Harmonising biodiversity conservation and food security in southwestern Ethiopia

Aisa O. Manlosa, Patrícia Rodrigues, Girma Shumi, Kristoffer Hylander, Jannik Schultner, Ine Dorresteijn, Jan Hanspach, Tolera Senbeto Jiren, Milena Mausbach, David J. Abson, Feyera Senbeta and Joern Fischer

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PREFACE

Creating a more food secure future while also maintaining biodiversity is a central challenge of our times. In southwestern Ethiopia, this challenge is highly acute because the region is a globally recognised biodiversity hotspot but also home to millions of people who are eager to improve their food security and general well-being.

This book summarises the findings of a five-year interdisciplinary research project studying topics such as biodiversity conservation, food security, livelihoods and the governance of these. The project constitutes an academically motivated, independent scientific study funded by the European Research Council. It was implemented through a collaboration between Leuphana University Lueneburg (Germany), Addis Ababa University (Ethiopia), and Stockholm University (Sweden). In the course of our work, we spoke with hundreds of local people, dozens of government agencies, several NGOs, as well as academic colleagues from different parts of the world. Moreover, we surveyed hundreds of locations in the forest and the farmland for their biodiversity. This book is a synthesis of the collective insights from all of this work. It condenses the findings of numerous, internationally published peer-reviewed journal articles into a readily accessible format. We hope the book can inspire and inform local stakeholders as well as colleagues in other parts of the world who may be working on similar topics.

To the best of our ability, we have avoided technical language and have tried to focus on key messages that are relevant for policy and practice. For those instances where we were unable to avoid a minimum of technical language, we have provided a glossary at the end of the book that defines important technical terms. To ensure key messages for policy and practice are readily found, every chapter concludes by highlighting key insights. We also recognize that some readers will be interested in the scientific methods underpinning our work. This is not a trivial point because indeed every single chapter of this book, apart from the introduction, is based on peer-reviewed, empirical research. To provide an overview of our methods, every chapter includes a box detailing the methods used for that particular chapter. At the end of each chapter, further information is provided through a reading list indicating the journal articles and in some cases doctoral theses a particular chapter is based on.

The book is structured into five logically connected sections, each of which contains several chapters (see Fig. A below). Section 1 gives a general introduction to our work (Chapter 1) and to the study area (Chapter 2). Section 2 focuses on the biodiversity of southwestern Ethiopia. It addresses the ecology of trees and shrubs in both forest and farmland (Chapter 3), birds in farmland and forest of different management intensities (Chapter 4), and mammals in the forest (Chapter 5).

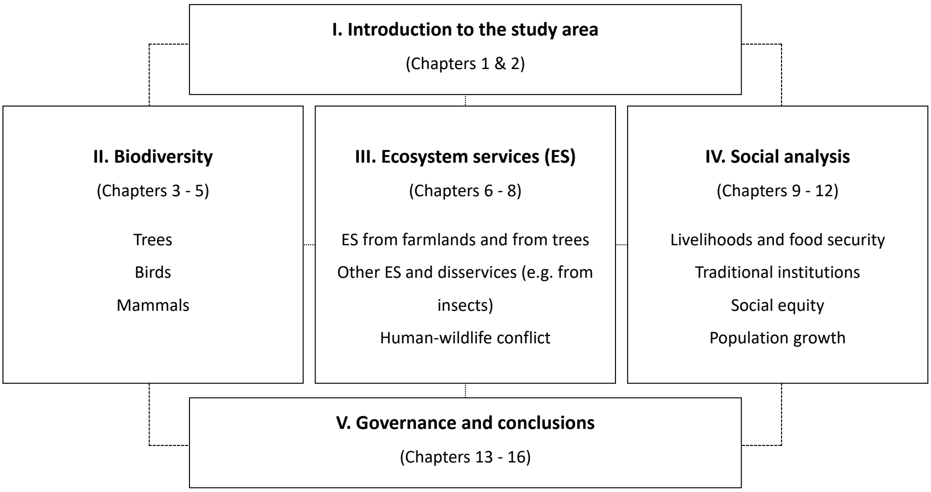

Fig. A. Structure of the book including sections and chapters.

Section 3 then investigates the intersection of biodiversity with the lives of local people. In Chapter 6, we look at how groups of local people benefit in different ways from the natural environment – including from trees, crops, and forest products such as coffee and honey. Chapter 7 outlines the benefits that local insects and fungi (e.g. pollination, improved tree growth) provide to people, but also shows that some insects and fungi can bring major disbenefits such as pests and diseases. Chapter 8 goes on to examine one of the biggest challenges for people living in southwestern Ethiopia – namely how to live side by side with a range of native mammals, some of which can cause serious problems by raiding crops or killing livestock.

Section 4 focuses on a range of social phenomena in the study area. In particular, Chapter 9 investigates local livelihoods including the capital assets needed to undertake these livelihoods and their implications for food security.

Chapter 10 zooms in to local traditions of collaboration because these can have important consequences for people's livelihoods. Chapter 11 deals with social and gender inequality. These are important issues because some development options may benefit some members of local communities while excluding or leaving behind others. Section 4 concludes with Chapter 12, which investigates issues of population growth and family planning.

Section 5 closes this book. Its first two chapters – Chapters 13 and 14 – address the governance of food security and biodiversity conservation. Specifically, Chapter 13 looks at how different actors frame the challenges around food security and biodiversity conservation in different ways, and hence differ in their preferences for how these challenges ought to be addressed. Chapter 14 follows on by looking at how collaboration among different actors can be improved. In Chapter 15, we synthesise our scientific understanding generated to this point, and combine it with the local knowledge provided by a comprehensive set of local stakeholders. This combination resulted in four plausible scenarios describing alternative future directions for development in southwestern Ethiopia. Chapter 16 concludes the book by distilling cross-cutting messages of particular relevance for policy and practice.

This book is prepared with a broad range of audiences in mind. We are particularly interested in communicating our work outside of the research community. To this end, we decided to streamline the content of the book, and decided to do without some of the usual scientific conventions such as references for all statements that have other sources or captions for all photos. Instead, we have indicated a short list of further readings at the end of every chapter that interested readers can refer to, and provided captions only for scientific figures. We trust that the benefits from this choice will outweigh any cost from omission.

We hope this book will help to inform and inspire your personal and professional efforts towards creating a sustainable future.

The authors
January 2020

ABOUT THE AUTHORS

This book is the product of an interdisciplinary, collaborative effort by researchers from several disciplinary backgrounds. Almost all chapters with the exception of the introduction are based on empirical research by the different authors and their collaborators.

Authors Aisa O. Manlosa, Patrícia Rodrigues, Girma Shumi, Jannik Schultner, Ine Dorresteijn, Tolera Senbeto Jiren, and Jan Hanspach provided substantive content into their respective chapters of the book. Feyera Senbeta facilitated the institutional arrangements required for the implementation of the research project, provided helpful comments on the research at various stages, and co-authored many of the journal articles this book is based on. Milena Mausbach drafted the chapter on traditional institutions (Chapter 10) in collaboration with David J. Abson and Jan Hanspach. Kristoffer Hylander drafted Chapter 2, which provided background to the landscape and Chapter 7 on ecosystem services and disservices from insects and fungi. Aisa O. Manlosa wrote the majority of the text for the chapters in close tandem with all co-authors. Joern Fischer led the production of the book by initiating a vision for the purpose and content of the book, designing the collaborative writing process, and closely editing all text to improve clarity, flow, and consistency.

Dr. Aisa O. Manlosa is currently a postdoctoral researcher at the Leibniz Centre for Tropical Marine Research (ZMT) in Bremen, Germany. Her master's degree is in environmental science and her doctorate degree is in sustainability science. Her research interests include the links between livelihoods, food security, gender, and the role of institutions in facilitating societal transformation towards sustainability.

Ms. Patrícia Rodrigues is a PhD student at the Faculty of Sustainability at Leuphana University Lueneburg. She is a biologist with a background in ecology. Her research focuses on the effects of land use changes on biodiversity and ecosystem services, and on understanding human-wildlife interactions and sources of conflict. Her PhD research will be completed in 2020.

Dr. Girma Shumi is a researcher at the Institute of Ecology within the Faculty of Sustainability, Leuphana University Lueneburg. His main research interests are social–ecological systems and sustainability, particularly in relation to the ecology, conservation and sustainable use of woody plant species. His research focuses on woody plant conservation and associated ecosystem services in southwestern Ethiopia.

Prof. Kristoffer Hylander is a professor at Stockholm University's Department of Ecology, Environment and Plant Sciences. Trained as a landscape ecologist, he is interested in patterns and determinants of species richness and composition in space and time in both natural and human-modified landscapes. His current research focuses on the performance and distribution of plants under varying local climates, and on the links between biodiversity and ecosystem services in Ethiopian agro-ecosystems.

Dr. Jannik Schultner has been a postdoctoral researcher at the Institute of Ecology at Leuphana University Lueneburg since 2014. He holds a PhD in Biology from the Norwegian University of Science and Technology. His interdisciplinary research is motivated by both the urgency of 'real world' problems as well as his fascination with the bi-directional interactions between people and the environment. Currently, his work investigates the future of biodiverse cultural landscapes in southwestern Ethiopia.

Dr. Ine Dorresteijn is an assistant professor at Copernicus Institute of Sustainable Development, Utrecht University, The Netherlands. She is an inter- and transdisciplinary researcher focusing mainly on human-environment interactions and sustainability. She has worked on human-wildlife coexistence in cultural landscapes in Romania and Ethiopia, and currently investigates possibilities for harmonising food security and biodiversity conservation in landscapes in the Global South.

Dr. Jan Hanspach is a research associate at Leuphana University Lueneburg. As a trained ecologist, his research interests include biodiversity conservation in farming landscapes. He is part of the international Programme on Ecosystem Change and Society (PECS) research network. Currently, he is leading a research project investigating the biocultural diversity of cultural landscapes in the Global South.

Dr. Tolera Senbeto Jiren is currently a postdoctoral researcher at the Faculty of Sustainability, Leuphana University Lueneburg. His research interests include the governance of sustainability with a particular focus on policy and institutional analysis, social network analysis, and futures methods and practices. In his PhD research, he investigated institutional prospects and challenges in the integrated governance of food security and biodiversity conservation in the multi-level governance context of southwestern Ethiopia.

Ms. Milena Mausbach is a Master's student enrolled in the study program "International Sustainable Agriculture" at the universities of Goettingen and Kassel (Germany). She holds a Bachelor's degree in Environmental and Sustainability Studies from Leuphana University Lueneburg and wrote her Bachelor's thesis about traditional institutions in southwestern Ethiopia. In her research, she is especially interested in interactions between people and the environment in the context of smallholder agriculture.

Prof. David J. (Dave) Abson holds the Professorship for Sustainability Economics and Assessment at Leuphana University Lueneburg. His interdisciplinary research seeks to integrate social and natural science perspectives of sustainability in rural landscapes, including systems thinking, value theory and ecosystem service research. He has been co-leading a major research project on Leverage Points for Sustainability Transformation.

Dr. Feyera Senbeta is an Associate Professor at the College of Development Studies, Addis Ababa University. He received his BSc degree in Forestry from Alemaya University of Agriculture in 1994, MSc degree in Natural Forest Management from the Swedish University of Agricultural Sciences in 1998, and PhD in Vegetation Ecology from the University of Bonn in 2006. His research focuses on biodiversity conservation, vegetation ecology, ecosystem services, natural resource management, and climate change.

Prof. Joern Fischer holds the Professorship for Sustainable Landscapes at Leuphana University Lueneburg. He completed his PhD in landscape ecology at the Australian National University in 2004. His solution-oriented research focuses on biodiversity conservation in human-modified landscapes. In 2010, he won the Humboldt Foundation's Sofja Kovalevskaja Award, enabling him to conduct a transdisciplinary research project on sustainable landscapes in Central Romania. His research has focused on Ethiopia since 2014.

ACKNOWLEDGEMENTS

As in most books, this one stands on the shoulders of many people who have contributed in many significant ways. The readers will notice that each of the chapters included in this book is based on empirical work that has been published – or is currently submitted for publication – in peer-reviewed international journals. This work has been accomplished through substantive support by networks of colleagues and friends in the academe, government offices, non-government organizations, and numerous local groups and individuals. We would like to extend our appreciation for all this support, and acknowledge them here.

Field work in the region was carried out with the indispensable and irreplaceable support of many field assistants. We deeply appreciate the help and presence of Dadi Feyisa, Birhanu Bekele, Tolani Asirat, Shiferaw Diriba, Olead Degefa, Sintayehu Tamirat, Lemane Gebeyehu, Dereje Gire, Obsuman Damena, Fasika Terefe, Fatuma Nurhussein, Hawin Lencho, Bethlehem Bayu, Raya Aba Oli and Konjit Dereje at various points of the field work. They not only helped collect data and translate, but also helped to make local connections, helped us begin to make sense of local complexity, and assisted in adapting to challenges and the occasional surprises during field work. Local field assistants who helped us get around the very remote parts of the kebeles included Mifta, Zakeeri, and Dafisi in *Kela Harari*, Sulti, Ili'aas, and Gali in *Borcho Deka*, Tahir, Biya and Jagama in *Kuda Kufi*, Ebissa, Negash, Nabso, and Mehamed in *Bere Weranigo*, Tadju, Hawi, and Sefu in *Gido Bere*, and Nabso, Aminu, and Aminu Umar in *Difo Mani*. We are grateful for their resilience, commitment, and support during data collection. They also assisted us in becoming more familiar with local ways of living and the landscape. Our car drivers, and there were many of them in the last five years, made field work logistics possible by taking care of our transport for an extended length of time, on difficult roads, even in challenging weather. Student assistants who provided help in classifying camera trap pictures included Katharina Wawerek, Jasmin Roetzer, Annika Johanna Kettenburg, Amy Newson, and Stephanie Langenbuch. Hannes Eggert assisted in data entry. Matthias de Beenhouwer and Gezahegn Berecha lent us ten camera traps. We are also grateful to João Guilherme for assisting with field work and for providing some of the landscape and bird pictures used in this book.

We thank the numerous organizations who worked with us in developing the scenarios for southwestern Ethiopia. They shared valuable time and insight, which formed the basis for the four alternative scenarios presented in Chapter 15. A full list of organizations involved can be found in another small book specifically on the four scenarios, which is freely accessible from the authors or via this link: *https://foodandbiodiversity.wordpress.com/outreach-materials/scenario-book/*. We are also grateful to various Ethiopian authorities from the federal level down to the kebele level for providing us with the necessary research permits which allowed us to undertake empirical work in their respective areas of jurisdiction.

Our collaborators and co-authors on a number of papers from which the book draws include Sileshi Nemomissa, Ulrika Samnegård, Debissa Lemessa, Tola Gemechu, Peter Hambäck, Connel Eardley, Lowe Börjesson, Josefin Delrue, Wolde Yohannes Enkosa, Werner Haerdtle, Neil French Collier, Henrik von Wehrden, Christina Hicks, M. Jahi Chappell, Julia Leventon, Arvid Bergsten, Matthias de Beenhouwer and Nicolas Jager. We appreciate the helpful and inspiring discussions they had with us, along with useful feedback on ideas and drafts of manuscripts. Arvid Bergsten, in particular, was a member of our research team for many months and provided vital field data and analytical input for several chapters in this book. Similarly, Ulrika Samnegård, Debissa Lemessa and Tola Gemechu completed their PhD under the supervision of Kristoffer Hylander, and their work constitutes the basis of Chapters 2 and 7. We appreciate their contribution as well as current discussions with our new collaborators Ayco Tack and Beyene Zewdie.

Elissa Dietrichs did a wonderful job in being on top of the administrative and financial requirements during the life of the project. In the early phase of the project, Elke Voigt (formerly Elke Ferner) supported the team. Lennard Thale-Bombien helped pull this book together by taking care of all logistic aspects related to its production.

