developing heterarchical methods of knowledge generation, which are closer to practice, experience and everyday life. This development can be an important start for comprehensive TD philosophies of sciences. Practically, it can lead TD towards identification of internal dilemmas between transdisciplinary necessities and disciplinary limitations, thereby developing new converging concepts for collaboration with different societal stakeholders. Considering this, this book in many ways embodies a rhizome itself, with its various ambitions of TD, entries, approaches and methodologies.

Note

1 The English translation misses out the difference between tracing (French: 'le tracè') and trailing (French: 'la trace'). 'La trace' means 'trail' while 'le tracé' has a polysemiotic meaning, among others, 'route', 'layout', 'delineation', 'alignment', 'trail' and 'plot' (Linguee, Dictionary French–English 2020).

References

Deleuze, G. and Guattari, F. (1987) *A Thousand Plateaus*. Minneapolis: University of Minnesota Press.

Herrero, P., Dedeurwaerdere, T. and Osinski, A. (2019) 'Design features for social learning in transformative transdisciplinary research', *Sustainability Science*. Springer Japan, 14(3), pp. 751–769. doi: 10.1007/s11625-018-0641-7.

Jantsch, E. (1972) 'Inter- and transdisciplinary university: A systems approach to education and innovation', *Higher Education Quarterly*, 1(1), pp. 7–37. doi: 10.1111/j.1468-2273.1947.tb02067.x.

Lang, D. J. et al. (2012) 'Transdisciplinary research in sustainability science: Practice, principles, and challenges', *Sustainability Science*, 7(S1), pp. 25–43. doi: 10.1007/s11625-011-0149-x.

Lévi-Strauss, C. (1966) *The Savage Mind*. Chicago, IL: University of Chicago Press.

Index