We thank the European Research Council for the “Consolidator Grant” to Joern Fischer, which enabled the project Social-Ecological System Properties Benefiting Biodiversity and Food Security (SESYP). We are also grateful to the Swedish International Cooperation Agency, Formas, and the Swedish Research Council for grants to Kristoffer Hylander.

Importantly, to the people in southwestern Ethiopia who were part of the research project and for whom this book is written – we hope you find this of use in your role as agents who shape the future. We are grateful to those who participated in the interviews and showed us your fields and forest plots – you welcomed us into your homes and helped us understand life in southwestern Ethiopia a bit better. And for everyone else, we appreciate that you were so friendly, welcoming, and helpful towards us. The pleasure indeed was ours.

Finally, each of us has our families and loved ones to thank – for supporting us and standing by us through the years.

I. INTRODUCTION TO THE STUDY AREA

CHAPTER 1

Introduction

Summary

- Food security and biodiversity conservation are both critical challenges for humanity in the 21st century.
- Globally, current rates of biodiversity loss are up to 1000 times higher than normal extinction rates estimated from the fossil record.
- The number of people who are food insecure has been increasing in the last four years, up to 821 million globally in 2018.
- Food security and biodiversity conservation have often been framed in terms of simple trade-offs. This can be overly simplistic in many situations.
- Instead, a social-ecological systems approach can be applied to identify ways to harmonise food security and biodiversity conservation.

Introduction

Food is elemental to human survival. As a species, we have come a long way in making sure that we are able to feed ourselves. Yet, despite all our technological and marketing advances, nearly a billion people in the world continue to face food insecurity in the 21st century in terms of the calories they consume; and this number is much higher still if deficiencies in certain vitamins or nutrients are considered. Alongside this challenge, we are seeing alarming rates of biodiversity loss, with data suggesting we are on the verge of the sixth mass extinction event in the history of our planet. Never in humanity's history have there been so many hungry people despite so much food being produced; and never has our capacity to decimate biodiversity been so high despite it being the basis of the life support systems we ultimately depend on. The terms "food security" and "biodiversity" capture a multitude of complex issues that thousands of researchers all over the world have been studying and working with for many decades. There have been many gains and victories in different places at different times. But at a global level, the key challenges remain – food insecurity has been increasing, especially in Africa; and current rates of biodiversity loss are many times higher than "normal" background rates of extinction estimated from the fossil record.

Food security and biodiversity are intertwined because agriculture, the process through which most of our food is produced, is known to be one of the leading drivers of land conversion. Such land conversion often leads to the loss of habitat for many plants and animals. The dominant narrative arguing that food production should be doubled by 2050 in order to meet the rising food needs of an increasing population thus does not bode well for the conservation of the biodiversity that remains.

Given the threat that agricultural land conversion poses to biodiversity, the relationship between food security and biodiversity conservation has most frequently been viewed in terms of trade-offs – a gain in one will necessarily involve a loss in another. However, more recently, scientists have increasingly found that the relationship is not a simple dichotomy of more food production equals better food security and less biodiversity on one hand, versus less food production equals lower food security and more biodiversity on the other hand. Instead, the relationships between food security and biodiversity are much more complex and depend on many social and biophysical mediating factors. The link between food production and food security is not necessarily positive and linear. And not all types of agriculture are equally destructive to biodiversity as the large scale, industrial agricultural production traditionally pursued during the so-called "Green Revolution".

As we show in this book, the relationship between food security and biodiversity plays out in complex and interesting ways in southwestern Ethiopia. This geographic area harbours high levels of plant and animal biodiversity, but land use has been undergoing significant changes in the past decades leading to a decline in biodiversity. The rural population has been growing continuously, and is expected to continue increasing over the next few decades. The majority of the population relies on agriculture for their livelihoods and is highly dependent on the natural environment on a daily basis. Food insecurity is seasonally experienced, posing a challenge particularly to the poorest households.

While the link between food security and biodiversity has been extensively studied, we have produced this book not only as a contribution to this discourse, but also as a contribution to the place-based and context-specific challenges faced by the people living in southwestern Ethiopia. This book reports on a five-year study (2014-2019) focused on food security and biodiversity using a social-ecological systems approach. In this first chapter, we provide basic background to current food security and biodiversity challenges, including global trends and their significance to southwestern Ethiopia; and we introduce the idea of seeing these issues as interlinked via a social-ecological systems perspective.

Biodiversity

Biodiversity is the diversity of genes, species, and ecosystems. For most purposes, species diversity is used as a proxy for biodiversity. It is estimated that there are 2-100 million plant and animal species in the world. It is likely that there are many species that have already gone extinct before they were identified. Insects comprise the largest fraction of biodiversity in the world, followed by higher plants and other animals. Conservation International has identified

35 biodiversity hotspots scattered in different parts of the world. These hotspots are described as extraordinary places that harbour vast numbers of plant and animal species found nowhere else. Moreover, the hotspots are heavily threatened by habitat loss and degradation, making their improved conservation management a global priority. Southwestern Ethiopia has been identified as part of one of these global biodiversity hotspots – namely, the eastern Afromontane biodiversity hotspot.

While occasional extinctions are a normal part of evolution, current rates of extinction are unusually high. The Millennium Ecosystem Assessment (2005) found that based on fossil records, for every one thousand mammal species, less than one went extinct every millennium in prehistoric times. Since the Industrial Revolution, however, extinction rates have been found to be up to one thousand times higher than these "normal" background rates in the fossil record – with current rates predicted to further increase in the foreseeable future. The loss of biodiversity is influenced by a set of direct and indirect drivers. Direct drivers include land use change such as the clearing of forests, agricultural intensification through inorganic fertilisers and pesticides, climate change, and introduced species. Indirectly, biodiversity loss is driven by human population growth and increasing demand for agricultural goods.

The current rates of biodiversity loss are alarming for two reasons – biodiversity is intrinsically important, and it is instrumentally important because humanity's survival and flourishing depend on the benefits provided by biodiversity. The benefits provided by biodiversity to people are called ecosystem services, and they come in various forms. Perhaps the most visible type of ecosystem service are *provisioning services* which include the food, freshwater, wood, fibre, and fuel we depend on. In addition, ecosystem services also benefit humans in the form of *regulating services* such as climate regulation and flood regulation; and there are vital *supporting services* including nutrient cycling and soil formation. Finally, *cultural services* include the aesthetic and spiritual benefits people derive from nature. All of these services are vital for humans: biodiversity thus is the basis of the life support systems we all depend on. As more biodiversity is lost, the planet's ability to provide ecosystem services is weakened. As we show in this book, at the moment, southwestern Ethiopia still harbours high levels of biodiversity, and people benefit from the ecosystem services provided by this biodiversity in many different ways.

Food security

Food security is a state or condition that exists “when all people, at all times, have physical, social and economic access to sufficient, safe, and nutritious food to meet their dietary needs and food preferences for an active and healthy life” (UN World Food Summit 1996). The commonly discussed pillars of food security are availability, access, utilisation, and stability. However, agency of people and environmental appropriateness are also important elements of food security. The prevalence of food insecurity is ironic in a world with more than enough food to feed everyone on the planet. Today, undernutrition and obesity co-exist at very high levels. While 2 billion people do not get sufficient vitamins and minerals, at the same time, some 1.9 billion people are overweight or obese (FAO et al. 2019). Africa is the continent with the highest number of people who are food insecure, with some level of food insecurity affecting nearly a third of the continent’s population. Africa has also experienced the largest increase in food insecurity in recent years.

Food insecurity is related to a range of other challenges including poverty, climatic extremes, conflicts and political instability, inappropriate agricultural techniques, post-harvest food losses, unsafe water, lack of good governance and gender inequity. Moreover, major indirect drivers of food insecurity include human population growth, global inequity, climate change, and conflict.

A social-ecological approach to address food security and biodiversity conservation

How can the two interlinked challenges of improving food security and biodiversity conservation be harmonised? Many studies have been conducted to this end. Most of these studies have had either a biophysical-technological focus or a socio-political focus. While scientists taking a biophysical-technological approach have emphasised issues such as improving agricultural yields, scientists focusing on socio-political aspects have highlighted issues such as equity or governance. Clearly, harmonising food security and biodiversity conservation requires both perspectives.

The research project on which this book is based used a social-ecological systems approach to integrate food security and biodiversity conservation (Fig. 1.1). Broadly put, a social-ecological systems approach recognises the links between the biophysical world and human communities. As we show in the remainder of this book, social-ecological systems research engages with issues such as rural livelihoods and local and traditional knowledge, considers not only food availability (or yields) but also issues of equitable access, and pays attention to biodiversity both in areas used by humans and in areas that are largely left untouched. A key premise of a social-ecological systems

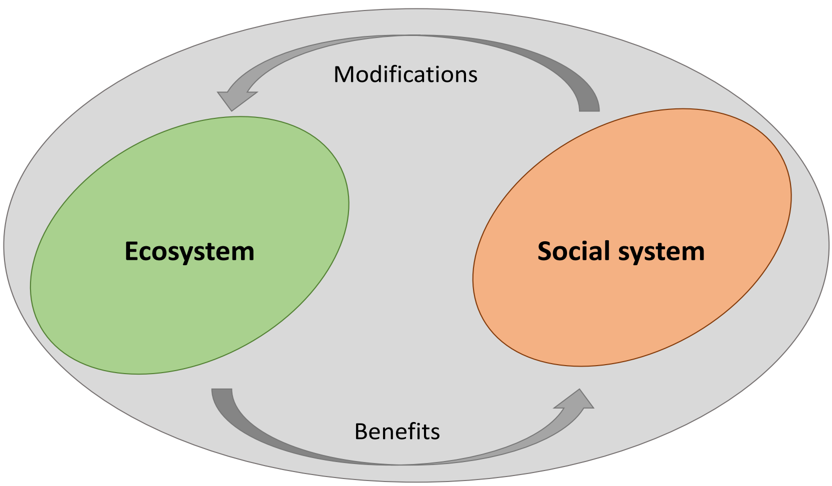

Fig. 1.1. Landscapes can be analysed using a social-ecological systems lens. Social and ecological processes are interlinked: societies depend upon benefits provided by ecosystems, which in turn are modified by human activities.

approach is that social and ecological problems cannot be solved in isolation from one another: we need to understand a landscape or a region from many different perspectives in order to effectively solve its problems related to food security or biodiversity conservation.

The following chapters synthesise the findings of our work in southwestern Ethiopia. The topics studied include the biodiversity of woody plants, mammals and birds in both farmland and forest; interactions of people with nature including benefits and challenges encountered; livelihood strategies with a focus on capital assets, food versus cash crops, and the role of gender; governance challenges with a focus on the network of stakeholders, preferences by different types of stakeholders and key policy challenges; and scenarios which provide an outlook for the future of Ethiopia.

Further reading

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If you have trouble accessing references, please email Joern Fischer at joern.fischer@uni.leuphana.de, or visit our project website at https://foodandbiodiversity.wordpress.com.

CHAPTER 2

Land cover dynamics in southwestern Ethiopia

Summary

- Southwestern Ethiopia is a mosaic landscape with high forest cover surrounded by a heterogeneous agricultural landscape. The landscape supports both high biodiversity and a large population of subsistence farmers.
- Over the last few decades, there has been a steady conversion of forests to open annual cropland, especially at altitudes above where coffee can grow.
- Coffee plays an important role by slowing deforestation at altitudes up to 2000 m above sea level, but coffee production can contribute to forest degradation and biodiversity loss.
- Many processes have shaped local land-use and tree cover dynamics, including human population growth, migration from lower to higher altitudes, connections across landscapes in resource use, immigration from other parts of Ethiopia, problems with crop-raiding animals, and changes in governance and state policies.

Introduction

The landscapes in southwestern Ethiopia are characterized by a mosaic of forests and open agricultural fields. The region harbours most of Ethiopia's remaining tall forests, and the amount of land covered by trees is higher than in most other parts of Ethiopia. Forested areas remain green even during the dry season. The region receives a high amount of annual precipitation (e.g. 1500 – 2000 millimetres in Gera district), which is highly conducive to plant growth. Still, those parts of the landscape with little tree cover undergo dramatic changes between the rainy and dry seasons. Most rain falls between June and September, while the driest months are from November to April. Yet, even in the dry season there are occasional showers, which in most years is enough to keep alive the grass in the pastures.

Most of the landscape is undulating and hilly, but there are also some areas with very rugged terrain and steep slopes. There are also some flatter plains, which can be inundated in the rainy season if they are not drained. The landscape is intersected by many rivers and streams. In our study area (Fig. 2.1) the lowest altitude is around 1500 metres above sea level (m asl) where the Didessa river flows towards the east, and the highest altitude is just below 3000 m asl on a mountain top in central Gera district. Temperature varies with altitude. As an example, in the town Chira (central to Gera district at 1950 m asl), the mean annual temperature is about 19 C°.

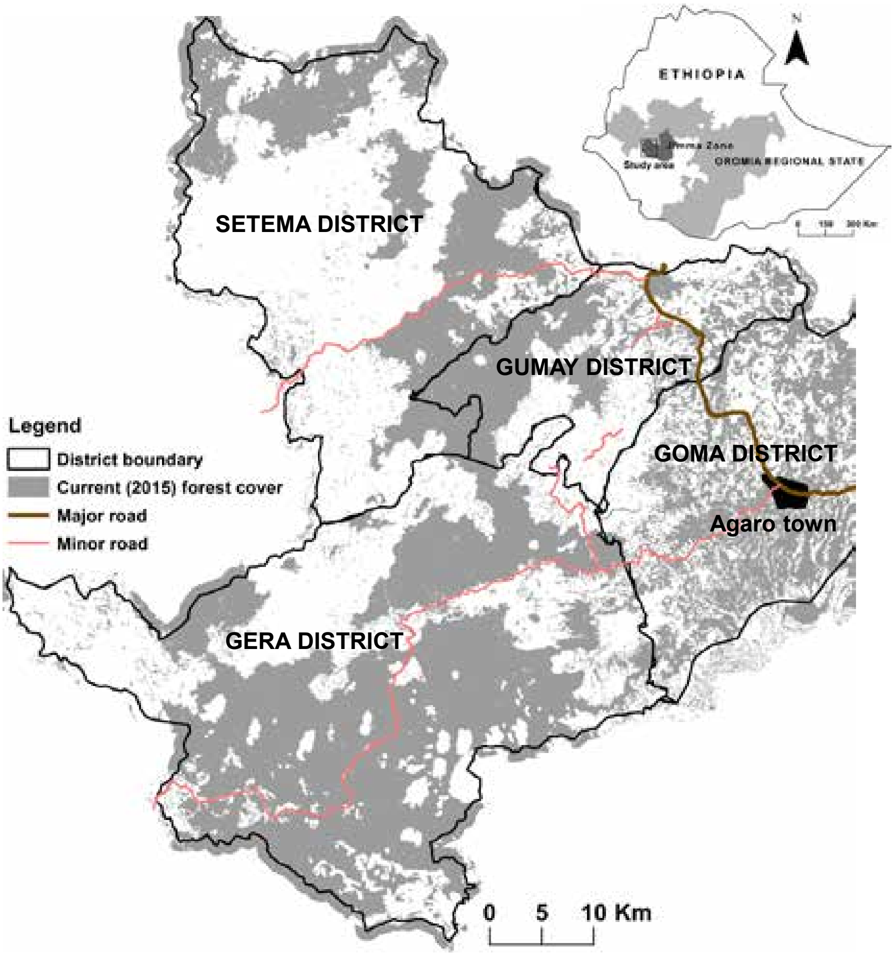

Fig. 2.1. Map of the area where our research was conducted. Different parts of this area were covered by different sub-components of the overall research project. Details are provided in each of the subsequent chapters.

Methods

- We classified the landscape surrounding Gera district into forest and non-forest based on Landsat satellite images from 1973, 1985, 1995, 2001 and 2010.
- We then compared the change of forest cover between periods for the entire Gera district, for its 30 specific kebeles, and for five state forest areas.
- To explore the drivers of land cover change, we analysed the change in forest cover in relation to population censuses from each kebele from 1984, 1994 and 2007; and to altitude and slope. Kebeles above 2000 m asl were considered to be outside the coffee growing zone.
- We also interviewed farmers and other local stakeholders about historical changes at different times and locations across the landscape.

Land use and land cover

Ethiopia has a long history of human evolution and landscape transformation. In the absence of human influence, the potential natural or "climax" vegetation in the southwest is believed to be moist Afromontane forest. This forest type is characterized by a dominance of mostly evergreen trees (see Chapter 3). When the landscape is viewed from above – for example via satellite imagery – the most obvious contrast in the landscape is the difference between forested and more open agricultural land.

Despite its strong contrast to forested areas, the agricultural landscape is still very heterogeneous in many different respects. The average size of field and other land-use units is small, often less than a hectare. There are many trees left or planted, both at the boundaries of fields and gardens, but also interspersed across the landscape. Most land is used for growing annual crops in monoculture fields. Common crops are maize, teff, wheat, sorghum, as well as a number of pulse crops with varying proportions depending on altitude and local climate. In addition, most farmers have a diversity of other food crops in their homegardens. Common crops in this setting are root crops (e.g. taro), pumpkin, pepper, carrot, and cabbage. In the homegardens it is also common to find fruit trees (e.g. avocado), ensete, coffee and khat. Ensete is also called false banana, and its starch rich corm is an important food source, not least during periods of the year with food shortages (see Chapter 9 on livelihood strategies and food security).

In addition to fields and homegardens, the third major land-use type in the agricultural landscape is grazing land. Compared to many other parts of Ethiopia the proportion of this is rather small. Pastures are interspersed but are most typically found at wetland and forest margins; grazing livestock in the forest is also common, especially in the dry season.

Most agriculture is rainfed and thus dependent on the rainy season, with harvesting taking place from October onwards when the landscape starts to dry up. However, in low lying areas there are some locations that are used to grow crops in the dry season because they are otherwise inundated, or that have been drained and with the help of irrigation provide the possibility for several harvests during one year.

What is perceived as forest from satellite images, or from a distance on the ground, could in fact be quite different because of variation in the level of human management intensity for coffee production (Fig. 2.2). Large areas of land covered by trees are in fact different types of shade coffee systems. Shade coffee systems in Ethiopia span a gradient of management intensity – coffee is grown in more or less modified forest patches, as well as in gardens and plantations. The most intensive type of management in Ethiopia is plantation coffee, in which coffee is grown in rows under a simplified canopy of a few tree species such as *Acacia abyssinica* or *Albizia* spp. Another system is called garden coffee. Here farmers grow coffee together with ensete or fruit trees. However, there can also be other types of trees in this system. Sometimes garden coffee covers just a very small patch, but sometimes larger areas are covered with this land-use, which is particularly developed in southern Ethiopia.

In our study area, the most widespread management systems are forest coffee and semi-forest coffee. In the forest coffee system the canopy is dense, has a vertical structure and is composed of a large variety of trees. In the least managed forest coffee systems, the coffee shrubs are regenerated naturally and are not pruned or managed. The so-called semi-forest system is more intensively managed than forest coffee (e.g. there might be occasional pruning of coffee shrubs and often removal of competing shrub species as well as slashing of understory vegetation), but less intensively managed than plantation coffee.

Dense stands of coffee under a canopy of trees are common both along forest margins and in patches that are embedded in the open agricultural landscape

Fig. 2.2. Examples of different types of locations in the landscape that are covered by trees.

– but it is also possible to find dense stands of coffee deep within the forest. However, at altitudes above 2000 m asl coffee naturally starts to become more uncommon and eventually disappears because conditions get too cold for it to grow well. Thus, tree covered areas above this altitude are likely to have a different management regime and hence also different impacts on biodiversity. Other tree bearing locations in the agricultural landscape are composed of woodlots of *Eucalyptus*, a land-use that seems to increase (see also Chapter 15). There are also a few areas of older plantations of exotic trees such as *Eucalyptus* and *Cupressus* spp. established during the Derg regime (~mid 1970-1990).

Largely undisturbed, "primary" forests are relatively rare, and the exact locations of such undisturbed locations are not well-known. Many areas are difficult to penetrate due to the steep topography and sometimes dense thickets of lianas and vines that take over in canopy openings caused by trees that have fallen (due to natural and human causes). What is known is that some central parts of Gera district have gone through periods of both deforestation and reforestation since 1850. Since tropical forest grows fast, some areas that now look "natural" and have large trees may in fact have been open one hundred years ago. However, in the current forests, there are clear gradients of human influence. Some locations have high densities of majestic trees that are up to 45 m tall and have large buttressed roots, as well as high densities of large logs on the forest floor, indicating at least a long time since clearance, and perhaps even primary forest status. Other locations have thinner trees of a more similar age, indicating they have been heavily impacted by human activities.

Patterns and drivers of forest cover change since the 1950s

Forest cover, according to our analysis of satellite images, decreased from 54 to 40% within a 3000 km^2 area in southwestern Ethiopia between 1973 and 2010. In the Gera district, it decreased from around 80 to 60%, along with at least twofold increase in the human population. However, forest cover change was not uniform, with much stronger declines in certain areas. Most notably, the decline was stronger in kebeles without coffee management than in kebeles with coffee management (Fig. 2.3). Thus, the largest areas of forest clearance since 1973 were located at altitudes above 2000 m asl where coffee does not grow well because of the cooler climate.

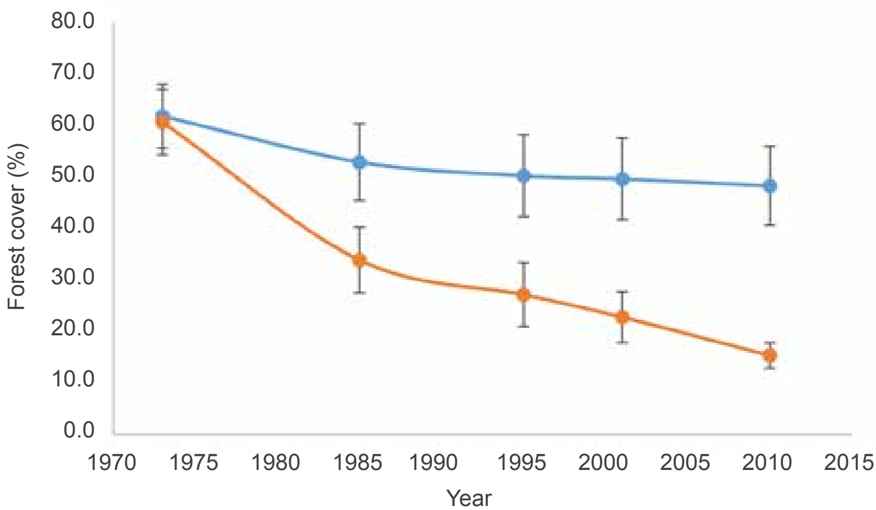

Fig. 2.3. Change in forest cover between 1973 and 2010 in coffee growing areas and in non-coffee growing areas at higher altitudes in Gera district. The graph shows means and standard errors for a total of 30 kebeles (blue line = 17 coffee growing kebeles, orange line = 13 non-coffee growing kebeles).

The period with the fastest decline in forest cover in Gera was 1973-1985, but after a period of slower deforestation, the rates were again high in the period of 2001-2010. Interviews with local people, together with our analyses of population trends, provided rich information about plausible causes for the observed patterns, including for the spatial and temporal variation in forest loss. The interviews confirmed that coffee cultivation in the forest provided a buffer against deforestation, because the shade from the forest trees was considered vital for sustainable coffee production. However, interviewees also reported that there were costs of having a farm close to the forest, especially because of crop-raiding wildlife (see Chapters 6 and 8), and for this reason, there may have been little incentive to save forests at higher altitudes that do not have coffee in their understoreys. On top of natural population growth, the study area also received many migrants from other parts of Ethiopia. This was driven both by official government resettlement programs and by people who voluntarily moved to the southwest, mainly due to a perceived availability of fertile land. Many of these migrants, but also internal migrants within the study area, settled along forest margins at higher altitudes and converted forested areas to annual cropland. Interestingly, sometimes the same people who cleared forest in one place kept their access to coffee areas at lower altitudes, and thus maintained the forest in that location. The dynamics of forest cover change thus depend on ecological as well as socioeconomic processes both in the specific kebeles as well as across the whole landscape; and these are interlinked with migration patterns and resource use, sometimes at large distances from the settlements.

Two other aspects are needed to understand the temporal variation in deforestation in this landscape. The first is the very strong but localized impact of logging of timber by both the government and private companies during the late 1980s to early 1990s. A second, more complex but general explanation to variation in deforestation rates over the study period relates to changes in governance, lack of effective governance during political shifts, and policy changes. Because of the lack of temporal resolution in our satellite image data we cannot pinpoint specific years, but based on interview data it seems clear that the lack of a strong government during the regime shift between the Emperor period and the Derg period (in 1974-75) increased the deforestation rate. Another example is the state proclamation called "land to the tillers", which led to an increase in immigration to the area from other parts of Ethiopia and subsequent deforestation during the 1970s and 1980s. Thus, when studying the local dynamics we need to understand both local social and ecological processes and how they are spatially interlinked with other locations. We also need to understand how drivers at higher levels – e.g. the national or international level – might change local social and ecological processes. A current trend in the landscape is that several new private coffee farms have been established, with consequences both for the forest cover and the livelihoods of neighbouring farmers. We return to issues of governance, trends in landscape change, and external influences on the study area in Chapters 13-15 in this book.

Key insights for policy and practice

- Southwestern Ethiopia has experienced dynamic changes in forest cover. Coffee cultivation has helped to slow deforestation rates, but many other social and economic factors have also contributed to changes in forest cover.

- Knowledge on both the ecology and management of coffee is needed when discussing possible conflicts between different goals, such as the conservation of forest biodiversity and the need of land for agricultural production.

- A deeper understanding of the social-ecological processes shaping the patterns of deforestation is important to develop future policies on sustainable land management and biodiversity conservation.

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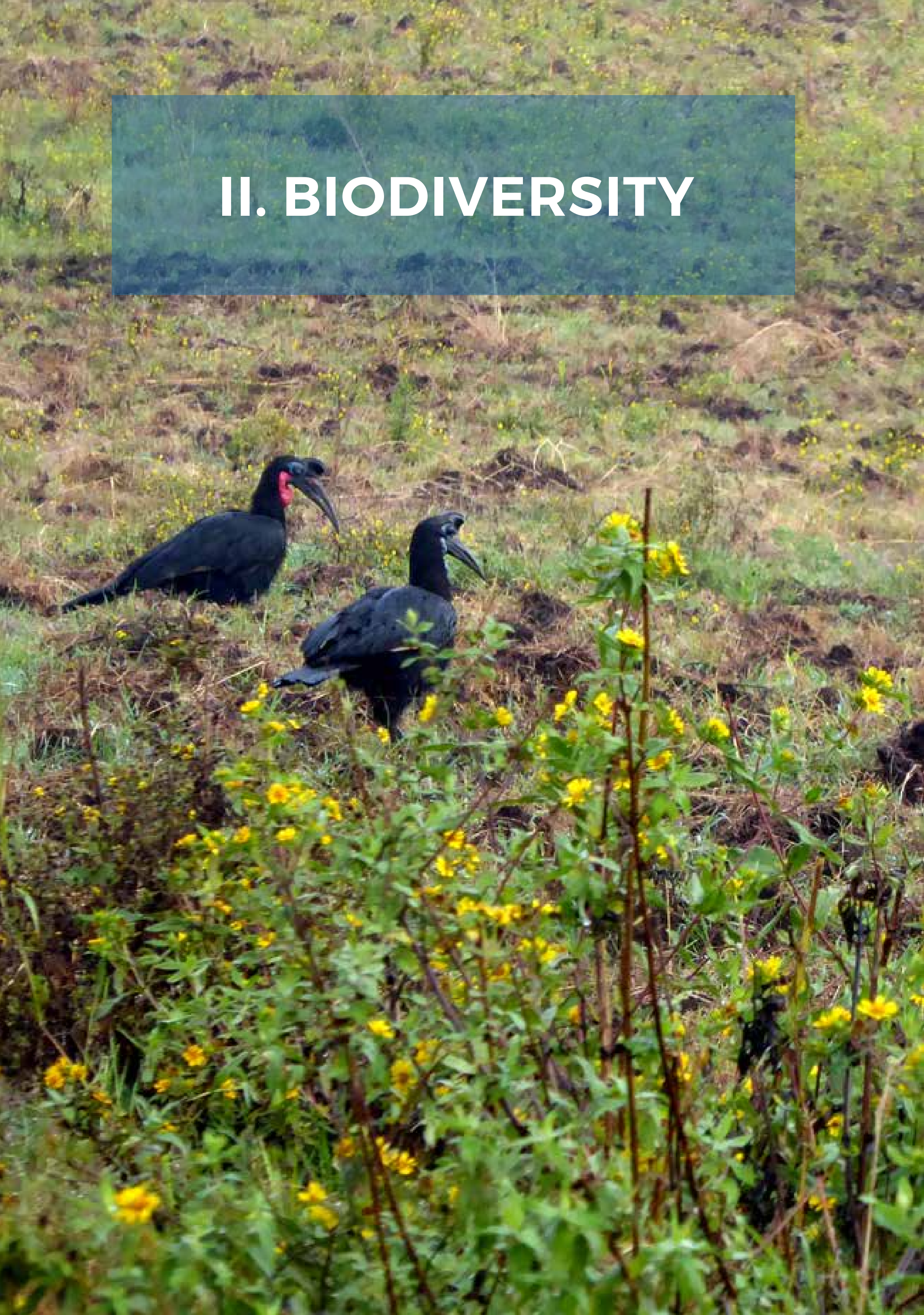
II. BIODIVERSITY



CHAPTER 3

Trees and shrubs in forest and farmland

Summary

- Southwestern Ethiopia supports a high diversity of trees and shrubs.
- Intensity of coffee forest management, distance to forest edge, and forest history affect the composition and diversity of trees and shrubs.
- Specialist species are primarily found deep within relatively undisturbed forest.
- Long-established farmland harbours a large number of native pioneer and generalist species, and therefore is of complementary value to forested areas.

Introduction

The preceding two chapters provided an introduction to our study and background about the study area. With this chapter, we begin to focus on the topic of biodiversity conservation, focusing, for now, on trees and other woody vegetation.

As detailed in Chapter 1, southwestern Ethiopia is internationally recognised as a biodiversity hotspot. However, the landscape is going through rapid changes with impacts on the state of biodiversity (Chapter 2). Current high rates of biodiversity loss in different parts of the world make it critically important to understand how landscape changes affect biodiversity. Such information is needed to determine appropriate measures to harmonise food production and conservation values.

Here, we synthesise our findings of how landscape change affects tree diversity in southwestern Ethiopia. We share our findings on how landscape context, disturbance, and forest history affect native plant species in forest sites. We further present findings on how landscape history has shaped the composition of trees in farmland.

Methods

Location: Forest surveys of trees and shrubs were conducted in five kebeles (i.e. *Kuda Kufi*, *Difo Mani, Gido Bere, Kela Harari,* and *Borcho Deka*), which were distributed across three woredas (i.e. *Gumay, Gera,* and *Setema*) in Jimma Zone. Forest cover in these kebeles ranged from 37-84%. Farmland surveys were conducted in the same kebeles and one additional kebele, namely *Bere Weranigo*.

Data collection: RapidEye satellite images were used to classify different parts of the current landscape into woody versus non-woody vegetation. In addition, Landsat imagery from 1973 (Landsat 1-MSS obtained from http://www.usgs.gov/) was used to determine historical forest cover. A survey of woody plants was conducted in which all trees and shrubs with a height equal to or above 1.5 meters were recorded. In the forest, we surveyed 108 individual 20 m by 20 m sites; in the farmland, we surveyed 72 circular 1 ha sites. Species were identified and classified as specialists, generalists, or pioneers.

Data analysis: Quantitative statistical analyses were used in the analysis including constrained correspondence analysis, non-metric multidimensional scaling, and generalised linear mixed effects models.

Effects of disturbance on forests

Forests are key areas for biodiversity conservation, and biodiversity at any given location is strongly influenced by human activities. Here we considered three gradients related to human disturbance in existing forest patches.

Because southwestern Ethiopia is the most important coffee-producing area in the country, the first gradient we investigated pertains to the intensity of coffee forest management in the landscape. Management intensity spans the spectrum of unmanaged to intensive shade coffee management (Fig. 3.1). Intensity was measured based on coffee dominance, which was quantified as the ratio of the number of coffee plants to the total number of woody plants in each site. High coffee dominance indicates that a site is used for intensive coffee production, and thus implies a high level of human interference.

The second gradient pertained to the distance between survey sites and the forest edge. Survey sites were classified as being located deep within the

Fig. 3.1. Illustration of the gradient of land use intensity within the forest. (a) Relatively unmanaged interior coffee forest site; (b) slightly managed interior coffee forest site; (c) managed coffee forest site; and (d) intensively managed site.

forest or near the forest edge. The edge of a forest is typically more disturbed, both through human influence as well as through natural effects (e.g. greater exposure to wind and to species living in the farmland).

The third gradient related to whether forest sites had been forested for a long time or if they have regenerated from farmland in the last few decades. This was determined by referring to forest maps and comparing present (2015) and past (1973) land use. Areas that show as forests in both present and past maps were considered as primary forests, while areas that were farmland in the past and are forests in the present were considered as secondary (i.e. regrowth) forests.

We found 113 tree and shrub species in the forest, which belonged to 40 families. The most numerous species were forest specialists, of which there were 45. A total of 30 generalist species and 38 pioneer species were also found. Forest specialist species were defined according to existing literature as those that have strictly defined environmental requirements for their survival and reproduction, such that they typically do not grow outside forested areas. Examples found in the study area are *Pouteria adolfi-friederici*, *Podocarpus falcatus*, and *Schefflera abyssinica*. Generalist species are those that can tolerate a broad range of environmental requirements, and therefore can thrive under various conditions, not only in the forest. An example is *Albizia gummifera*. Pioneer species are those that are able to regenerate quickly in an open area – this could be a natural forest gap created by an old tree collapsing or an open area created by human disturbance. Following such disturbance, pioneer species are the first to grow and colonise an open area. An example is *Croton macrostachyus*. The most widespread specialist species was *Coffea arabica*, which was found at 78 sites. The most widespread generalist species was *Maytenus arbutifolia*, and this was observed at 64 sites. *Vernonia auriculifera* was the most widespread pioneer species, found at 50 sites. Forest and generalist species occurred in somewhat different locations of the landscape, but also overlapped in many areas.

Our findings indicated that the three gradients of human disturbance – coffee forest management intensity, distance from the forest edge, and forest history – significantly influenced the composition of woody plant communities. First, the intensity of coffee management negatively influenced forest specialist species. That is, as the intensity of coffee management increased in a specific area, fewer forest specialist species were found. Species that were negatively affected by the intensity of coffee management in our study included, for example, *Cassipourea malosana*, *Chionanthus mildbraedii* and *Pouteria adolfi-friederici*. Distance from the forest edge positively influenced forest specialist species. This means that survey plots in the forest interior hosted more specialist species than plots closer to the forest edge. In contrast, distance from forest edge negatively influenced the number of generalist species and pioneer species – suggesting that disturbed locations near the forest edge were especially suitable for generalist and pioneer species.

In combination, these findings reveal that different parts of the forest were used by distinctive groups of species. Therefore, different areas have distinct biodiversity conservation values. Relatively undisturbed locations in the forest interior are especially critical for forest specialists, but many other locations in the forest can support a rich diversity of generalist and pioneer species.

Finally, we found that locations that have only recently regenerated into forested areas (secondary forests) had a different species composition from areas that had been forests for a much longer time (primary forest). Secondary forests had fewer forest specialist species than primary forests. This shows that human disturbance influences the composition and diversity of trees, and can pose a threat to forest specialists in particular.

Historical effects of land use change on woody vegetation

As illustrated by our findings on secondary versus primary forest sites, landscape changes can influence the types of species that occur in a particular location. Generally speaking, two types of effects can be distinguished, namely *extinction debt* and *immigration credit*. An extinction debt exists when a landscape contains a species that is left over from a previous land use, but such that this species does not reproduce in the altered environment and therefore and is no longer able to maintain its population. When an extinction debt is present, certain species are doomed to go locally extinct in the foreseeable future, but for long-lived species such as trees, this can sometimes take many years. An immigration credit refers to the opposite situation, namely a situation in which species are gradually being added to an area that underwent land use change. However, because species are only gradually being added to a location, the location has not yet reached its full potential in species diversity. In our study, we examined communities of trees and shrubs in the farmland, to test whether historical land use had caused an extinction debt or perhaps an immigration credit in some locations.

Based on a comparison of satellite images between the 1970s and 2015 (see Methods box), we found that when land use underwent a change from forest to farmland, forest species rapidly declined and disappeared from the farmland, suggesting there was no extinction debt in the farmland.

In contrast, we found evidence of an immigration credit in farmland for generalist and pioneer species. Old farmland supports a higher diversity of generalist and pioneer species than recently established farmland (Fig. 3.2). Notably, forest specialists were not included in this process of gradual species accumulation, because as discussed above, they were restricted to the forest interior and often lost from farmland immediately after its establishment.

Our findings show that farmland in southwestern Ethiopia is therefore important not only for agricultural production but also for hosting a diversity of (generalist and pioneer) tree species. These tree species, in turn, provide habitat for other elements of biodiversity such as birds (see Chapter 4); and they generate important benefits for local people (Chapter 6). These results suggest the need to broaden conservation strategies to also consider farmland, such that local people are supported in their practice of growing and retaining different types of pioneer and generalist tree species.

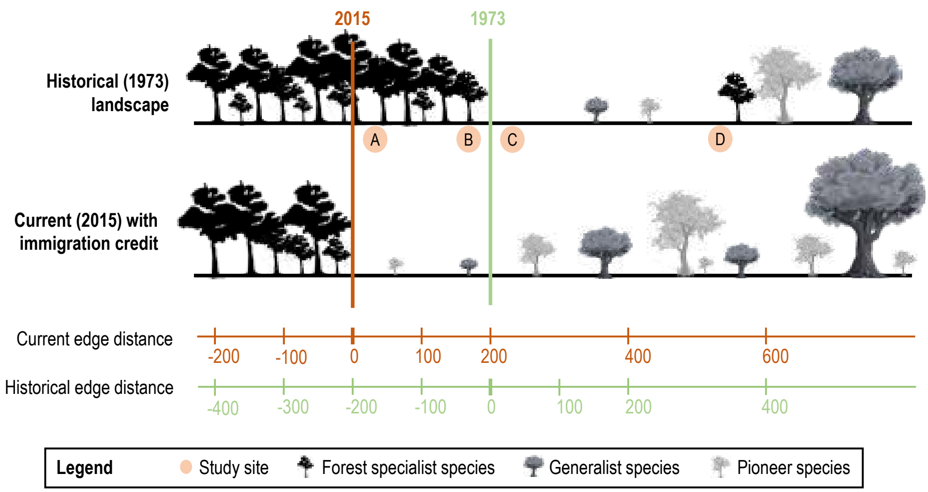


Fig. 3.2. Schematic depiction of the effects of land use change on tree species composition in the study area. The green line represents the forest edge in 1973, and the red line represents the current (2015) forest edge. Tree species diversity in farmland is highest in long-established farmland, suggesting an immigration credit.

Key insights for policy and practice

- To conserve woody plant diversity, conservation measures should encompass the entire landscape mosaic, including both forest and farmland.
- Large and undisturbed forest sites need to be protected to maintain forest specialist species.
- Native species should be prioritised in managed and regenerating forests.
- Policies should support not only the production value of farmland but also recognise its value for biodiversity conservation.

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CHAPTER 4

Bird diversity in farmland and forest

Summary

- Both farmland and forest provide important habitat for numerous bird species.
- Farmland supports a more diverse suite of species than forests, but forests offer vital habitat for sensitive species and those with specialized diets.
- Human disturbance to the forest, including for coffee production, can adversely affect bird species that are dependent on forests.

Introduction

Similar to the findings on woody plants outlined in the previous chapter, birds, too, are diverse and occur throughout the landscapes of southwestern Ethiopia. In this chapter, we look at bird diversity patterns and compare bird diversity in forest and farmland settings. We also consider environmental features that make different parts of the landscape suitable for birds and reflect on management implications.

Methods

Location: Forest surveys were conducted in five kebeles (i.e. *Kuda Kufi*, *Difo Mani*, *Gido Bere*, *Kela Harari*, *Borcho Deka*) belonging to three woredas in Jimma Zone, namely *Gumay, Setema,* and *Gera*. Farmland surveys were conducted in the same kebeles and one additional kebele, namely *Bere Weranigo*.

Bird surveys were conducted throughout the landscape, including at 83 sites in farmland and 66 sites in the forest. In farmland, survey points included arable fields, pastures and homegardens. In the forest, survey points were strategically placed to capture gradients in the landscape such as remoteness and coffee management intensity.

Data collection: At each survey point, birds were surveyed using 15-minute point counts, where all individuals heard or seen within a 1 ha circle were noted. Surveys occurred between 6 and 10:30 am.

Data analysis: Non-metric multi-dimensional scaling, detrended correspondence analysis, canonical correspondence analysis and generalized linear mixed modelling were used to statistically analyse the data.

Differences between farmland and forest bird communities

Southwestern Ethiopia is an important area that hosts many different kinds of birds. In total, we observed 3137 individual birds belonging to 131 species. Of these species, 13 were endemic to Ethiopia and Eritrea. Endemic species are those that naturally occur only within specific geographic areas.

We found marked differences in bird communities between farmland and forest areas. Overall, farmland supported a higher number of different species than forests. In farmland, we found a total of 112 species, while we found 76 species in forests (Fig. 4.1). The species found in the farmland represented a diverse suite of birds. They included weavers (e.g. Baglafecht weaver Ploceus baglafecht), doves and pigeons (e.g. Red-eyed dove *Streptopelia semitorquata*), flycatchers (e.g. Pale flycatcher *Melaenornis pallidus* and Abyssinian Slaty flycatcher *Melaenornis chocolatinus*) and sunbirds (e.g. Variable sunbird *Cinnyris venustus* and the Tacazze sunbird *Nectarinia tacazze*). This diversity of birds is likely to result from many different types of environments and available food sources within farmland. In particular, the farmland mosaic in the study area consists of arable fields, grazing areas and homegardens. Within these major land use types, there is a high level of structural diversity because of the widespread presence of trees, shrubs, and live fences. Different bird species use these different environments. For instance, sunbirds, which feed on nectar and insects, were typically found in homegardens where their food was readily available. The Red-eyed dove, in contrast, feeds on grains, and was often found in arable fields.

Overall bird diversity in the forest was lower. Different survey points within the forest had bird communities that were more similar to one another than different locations within farmland – that is, there was a lower level of community change or turnover between different survey points in the forest. Importantly however, unlike in the farmland, forested locations supported a higher number of sensitive species of conservation concern. Such sensitive bird species are more likely to be negatively affected by disturbances to the forest ecosystem because of their very specific habitat requirements. The concentration of highly sensitive bird species in forest patches underscores the critical importance of the remaining forest ecosystems for biodiversity. We explore this in more detail below.

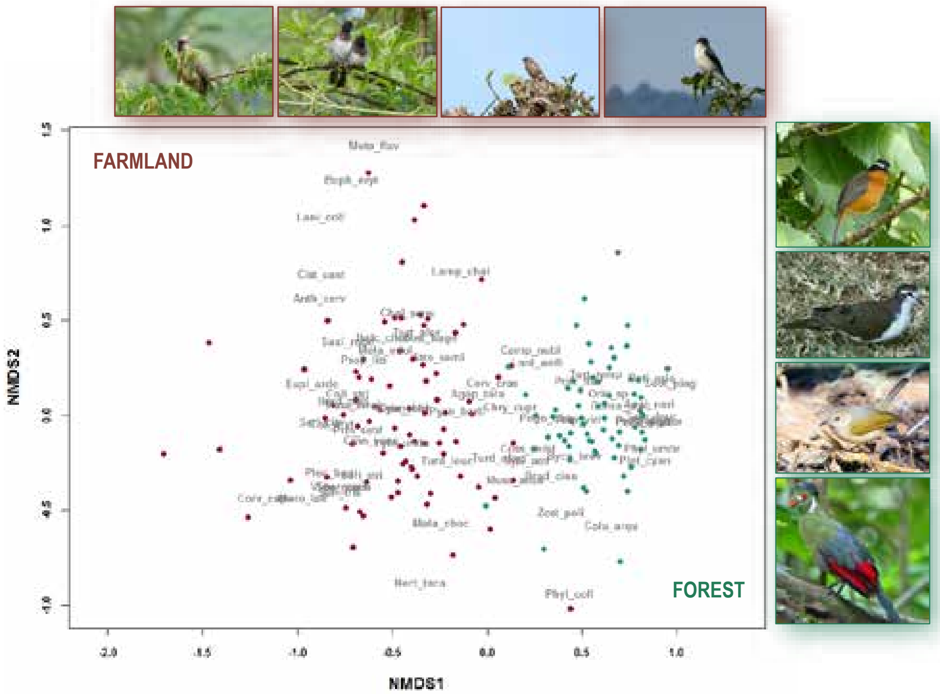

Fig. 4.1. Ordination plot (generated via non-metric multidimensional scaling) separating farmland and forest bird communities. Species names are as follows, from left to right and top to bottom: Speckled Mousebird *Colius striatus*, Common Bulbul *Pycnonotus barbatus*, Swainson's Sparrow *Passer swainsonii*, Common Fiscal *Lanius collaris*, Robin Chat *Cossypha* spp., Tambourine Dove *Turtur tympanistria*, Grey-backed Camaroptera *Camaroptera brachyura* and White-cheeked Turaco *Tauraco leucotis*. A total of 112 bird species were found in farmland while 76 were found in the forest. The total number of species found in the landscape was 131. Photo credits to Wikimedia Commons; Photographers: Doug Janson (2003), Derek Keats (2012) & Alan Manson (2007).

Effect of coffee cultivation on forest bird communities

In the study area, coffee is economically important as a component of diversified local livelihoods – a topic that we discuss in detail in Chapter 9. However, while the economic value of coffee has effectively protected the forest from being cleared in areas where coffee production is possible, intensive use of the forest for coffee production could also be an ecologically significant source of human disturbance for forest animals, such as birds. We therefore specifically set out to investigate how gradients of human disturbance within the forest might affect bird communities.

Two types of disturbance gradients were considered. The first was a gradient of coffee management intensity. This gradient was already discussed in the previous chapter on tree biodiversity – it essentially relates to the degree to which a given location is used for increasingly intensive coffee production. The second gradient was related to the combined effect of changing environmental conditions as one moves from the forest edge to the forest interior. Locations at the forest edge are exposed to different levels of light and wind, and may support different plant species. Moreover, they are likely to be more heavily impacted by human activities such as firewood collection. In contrast, the forest interior is characterized by having a lot of potentially undisturbed forest around any given survey point, which could be important for birds that are sensitive forest specialists.

We found that birds responded in statistically significant ways to both types of gradients. Bird species that were highly dependent on forest habitat responded positively to both gradients (Fig. 4.2). The number of such specialized bird species increased from the edge towards the forest interior. Moreover, the abundance of dietary specialists or birds that have very specific food requirements increased with more natural forest conditions – that is, it decreased with increasingly intensive coffee production. Such dietary specialists included insectivores (birds that feed on insects). Examples of such insectivores are the African Hill Babbler *Pseudoalcippe abyssinica* and the Narina Trogon *Apaloderma narina*. This finding is important because insectivores are globally recognized as one of the dietary guilds most vulnerable to human-induced landscape change (where dietary guilds refer to groups of species that rely on the same resources). Because insectivores can also control insect pests, their abundance is important not only for biodiversity conservation but could also have benefits for people. We return to the idea of such "ecosystem services" provided to people by the

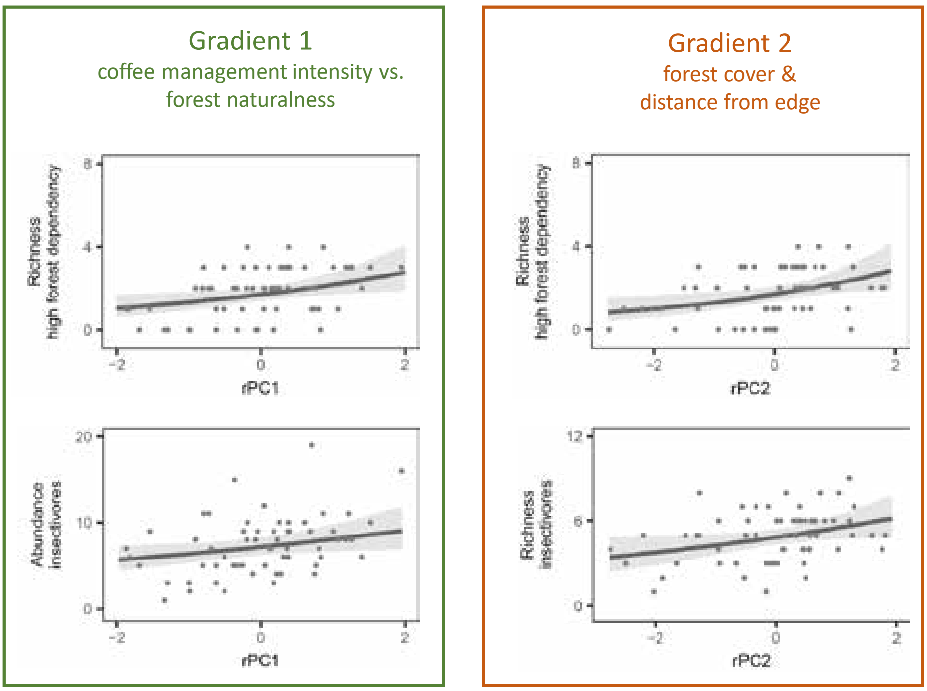

Fig. 4.2. Responses of bird species to coffee management intensity and distance from the forest edge. Responses indicate that low levels of coffee management, and locations in the forest interior, were most suitable to specialist bird species.

natural environment in Chapters 6 and 7. Our findings indicate that the least disturbed forest interior, as well as locations where coffee management is limited in intensity, are very important for specialist birds. Other groups of birds did not respond to these two disturbance gradients but were found in all parts of the forest. These generalist species included omnivorous species such as the Ethiopian boubou *Laniarius aethiopicus*, ground foragers such as the Senegal coucal *Centropus senegalensis* and Red-eyed dove *Streptopelia semitorquata*, and non-migratory species such as Robin chats *Cossypha* spp.

Implications for conservation

At present, the landscapes in southwestern Ethiopia support a high diversity of bird species. Our findings indicate that this bird diversity results from a diversity of conditions in the landscape. Different groups of birds responded differently to these variable landscape conditions. Therefore, in order to maintain bird biodiversity, it is important to maintain a diversity of habitats in the landscape. This should include structurally complex farmland, which is where generalist bird species can thrive, as well as largely undisturbed, large tracts of forest where highly sensitive forest bird species can flourish.

This combination is important because simplification of habitats in either the farmland or the forest is likely to reduce bird diversity overall. Because different species complement one another in terms of their functions in the ecosystem, a diversity in habitats will benefit the long-term resilience (i.e. the capacity to respond, recover and adapt to changes) of regional bird communities and ecosystems.

Key insights for policy and practice

- A diverse landscape consisting of large, relatively undisturbed tracts of forest and structurally variable farmland should be promoted in order to sustain current levels of bird diversity.

- Management strategies and certification schemes that support suitable farming practices should be developed as tools to foster landscape complexity and heterogeneity.

- Policies that protect large and undisturbed tracts of forest need to be effectively enforced to keep forests intact and protect forest specialist bird species.

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CHAPTER 5

Mammal diversity in the forest

Summary

- Southwestern Ethiopia is an important area for mammal conservation.
- It supports many species of mammals, including large predators.
- Mammals are intrinsically important and also perform functions that are beneficial for humans.
- Several mammal species would be adversely affected by a future growth in the human population, especially if new houses encroach into forested areas (including into forest with coffee management).

Introduction

In addition to birds and trees, we also studied mammal diversity. We were interested to learn more about mammals because they can be negatively affected by landscape change, and because they are important species for conservation. Some mammal species need large areas to live in, and some are highly sensitive to disturbance. Mammals perform functions that are important for ecosystems and for people. For example, pigs and primates disperse seeds, and this assists in forest regeneration. Other mammal species are at the top of the food chain – so called "apex predators" – and because of this, they are important in controlling populations of species that cause damage to crops and people. The leopard is an example of such a species that occurs in our study area. On the other hand, some mammals can cause problems to people by disrupting and causing losses in local livelihoods. Conflict between people and wildlife is a major challenge in southwestern Ethiopia and for this reason, an entire chapter specifically focuses on this problem later in the book (Chapter 8).

This chapter focuses on patterns of mammal diversity in different parts of the forests in southwestern Ethiopia. We first provide an overview of the mammal community throughout the landscape. We then discuss selected species in some level of detail. This will include the leopard, which is an ecologically important apex predator, as well as several species identified by local people as potentially hazardous crop raiders (e.g. the baboon and the bushpig). We conclude the chapter by considering how future changes in human population density might affect mammal communities in the forest.

Methods

Location: This work was conducted in four kebeles namely *Kuda Kufi, Difo Mani, Gido Bere, and Kela Harari*. These kebeles spanned an elevation range from 1900 to 3000 meters above sea level.

Data collection: Data was collected using motion-triggered Bushnell Trophy Cam HD Max cameras, which were placed at 96 sites from the forest edge to the forest interior. Cameras collected data over a period of 13 months. On average, an individual camera collected data at a given site for 118 days.

Data analysis: ExifPRO software was used for manual classification of the pictures. To analyse how mammals can be affected by future changes in human population density, generalized additive mixed models were used.

The forest mammal community

Over half a million photos were captured from camera traps during the data collection period. Of these, approximately a third corresponded to wild mammal species and nearly a fifth corresponded to people (the rest were "empty" pictures, e.g. caused by vegetation moving in the wind). A total of 33 mammal species from 16 families were identified, including groups such as hares where the specific species could not always be identified from the photos (Table 5.1). A range of 2-18 species was found at a given site where a camera trap had been installed. On average, ten mammal species were recorded per site.

The most common species were the baboon, bushduiker, bushpig, genets, and bushbuck (Fig. 5.1). The bushpig and bushbuck were found at 89% of sites, bushduiker and baboon were found at 86% of sites, and genets were found at 85% of sites. Typical species of medium abundance included the porcupine, which was found at 72% of sites, the civet found at 58% of sites, the giant forest hog found at 48% of sites, and the mantled guereza found at 47% of sites (Table 5.1). Rare species included the caracal, African wildcat, aardvark, and jackals, each of which was found at less than 10% of sites.

Table 5.1. Mammal species recorded by camera traps in the forests of southwestern Ethiopia, in a total of 96 sampling sites and during 10955 camera trap days. Nomenclature follows Wilson and Reeder (2005). % sites: proportion of sites where the species was detected; Nights: total number of nights with detection of species.

ORDER & Family	Species	Common name	% sites	Nights
HYRACOIDEA				
Procaviidae[#]	*Heterohyrax brucei, Procavia capensis*	Hyrax	44	144
TUBULIDENTATA				
Orycteropodidae	*Orycteropus afer*	Aardvark	3	4
PRIMATES				
Galagidae	*Galago senegalensis*	Northern lesser galago	13	64
Cercopithecidae	*Cercopithecus neglectus*	De Brazza's monkey	19	49
Cercopithecidae	*Cercopithecus mitis*	Blue monkey	25	49
Cercopithecidae	*Chlorocebus aethiops*	Grivet monkey	40	252
Cercopithecidae	*Papio anubis*	Olive baboon	86	1325
Cercopithecidae	*Colobus guereza*	Mantled guereza	46	143
RODENTIA				
Sciuridae	*Heliosciurus gambianus*	Gambian sun squirrel	11	29
Hystricidae	*Hystrix cristata*	Crested porcupine	72	346
Muridae	*Lophiomys imhausi*	Crested rat	8	16
LAGOMORPHA				
Leporidae[*#]	*Lepus saxatilis, L. capensis*	Hare	16	101

ORDER & Family	Species	Common name	% sites	Nights
CARNIVORA				
Felidae	*Felis lybica*	African Wildcat	1	1
Felidae	*Caracal caracal*	Caracal	2	2
Felidae	*Panthera pardus*	Leopard	28	57
Viverridae	*Civettictis civetta*	African civet	58	319
Viverridae#	*Genetta maculata, G. genetta*	Genets	85	936
Herpestidae	*Atilax paludinosus*	Marsh mongoose	8	27
Herpestidae#	*Herpestes sanguinea, H. ichneumon*	Mongoose	18	35
Herpestidae	*Ichneumia albicauda*	White-tailed mongoose	21	51
Hyaenidae	*Crocuta crocuta*	Spotted hyena	18	31
Canidae#	*Canis mesomelas, C. adustus*	Jackals	9	19
Mustelidae	*Mellivora capensis*	Ratel / honey badger	18	27
Suidae	*Phacochoerus africanus*	Warthog	32	233
Suidae	*Hylochoerus meinertzhageni*	Giant forest hog	48	217
Suidae	*Potamochoerus larvatus*	Bushpig	89	870
Bovidae	*Tragelaphus scriptus*	Bushbuck	89	868
Bovidae	*Sylvicapra grimmia*	Bushduiker	86	1274
Bovidae	*Syncerus caffer*	African buffalo	14	37

*not identified to the species level;
#grouped for the purpose of data summary and analysis.

Fig. 5.1. Some of the abundant (A) and rare (B) mammals found in southwestern Ethiopia: (a) baboon; (b) bushduiker; (c) genet; (d) bushbuck; (e) bushpig; (f) giant forest hog; (g) buffalo; (h) De Brazza monkey; (i) caracal; (j) African wildcat; (k) slender mongoose; and (l) honey badger.

Selected species in detail

The overall composition and "health" of a mammal community is sometimes indicated by the presence of apex predators. Leopards and spotted hyenas were the apex predators present in the landscape we studied. Interestingly, despite substantial sampling effort and although some elders mentioned sightings in the past, we did not record any lions (*Panthera leo*) during this study. Apex predators help control the populations of baboons and pigs either by predation or by creating a so-called “landscape of fear”. A landscape of fear is the area where prey perceives to be at risk of predation and therefore alters its behaviour – for example, in the presence of a predator, baboons might be less likely to move away from sheltered areas (where they are relatively safe) into open areas where they are at greater risk of being attacked by a predator. Both through actual predation and through the creation of a “landscape of fear”, apex predators potentially provide a beneficial function to people by helping to control the population of animal species that can disrupt local livelihoods.

Spotted hyenas were also found in the study area. Unlike leopards, which are elusive and solitary, hyenas are gregarious and opportunistic in their hunting behaviour. They also tolerate a higher level of human interference, and are therefore more commonly encountered by people than leopards. Leopards were recorded at 28% of sites. Interestingly, we obtained photographs of the relatively rare, black (“melanistic”) form of the leopard, as well as evidence of mating behaviour, and of a juvenile being carried by its mother (Fig. 5.2).

Fig. 5.2. Camera trap pictures of the leopard: (a) adult male; (b) melanistic form; and (c) mating behaviour.

Species that were potentially hazardous due to their impact on local livelihoods included the baboon, grivet monkey, bushpig, warthog, and a number of meso-carnivores including the white-tailed mongoose and the civet. Chapter 8 will discuss in greater detail how certain species adversely impact human livelihoods and what options are available to address the resulting challenges.

Future changes

Due to the increasing impact of humans on natural ecosystems such as forests, we assessed what future landscape changes caused by human population

growth may mean for mammals. To this end, we simulated three different levels of human population growth and three different types of housing development. For each simulation, we investigated the likely effects on forest cover and mammals. We found that some species like the leopard, the bushbuck and the warthog can be negatively affected by high human population density in the landscape. The severity of negative impacts for these species increases when future houses encroach into the forest, and when forest with coffee management is not protected against housing development. The least damaging outcomes for mammals are achieved when housing development occurs within existing residential areas, and when forest with coffee management is protected. However, not all mammal species will respond in the same way. Some opportunistic species such as the grivet monkey and the mantled guereza can tolerate relatively high levels of human population in the landscape.

Key insights for policy and practice

- Mammal communities in southwestern Ethiopia are highly diverse and need to be a priority for conservation.
- Forest with coffee management can protect some mammal species, but large, undisturbed areas of natural forests are needed to protect the entire mammal community. These areas need to be maintained and protected from human disturbance.
- Further encroachment into the natural forest and the conversion of forest with coffee management would have major negative consequences for the mammal community.
- Housing development should take place within existing farmland; forest with coffee management should be retained; and efforts to reduce human population growth should be prioritized.

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III. ECOSYSTEM SERVICES

CHAPTER 6

Ecosystem services from the forest and farmland

Summary

- Landscapes in southwestern Ethiopia are highly diverse in both biodiversity and ecosystem services. People highly depend on a large number of services provided by forests and farmland.
- Benefits from the environment are not evenly distributed across different groups of people.
- A minimum level of tree diversity is needed in farmland and forests to provide ecosystem services.

Introduction

The previous three chapters summarised biodiversity patterns in southwestern Ethiopia. Biodiversity is important in its own right, but also because of its impacts on the lives of people. These impacts could be either positive (bringing benefits) or negative (bringing disbenefits). This chapter and the following two investigate the benefits and disbenefits to people in southwestern Ethiopia, who live side by side with a vast amount of other species. Benefits flowing from the environment are also referred to as ecosystem services (see Chapter 1), while disbenefits are called ecosystem disservices.

The benefits provided by the environment take various forms such as direct provisioning of fuelwood, medicinal plants, and wood for house construction; regulating services such as prevention of soil erosion and flooding; and cultural benefits such as the importance of old, large trees as a venue for community meetings. This chapter focuses on the general benefits flowing from farmland and the forest. The specific benefits provided by insects or fungi, as well as their disbenefits, are then discussed in Chapter 7, while Chapter 8 specifically focuses on human-wildlife conflicts.

This chapter first highlights the most important ecosystem services from forests and farmlands for different groups of beneficiaries. It then provides a brief discussion on the relationship between biodiversity and ecosystem services. Because of the distinctive importance of trees in the study area, we also include a separate sub-section on the benefits that people receive from trees.

Methods

Location: The studies focused on ecosystem beneficiaries, on the relationship between tree diversity and ecosystem services, and on tree uses were conducted in six kebeles namely *Kuda Kufi, Bere Weranigo, Difo Mani, Gido Bere, Kela Harari*, and *Borcho Deka* in the woredas *Gumay, Setema,* and *Gera*.

Data collection: In order to identify different beneficiaries of ecosystem services, a quantitative survey was conducted with 367 households. A subset of the respondents were interviewed using open-ended questions. For the study of the relationship between woody plant diversity and ecosystem services, 181 plots of 20 m x 20 m were surveyed (109 in forest, 72 in farmland). For the woody plant use and management study, 192 plots were surveyed (109 in forest, 72 in farmland, 11 in homegardens). Tree and shrub species with a height of at least 1.5 m were recorded. Diameter at breast height (DBH) of trees was measured and species were identified. Data on tree uses was collected through interviews with 180 households.

Data analysis: Survey data was analysed using a number of multivariate techniques such as hierarchical clustering, non-metric multidimensional scaling, and ranking of factors that mediate access mechanisms. The relationship between tree diversity and ecosystem services was determined using linear mixed effect models. For the tree uses study, data from interviews was analysed using descriptive statistics and by calculating the redundancy of species for a given purpose.

Beneficiaries of ecosystem services from the forests and farmlands

The environment provides different kinds of benefits to people. However, the distribution of benefits can be uneven such that some people receive more benefits from the environment while others receive less. Our study identified five groups of beneficiaries. These groups differed in the types and levels of benefits they received (Fig. 6.1). The five groups were 'generalist beneficiaries' (16%), 'forest beneficiaries' (31%), 'cropland beneficiaries' (24%), 'generalist losers' (19%), and 'cash croppers' (10%). The generalist beneficiaries were characterised by a high level of benefits both from forests and farmlands. In particular, they received high benefits from the cash crop coffee. Forest beneficiaries received more benefits from forests than from farmlands. They also benefitted from coffee, but less so from other types of crops. Cropland beneficiaries received high benefits from various crops, excluding coffee. Of particular concern was a group of "generalist losers" who had distinctively poor access to many of the potential benefits the environment provides. Finally, cash croppers received high benefits from the cash crop khat (a plant that can be chewed as a stimulant) as well as from various types of food crops.

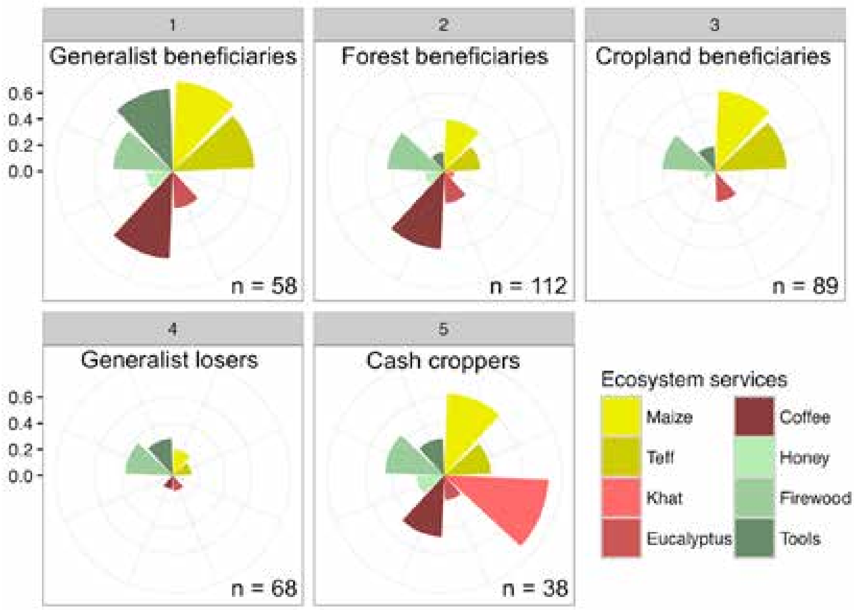

Fig. 6.1. Profiles of different groups of ecosystem service beneficiaries.

The different groups of beneficiaries encountered barriers to accessing the potential benefits offered by the environment. The most common of these access barriers included economic reasons, wildlife damage, and shortage of labour. In particular, generalist losers who received the lowest levels of benefits were distinctly constrained from access to ecosystem services by a combination of shortage of farmland, forest ownership, and economic challenges. They perceived the demarcation of forests as restricting their access to various forest benefits. Their experience was different from those who held usufruct certificates for coffee plots in forests – who received relatively higher levels of benefits because of their forest use rights. The generalist losers were also severely constrained by either low access to farmland or lack of economic means to purchase farm inputs, thus limiting the benefits that they could derive from farmlands.

These findings suggest that people differentially benefit from the goods and services provided by the environment. They also differed in the factors and mechanisms that shape their access to the benefits. These key differences should be considered in planning for interventions to facilitate equity in the distribution of benefits from the environment.

The relationship between biodiversity and ecosystem services

It has long been recognized that diverse ecosystems provide more diverse and stable functions compared to highly simplified ecosystems. How does this general observation apply to southwestern Ethiopia specifically in the context of trees and their management? To answer this question, we investigated the relationship between tree diversity and ecosystem services.

Across the 181 survey plots in farmland and forests, a total of 128 woody plant species were observed representing 43 families. Seventy-two percent (72%) of the species observed occurred in more than one land use type, while 11% were exclusively observed in farmlands, 10% exclusively in forests without coffee management, and 7% exclusively in forests with coffee management. While there was an overlap in the potential benefits provided by different tree species under different land uses, some benefits were distinctly higher in a specific land use type. For example, provisioning of materials for house construction, fuelwood, and honey production were highest in forests with coffee management. Household utilities, materials for constructing fences, and poles and timber, were distinctly most abundant in forest without coffee management. Farmland also provided materials for fence construction, fuelwood, and materials for house construction, but at lower levels relative to forests.

In farmland, we found that as tree diversity increased, the diversity of ecosystem services also rapidly increased (Fig. 6.2). This relationship was especially true for the first ten species observed in 20 m x 20 m plots, where there was a rapid increase in the diversity of ecosystem services. This finding could indicate that local people actively manage trees in farmland in such a way as to maintain and increase landscape multifunctionality. Landscape multifunctionality is the ability of a landscape or different land use types within the landscape to simultaneously provide multiple services. Since ecosystem services do not occur separately, local people appear to manage their land for multiple ecosystem services rather than optimizing land use to maximise one or few services.

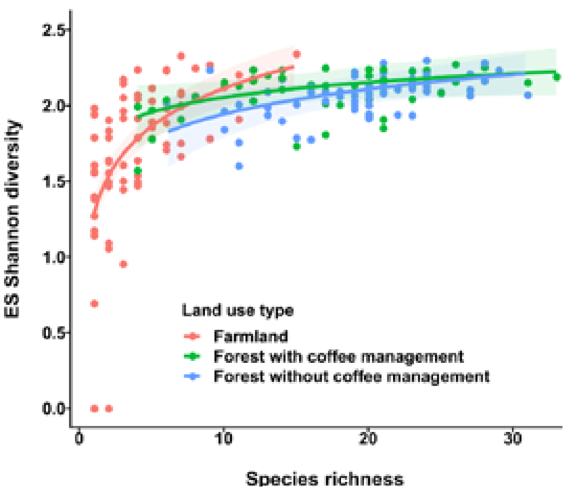

Fig. 6.2. Relationship between woody plant species richness and ecosystem services Shannon diversity in farmland (red), forest with coffee management (green), and forest without coffee management (blue).

In forests, the diversity of ecosystem services for any survey plot was typically higher than in farmland plots. A possible reason for this is that there were more trees in forest plots, and therefore both more individuals and more different types of tree species compared to farmland plots. Interestingly however, in the context of forests, the relationship between tree diversity and ecosystem services was flatter. This could be because adding more species to an already diverse system did not add much additional functionality.

In combination, our findings from the farmland and forest imply that a minimum tree diversity is important to provide essential ecosystem services to people. Increasing tree diversity in farmland could be highly effective in improving landscape multifunctionality.

Local uses and management of trees and shrubs

Having established that a high diversity of trees is related to a diversity of benefits from trees, we also investigated the specific benefits that people derived from different types of trees. Many species were used for livelihoods. In total, there were 90 species including 17 exotic species that were used by local people and that occurred within our survey plots.

The tree species were used for 11 different purposes. Some examples are presented in table 6.1. Overall, 17 tree and four shrub species (including *Albizia* spp. representing *Albizia gummifera* and *Albizia schimperiana*, and *Eucalyptus* spp. representing multiple species of *Eucalyptus*) were the most widely used, based on the high number of local residents who reported using them, and the variety of purposes they served. These included *Erythrina brucei*, *Ehretia cymosa*, *Ocimum lamiifolium*, *Chionanthus mildbraedii*, *Cordia africana*, *Albizia* spp., and *Croton macrostachyus*. The most versatile species or those with the highest number of uses were *Croton macrostachyus*, *Vernonia amygdalina*, *Cordia africana*, *Millettia ferruginea*, *Pouteria adolfi-friederici*, *Vernonia auriculifera* and *Syzyium guineense*. Other species were important for very specific purposes and were therefore difficult to find replacements for. Examples of such species included *Cordia africana* and *Pouteria adolfi-friederici*, which were used for poles and timber. There were only few readily available alternatives for these species.

Table 6.1. Use of woody plants, total number of species used for each purpose, and examples of some of the most widely used species. Note that individual species may be used for multiple purposes.

Use	Total number of species used	Example species (Latin and local names)
House construction	52	*Eucalyptus* spp. (Baargamoo) *Syzygium guineense* (Baddeessa) *Croton macrostachyus* (Bakkannissa)
Farm implements	42	*Ehretia cymosa* (Ulaagaa) *Chionanthus mildbraedii* (Gagamaa) *Olea welwitschii* (Bayaa)
Fuelwood	38	*Albizia* spp. (Ambabbessa) *Croton macrostachyus* (Bakkannissa) *Millettia ferruginea* (Astiraa)
Honey production/ beehives	37	*Albizia* spp. (Ambabbessa) *Croton macrostachyus* (Bakkannissa) *Vernonia amygdalina* (Ebicha)
Fences	36	*Erythrina brucei* (Beroo) *Euphorbia abyssinica* (Adaamii) *Vernonia auriculifera* (Reejii)
Medicines	25	*Ocimum lamiifolium* (Dammaakkasse) *Croton macrostachyus* (Bakkannissa) *Vernonia auriculifera* (Reejii)
Coffee shade	23	*Albizia* spp. (Ambabbessa) *Millettia ferruginea* (Astiraa) *Croton macrostachyus* (Bakkannissa)
Household utilities	21	*Cordia africana* (Waddessa) *Ficus sur* (Harbuu) *Pouteria adolfi-friederici* (Qararoo)
Enhancement of soil fertility	18	*Albizia* spp. (Ambabbessa) *Vernonia amygdalina* (Ebicha) *Croton macrostachyus* (Bakkannissa)
Animal fodder	17	*Vernonia amygdalina* (Ebicha) *Dracaena steudneri* (Yubdoo) *Dracaena fragrans* (Eemoo)
Poles and timber	11	*Cordia africana* (Waddessa) *Pouteria adolfi-friederici* (Qararoo) *Ficus sur* (Harbuu)

The majority of the households surveyed had usufruct (or use right) certificates for their farmland plots (i.e. for arable land, grazing land and homegardens). However, only about a third felt that their land tenure was truly secure. This was markedly different for forest plots for coffee production in which less than half of those who were surveyed had a usufruct certificate, and only a quarter perceived their tenure to be secure. Land certificates had not been issued for forest areas that were not managed for coffee. Interestingly, the majority of residents had a sense of ownership and management responsibility for their farmland and the forest plots they managed for coffee, but no such perception toward forests without coffee management.

In terms of management, one positive finding is that tree regeneration was ample throughout the landscape, in both farmland and forest. Most of the widely used tree species in farmland (90%), forests without coffee management (75%), and forests with coffee management (55%) were characterised as having a healthy population structure. These species had a high number of young individuals and increasingly fewer individuals that were older and larger. However, some species, including several with few replacement options, appeared to be over-harvested in some environments – especially in forests that were managed for coffee production.

Overall, this component of our research underlines that woody plants are very important for rural households and for maintaining the multifunctionality of the landscape. It also revealed that tenure security may influence people's sense of responsibility in managing various parts of the landscape.

Key insights for policy and practice

- Access of disadvantaged social groups to ecosystem services should be enhanced by addressing key barriers.
- Agricultural policies that support and incentivise the maintenance of a diversity of trees in farmland are needed.
- Measures to prevent overharvesting of forest goods and services, particularly in relation to specific tree species, need to be put in place.

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CHAPTER 7

Beneficial and harmful insects and fungi across the landscape

Summary

- The honey bee is semi-wild in Ethiopia and provides important pollination services to crops, as well as generating honey. Other wild bees also pollinate crops, but many of these are low in abundance, which may put a limit on crop yields.
- Ants, spiders, flies, moths, parasitoids and beetles are among the additional types of insects and other arthropods that impact on people, sometimes in surprising ways.
- In the absence of detailed ecological knowledge on all of these species, the best management approach seems to be to support a variation in tree cover, tree species and grass cover throughout the landscape. This can provide important habitat to the natural enemies of various crop pests.
- In addition to insect pests, there are also several fungal diseases on coffee that are problematic for farmers. Future research will clarify how these fungi vary in relation to climate and management types.

Introduction

The previous chapter discussed many of the general benefits flowing from the forest and from farmland, and especially from trees. In this chapter, we focus on insects and other arthropods as well as fungi. These, too, can provide numerous important benefits to people, but some of them can also bring disbenefits. We first discuss bees, before then focusing on other arthropods. We conclude the chapter by a discussion of fungal diseases on coffee, highlighting that better understanding such diseases is a key research frontier.

Methods

Location: The studies of beneficial and harmful arthropods and fungi were done in the woredas (districts) of *Gera* and *Goma*.

Data collection: For the coffee pollination study, we surveyed 19 sites with shaded coffee across the landscape. We netted pollinators visiting the flowering coffee during 3 hours in total in each stand. In 28 homegardens that differed in distance to forest edge as well as local complexity in terms of the amount of trees and shrubs in the immediate surroundings, we collected bees using vane traps and pan traps for 67 days in the dry season and 86 days in the wet season. In all of these sites, we also planted rapeseed, but could only monitor its development in 23 sites. When the rapeseed plants had buds, we put bags around some of them to prevent pollinators to enter, and when they flowered, we hand-pollinated some. At the end of the season, we harvested them and evaluated the variation among gardens in terms of the effect of bagging and hand pollination. In 40 home gardens with different complexity in terms of distance from forests and local amount of trees and shrubs, we put out pitfall traps to catch spiders, beetles and ants. We put the animals in alcohol for later identification. In 31 sites with shaded coffee, we surveyed both insect and fungal pests, on 5 shrubs in each stand.

Data analysis: We analysed richness and abundance values against different environmental predictors, such as amount of forest in the surroundings as well as local variables such as canopy cover, using linear or linear mixed models depending of the structure of the data. The pollination experiment was analysed with a linear mixed model.

Bees – important pollinators

The honey bee is popular in southwestern Ethiopia because of the honey it produces. Tube-like beehives are put high up in trees to attract a wild bee swarm, and when the honey is ready for harvest, the bees are chased away, sometimes using smoke. Several plants are considered especially important for honey production, among them trees such as *Schefflera abyssinica*, *Syzygium guuinense* and *Vernonia* spp.

The honey bee is also by far the most important pollinator of coffee. In one of our studies, over 96% of the flower visits on coffee was by honey bees. What is less well known is that many other bee species also live in the landscape. We found that the abundance of these was highest in shade coffee stands with a high species richness in the canopy layer. Even if coffee is self-compatible, it will still benefit from pollination. How much exactly coffee benefits from different types of pollinators remains an open question in the southwestern Ethiopian landscape. A key reason why coffee pollination is difficult to study is that coffee flowers only for a very short time, often just two days.

In addition to coffee, farmers grow many other crops that also benefit from pollination such as rapeseed, onion, pepper, pumpkin, tomato, papaya, mango and various pulses. Many of these species grow in homegardens, and indeed, we found that homegardens were visited by numerous different bee species. Interestingly, the number of different bee species was found to be almost the same in the dry season and the wet season, but the composition of species was found to vary. It seems that large species are somewhat more abundant in the dry season, perhaps because most pollen resources are on trees in that season, a resource that might be more scattered and thus be more reachable by larger bees that can fly longer distances. At present, very little is known about the requirements of different bee species in terms of where they build their nests, when they fly, what kinds of resources they need, and what their general life cycle looks like (Fig. 7.1).

Fig. 7.1. This large carpenter bee is beneficial because it pollinates crops, but it can also be harmful because it nests in dead wood and can create a lot of holes in the wood of buildings. (Photo: Kristoffer Hylander.)

The number of bee species in homegardens was slightly higher in gardens that were close to the forest. However, when we measured the impact of pollination on crops (we used rapeseed – see methods box) we did not find an increase in pollination services closer to the forest. In fact we found out that the rapeseed yield could be substantially increased with additional pollination (hand pollination in the experiment). Although the landscape is heterogeneous and therefore should harbour a rich insect fauna we were surprised to find such a clear pollination deficit in people's homegardens. Even though the richness of insects was quite high, the average abundance of pollinators was relatively low when compared to many other places in the world. At this point, we still do not know why insect abundances are so low, and if this is the reason for the pollination deficit in our experiment.

Ants, spiders, flies, moths, parasitoids and beetles

There is a great diversity and abundance of insects and other arthropods such as spiders in all types of both natural and anthropogenic habitats in southwestern Ethiopia. Some species or groups of species are well-known, while others are seen only if you know precisely what you are looking for. While direct impacts of insects and other arthropods on people – e.g. being stung or bitten – are obvious, the indirect impacts of these species can be very difficult to assess. For example, the *Crematogaster* ant builds nests high up in trees in the forest and in coffee plantations (Fig. 7.2). Ants of this species patrol the surrounding coffee plants, and probably remove caterpillars that feed on coffee leafs. However, the ants might also protect other, so-called scale insects, which are

Fig. 7.2. The typical appearance of an ant nest of the genus *Crematogaster* high up in a shade tree above the coffee shrubs. (Photo: Kristoffer Hylander)

harmful to coffee. On balance, it is therefore not easy to know the net effect of the presence of this ant on the coffee harvest.

Like all plants, coffee shrubs house a variety of associated biodiversity. Three pest species that are frequently observed are the skeletonizer (*Leucoplema doherthi*), the serpentine leaf miner (*Chryphiomystis aletreuta*) and the blotch miner (*Leucoptera* spp). All of them damage the coffee leaves. However, none of them seems to occur in abundances so high that the coffee loses all its leaves. It is possible that there are other antagonistic insect or arthropod species that control these three pest species. One candidate for that is tiny parasitic wasps – so called parasitoids – which lay their eggs inside the larvae that feed on the coffee and thereby eventually kill them. We know very little about the complex interactions among different insect and arthropod species within the coffee system. Based on current knowledge, it is likely that a more heterogeneous system with many tree species and less intensive coffee management is more resilient to outbreaks of various pests. However, more research is needed in this field.

In addition to coffee, other crop species also support many different insects and other arthropods, including ones that feed on the crop, as well as natural enemies that feed on the pest species. Again our understanding of these complex systems is poor, but what we do know is that the abundance of potential enemies of the pests (such as ants) decreases further away from the forests; and we found that spiders are more common in homegardens surrounded by grasslands (Fig. 7.3). It is thus not easy to give advice on how to manage a garden to maximize the positive impact of natural enemies, but homogenization and intensification of land-use most likely would be major threats to the ecosystem service of pest control.

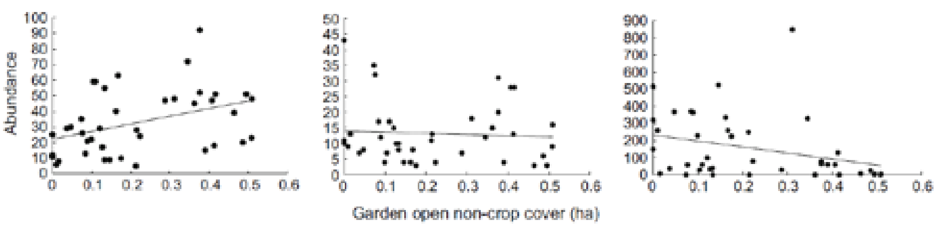

Fig. 7.3. Abundance of spiders (left), beetles (middle) and ants (right) in relation to proportion of open non-crop cover surrounding home gardens. Modified from Lemessa et al. 2015. Landscape Ecology.

Fungal interactions with coffee

In addition to insect pests, fungal diseases can also cause losses in agricultural yields. For example, the most problematic pests on coffee in this region are several different fungal diseases, namely coffee berry disease (*Colletotrichum kahawae*), coffee wilt disease (*Gibberella xylarioides*) and coffee leaf rust (*Hemileia vastatrix*). The effect of coffee berry disease is very obvious to see when a large proportion of the coming harvest turns black and falls off the branches. The rust is seen as orange pustules on the underside of the leaves (Fig. 7.4). This pest is very problematic in many other countries, but seems to be somewhat less detrimental in southwestern Ethiopia. Still, it would be important to understand more about the large variation in severity that is observed both between sites and within sites. There is an ongoing project at Stockholm University that studies the dynamic of the fungal pests across management gradients in southwestern Ethiopia.

Fig. 7.4. Coffee leaf rust (the orange coloured area) on the underside of a coffee leaf. If heavily affected, the leaf will fall off the coffee shrub. (Photo: Kristoffer Hylander).

Notably, not all fungi are harmful. For example, there is a large group of beneficial fungi that colonize the roots and help the plant to take up water and nutrients – the mycorrhizal fungi. Coffee is one of the plants that has arbuscular mycorrhizal (AM) fungi as symbionts.

Key insights for policy and practice

- Nature is diverse and there are numerous species that interact with each other including many tiny species such as arthropods and fungi that are difficult to observe and study. Some of them are beneficial and provide pollination and pest control services, while others are harmful pests.

- There are many good reasons for growing a variety of crops and managing the landscape for multifunctionality, including the likelihood for a better resilience to pest outbreaks and the protection of biodiversity. However, since people grow many different crops and utilize many different types of resources simultaneously, it is not advisable to give specific recommendations based on only a few studies.

- The challenge for future research is to learn more about possibilities for modification of management practices to enhance the positive effects and reduce the negative effects of various species, while also protecting a rich biodiversity.

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Pollination:

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Pests and natural enemies:

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Samnegård, U, Hambäck, P, Nemomissa, S, Hylander, K (2014) Local and regional variation in local frequency of multiple coffee pests across a mosaic landscape in Coffea arabica's native range. Biotropica 46, 276-284.

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CHAPTER 8

Ecosystem disservices: human-wildlife conflict

Summary

- People receive both benefits and disbenefits from forests.
- Especially people who live very close to forests experience a range of direct and indirect disbenefits, mostly because of conflict with forest wildlife.
- Both benefits and disbenefits are unevenly distributed, and many households in the study area received relatively low levels of benefits from the forest while experiencing high levels of disbenefits.
- Despite adverse impacts, many locals maintain a positive attitude toward the forest because they highly value its regulating services.

Introduction

As we highlighted in Chapter 6, ecosystems such as forests provide important benefits to people. In some cases however, people living in areas that are very close to forests also encounter disbenefits, which adversely affect their livelihoods and other aspects of their daily lives. Such disbenefits can be very challenging for local people and can even influence the extent to which they are food secure.

This chapter discusses the balance of benefits and disbenefits that flow from forest ecosystems. Since many of the benefits were already covered in Chapter 6, this chapter will especially highlight the disbenefits, and then compare these to the benefits. We identify groups of households that either benefit more or suffer more, and we analyse the characteristics of such different groups of households. At the end of this chapter, we discuss how local residents are collaborating to mitigate problems with wild animals and what this implies for finding appropriate solutions in the future.

Methods

Location: The study on forest ecosystem benefits and disbenefits was conducted in six kebeles namely *Kuda Kufi, Difo Mani, Done*, *Gido Bere, Kela Harari*, and *Borcho Deka*. The sub-section on local measures to mitigate wild animal problems was drawn from a different study covering five of the above-mentioned kebeles, excluding *Done.*

Data collection: Data for the study on benefits and disbenefits was drawn from a survey with 150 households. The sub-section on mitigating measures drew from qualitative data based on semi-structured interviews with 30 households.

Data analysis: Data from the survey was used to group households with respect to benefits versus disbenefits using hierarchical clustering. Linear models were used to assess differences between groups in terms of geographical, biophysical and socioeconomic variables and their attitudes towards forests. Interview data was analysed using content analysis.

Types of disbenefits

Disbenefits of living near the forest can be direct or indirect. Direct disbenefits reported by local people included crop losses, livestock loss, and associated losses in income. Crop losses were especially high for maize, sorghum, and teff. These were mainly caused by baboons (*Papio anubis*), grivet monkeys (*Chlorocebus aethiops*), bushpigs (*Potamochoerus larvatus*), and warthogs (*Phacochoerus africanus*) (Fig. 8.1). Crop losses caused by wild animals were said to range from 0-100% of the harvest, with an average loss reported across all fields of 36.4%. Losses of oxen, cows, and horses were typically caused by leopards (*Panthera pardus*) and hyenas (*Crocuta crocuta*). Poultry was eaten mainly by baboons, civet cats (*Civettictis civetta*), and genets (*Genetta* spp.); while losses in goats and sheep were caused by baboons and leopards.

In contrast, indirect disbenefits are not immediately visible and result from working to implement measures to mitigate direct disbenefits (Table 8.1). Indirect disbenefits included negative impact on children's education as they missed school days to help guard farm fields from wild animals. Adults' health also suffered due to exposure to cold temperatures as farmers spent their nights in the field in order to continue guarding their farms. Despite

Fig. 8.1. Baboon on a former crop field.

farmers taking measures to protect themselves from the weather by building guarding huts for shelter from rain and making fire to keep warm, they still reported experiencing adverse health effects. Social relationships were also negatively affected in some cases. Activities such as attending a funeral or a celebration in the community is an important way of maintaining social ties. However, many farmers have had to miss these activities to stay with their fields in order to guard against wild animals. In some instances, conflicts were reported between relatives and family members concerning guarding duties, and some interviewees also reported strained relationships with spouses due to time away spent guarding fields. Moreover, the problem with wild animals influenced farming decisions including which crops to plant and which livelihoods to engage in. Local people reported purposively avoiding certain livelihood activities such as raising livestock to avoid further losses, thus leading to foregone opportunities. Taken together, both direct and indirect disbenefits significantly impacted local households, particularly their incomes and food security.

Table 8.1. Overview of benefits (services) and disbenefits (disservices) from the forest and their importance for human well-being.

Variable	Type	Importance	Description
Services	Fuelwood	Satisfies basic human need, is used for heating and cooking	Number of fuelwood bundles a household collected from the forest per week
	Trees for construction	Satisfy basic human need, is used to build shelter and fences	Number of trees cut from the forest for building construction in the past
	Ploughs	Satisfy basic human need, is used for preparation of cropping field	Number of ploughs constructed from forest trees per household during the past year
	Household utensils	Improve living comfort in form of furniture and storage space	Number of larger utensils constructed from wood that were present in a household, such as chairs, tables, benches, boxes
	Lianas	Satisfy basic human need, is used for constructing shelter and fences	Number of liana bundles a household collected from the forest during the past year
	Medicine	Satisfies basic human need, has traditional and current value in addition to the local health infrastructure. Also used for livestock	Number of times a household collected wild medicinal plants from the forest during the past year
	Spices	Valued ingredients of local cuisine	Number of times a household collected wild spice plants from the forest during the past year
	Coffee	Traditional and cultural values, but also a major cash crop	Amount of coffee (kg) a household harvested from the forest during the past year
	Beehives	Honey is valued for health benefits and dietary diversity, but also a cash crop	Number of beehives a household had suspended in the forest at time of interview

Variable	Type	Importance	Description
Disservices	Stock loss	Impacts basic needs (nutrition, economic status)	Livestock loss during the past 5 years
	Crop loss	Impacts basic needs (nutrition, economic status)	Loss of cropland during the past year in 'oxen', a local land size unit
	Food insecurity	Impacts basic human need	Includes meal size reductions, meal skipping, and going to bed hungry because of wild animals
	Cash income loss	Impacts economic opportunities	Includes missing coffee/honey income opportunities, labour work opportunities, and market sale opportunities
	Farming impacts	Impact opportunities to satisfy basic human need	Include the inability to use own land, being unable to use modern farming methods, and being unable to keep poultry/livestock
	Education impacts	Impact personal development and skills, and future economic development	Include school dropouts of children, children skipping school, and adults missing education or training opportunities
	Health impacts	Impact basic human need	Include injuries inflicted by wild animals, loss of sleep, and the suffering of illnesses
	Social impacts	Impact traditionally and culturally valued exchange with others	Include the missing of visits to sick people/ mourning events/ funerals, to friends/ family/community work, and having conflict with relatives/neighbours

Groups of households experiencing disbenefits

In addition to determining disbenefits from living close to forests, we were also interested in understanding whether there were important differences in how households experienced benefits and disbenefits. Three groups of households were identified (Fig. 8.2). The *win-lose group* experienced a major gain from ecosystem services, but they also had high levels of losses. This group had the lowest number of households relative to the two other groups. They especially received the largest amount of coffee, lianas, and wood for making ploughs and for fuel. In terms of disbenefits, they were heavily affected by direct disbenefits in the form of crop and livestock losses. In terms of indirect disbenefits, households in this group missed livelihood opportunities.

More than half of the households included in the study belonged to the *lose-lose group*. They generally benefited less from ecosystems than the *win-lose group*. They also incurred a range of negative impacts, which were similar to

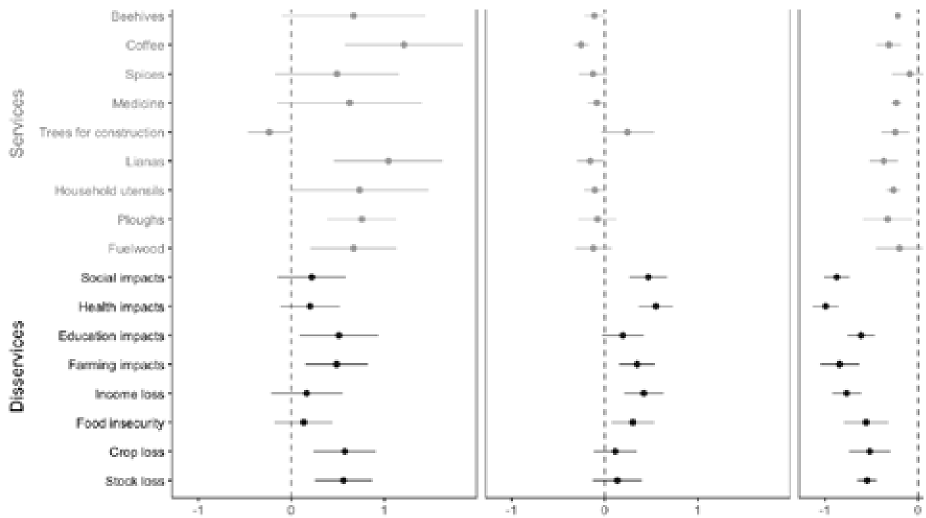

Fig. 8.2. Service–disservice profiles of the three household profile groups: *win–lose*, l*ose–lose* and *lose–escape*. Benefits or services are shown in the upper eight rows, while disbenefits or disservices are shown in the lower eight rows. Group means and 95% confidence intervals are presented. The dashed 0-line is the overall mean across all households.

the previous group, but they were more affected in the areas of health and social relations and were generally more food insecure.

The *lose-escape group* did not receive high levels of benefits, but on the positive side, they were also generally able to escape problems from wild animals. Households within this group used the forests only for fuelwood and spices.

Taken together, our findings highlight that there are important equity issues around the distribution of benefits and disbenefits from forests – not everyone benefits the same from the forest, and not everyone suffers the same from living with wildlife. We now turn to the factors that influenced these differences.

Characteristics of groups of households

First of all, distance to the forest influenced the distribution of benefits and disbenefits that households received. Households in the *win-lose group* had the highest amount of forest cover around their homes. Households in the *lose-lose group* did not have good access to forests despite a considerable amount of forest around their home, and they therefore did not benefit as much, but they still experienced a number of disadvantages. Those households in the *lose-escape* group, who lived farther from forests had few benefits, but they also avoided many of the associated problems.

Moreover, the *win-lose group* tended to be wealthier households in comparison to the two other groups. More of these households had tin-roofed homes, which in this part of Ethiopia, indicates a relatively better socioeconomic status. In addition, the *win-lose group* typically reported better forest access and use rights to the forest (a topic already touched on in Chapter 6).

Finally, we determined people's perception whether the benefits of living near the forest outweighed its disbenefits. In total, 85% of respondents considered the benefits to outweigh the costs. The main reason given for this pertains to forest regulating services such as climate regulation, clean air, shade, and prevention of soil erosion. Therefore, at present, despite the challenges of living near the forest, it is currently highly valued by local people.

Outlook for mitigating disbenefits from wild animals

Local solutions to mitigating the disbenefits from wild animals have tended to focus on increasing labour input by spending longer time in the fields to guard crops. As we explained above, both adults and children are typically involved in this.

However, an alternative solution to guarding fields is the practice of *didaaro*, in which households with adjacent farms agree to plant similar crops and share guarding duties (see also Chapter 9). Similar crops mean that all fields will require a roughly similar duration to be ready for harvesting. Farming activities therefore can be synchronised, allowing households to pool their labour.

Moreover, in the *didaaro* system, households do not need to guard all edges of their fields because some edges are being guarded by the owners of neighbouring fields. Discussions between members of the *didaaro* are an important basis for decisions about the types of crops to plant. Despite its local importance, some people have reported a weakening of the *didaaro* system in their area. This was said to be caused by out-migration of certain farmers whose farming situation had become untenable and who had been forced to make a living through other means. When a person emigrates to another place, a field in the landscape is often left unguarded, creating an opening for wild animals to get through to other fields. It also means a reduction of labour input into the overall guarding effort.

Despite the severity of impacts from wild animal pests, interventions for improving farming livelihoods have often focused on the use of fertilisers and improved crop varieties, without commensurate attention to wild animal pests. However, as our findings show, alleviating crop raiding is a strategic area of intervention for supporting farming and food security in the study area. Our findings point to local solutions as an entry point for beginning to address the disbenefits that people experience from wild animals. For example, the government could incentivise participation in the *didaaro* system to prevent its weakening. It could also encourage or facilitate engagement of young, unemployed or landless people in crop guarding. Providing monetary remuneration to such people for crop guarding could be a way to make use of available labour while providing paid work to people who desperately need it. Finally, a more direct strategy to reduce crop raiding would be to consider occasional culling of some of the most populous and harmful wild animals.

This should be planned with a high level of involvement of both local residents and wildlife experts. While biodiversity needs to be protected, measures to maintain and protect biodiversity need to be balanced with its positive and negative impacts on local communities.

Key insights for policy and practice

- Some mammals are a problem to local residents, and many people see crop raiding by mammals as the single biggest threat to their food security.

- Because many people also benefit from forests, forests are generally perceived in positive terms – despite harbouring large populations of mammals.

- To maintain this positive attitude towards the forest, equity among households should be improved, such that everyone can equitably gain from the forest and is equally capable of mitigating the disbenefits of living with wildlife.

Further reading

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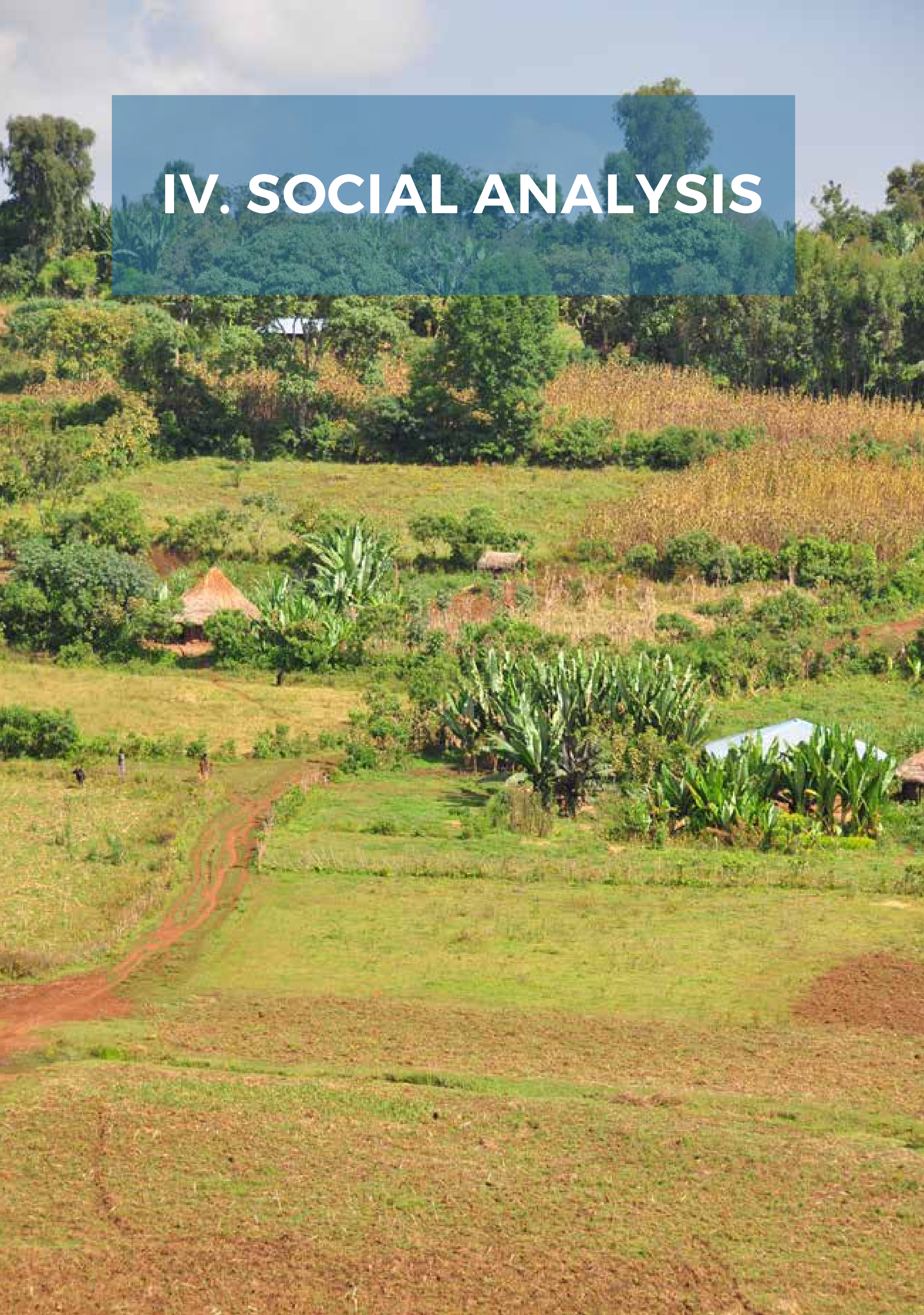
IV. SOCIAL ANALYSIS



CHAPTER 9

Livelihoods and food security of small-holder farming households

Summary

- Households that produced diverse food crops in combination with diverse cash crops were most food secure.
- Limited access to key capital assets such as land and livestock restricted livelihood diversification.
- Coping strategies that resulted in the erosion of a household's assets (such as selling livestock) reduced the ability to cope with future challenges.
- Coping strategies drawing on social relationships generally seemed to be more sustainable than those causing asset erosion.

Introduction

Livelihoods are the means through which people meet their needs for food and income. More than half of the population in Ethiopia rely on smallholder agriculture as their main livelihood. Different types of farming systems have been identified across Ethiopia. In our study area, livelihoods can be classified as a highland mixed farming system. However, a more nuanced understanding of the links between livelihood strategies, food security and underlying factors is needed to contribute insights for agricultural policy and practice.

Methods

Location: The study was conducted in six kebeles belonging to three woredas namely *Kuda Kufi*, *Bere Weranigo*, *Difo Mani*, *Gido Bere*, *Kela Harari*, and *Borcho Deka*. The six kebeles had 4081 households in total at the time of the study.

Data collection: We collected quantitative data through a survey of 365 randomly selected households and interviews with a subset of 30 households. The survey and interviews were conducted from November 2015 to January 2016, and were administered in the language Aafan Oromo. Data was generated on livelihood strategies as well as on the food security of each household; and on coping strategies at times of shortages in food or assets.

Data analysis: Multivariate statistical analyses were applied on quantitative survey data using the R platform, and content analysis was applied on qualitative interview data using the NVivo platform.

Livelihood strategies and food security

The majority of the population engaged in diversified smallholder farming involving mainly the production of different types of crops. Food crops such as maize, teff, sorghum, and in smaller quantities barley and wheat, were primarily produced for subsistence. In every kebele, more than 90% of these food crops were consumed by the households. Cash crops – namely coffee and khat – were primarily produced for the market. Approximately three quarters of coffee and most of the khat were sold for income.

Five livelihood strategies were identified and these strategies differed in terms of their combination of food and cash crops (Fig. 9.1). The strategies are explained below in order of decreasing food security. The food security of each household was measured using the internationally established Household Food Insecurity Access Scale, which generated a score for each household. Higher scores indicated higher food insecurity, while lower scores indicated lower food insecurity.

The two most successful livelihood strategies included three food crops, namely maize, teff, and sorghum. These two strategies were ‘three food crops, coffee, and khat’ (68 households), and ‘three food crops and khat’ (59 households).

The next two livelihood strategies included the food crops maize and teff. These were 'two food crops, coffee, and khat' (78 households), and 'two food crops and khat' (88 households). The least successful livelihood strategy included only maize as a food crop and was called 'one food crop, coffee, and khat' (44 households). Household food security thus decreased with fewer food crops included in the strategy (Fig. 9.1). In addition to livelihood strategies, gender and the educational attainment of the household head were also found to be significantly associated with food security – female-headed households were generally less food secure, and households with educated household heads were generally more food secure.

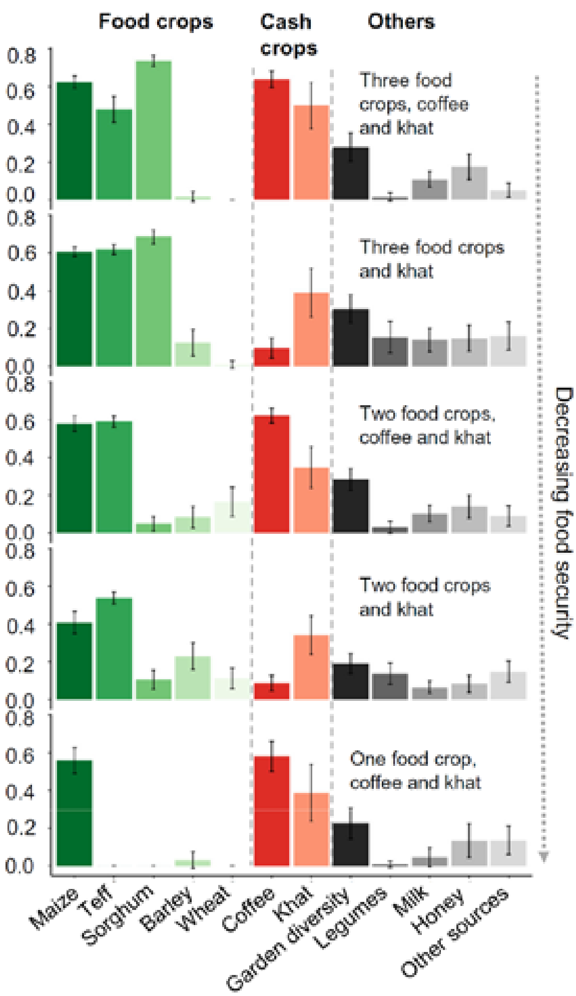
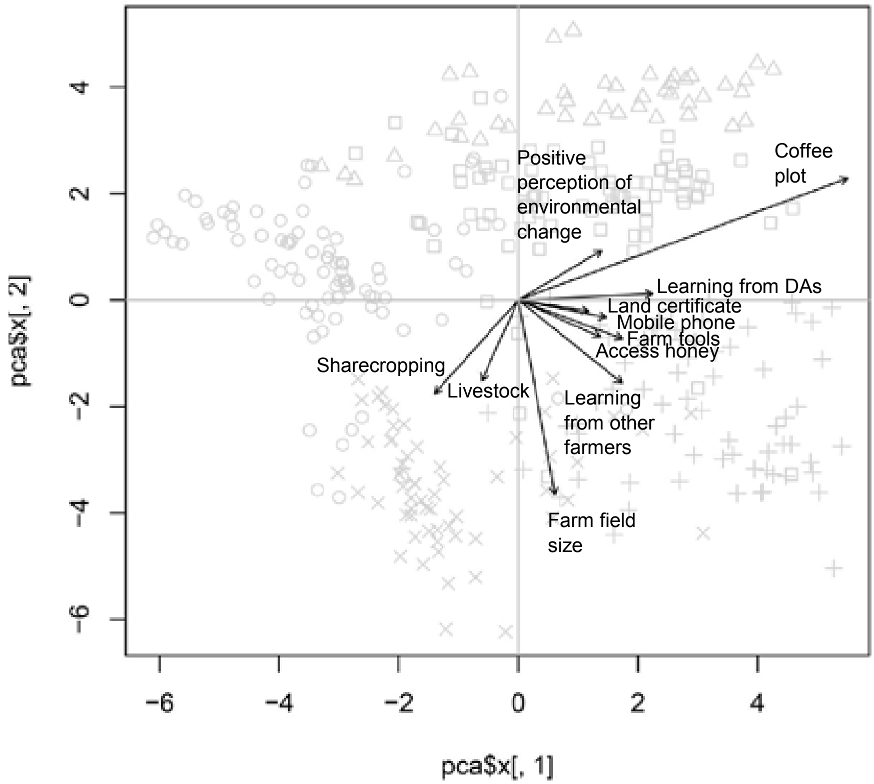


Fig. 9.1. Profiles of five livelihood strategies arranged in order of decreasing food security. Composition of the livelihood strategies in terms of livelihood activities and production levels (scaled for comparability) are shown.

The combination of food crops and cash crops enabled households to produce food for themselves while also generating income to meet other needs (e.g. for children's education or the purchase of medicine). Many local residents expressed a preference for sourcing staple food items from their own farms, rather than purchasing food. They associated this with their identity as farmers, explaining that purchasing food from the market did not make them feel like they were real farmers. Consuming food from one's own land also protected farmers from food price fluctuations. This was particularly important during the lean season just before harvest, when food stocks are generally low and food prices are high.

Capital assets as enabling factors for livelihoods

The abilities of households to engage in certain types of livelihood strategies depended on the capital assets that they had access to (Fig. 9.2). Specifically, the aggregate size of farm fields, access to coffee plots, number of livestock owned, and number of farm tools owned were significantly associated with livelihood strategies. Households that were able to undertake the livelihood strategy with the highest number of crops and the best food security outcome (i.e. 'three food crops, coffee, and khat') had better access to a range of capital assets. For example, they had a larger aggregate farm field size. They were also more frequently involved in learning with other farmers through informal exchange of information and knowledge, had more farm tools, had better access to honey, and often had mobile phones. In contrast, the capital asset endowment of households with the least crops in their livelihood strategy and the worst food security outcome (i.e. 'one food crop, coffee, and khat') often involved access to coffee plots but poor access to all other types of capital assets. These findings show that coffee alone is unlikely to be viable as a livelihood activity for many households, and that other types of capital assets (especially access to farmland) are critically important.



Legend:

□ Two food crops, coffee and khat

○ Two food crops and khat

△ One food crop, coffee and khat

+ Three food crops, coffee and khat

× Three food crops and khat

Fig. 9.2. Different capital assets underpin different types of livelihood strategies. For example, the strategy 'three food crops, coffee, and khat' was associated with having a larger farm field size relative to others in the area, and having access to more types of capital assets as shown by the arrows in the lower right hand area.

Local livelihood challenges

Many households struggled with challenges related to natural, economic, physical, and human capital assets. A high incidence of crop-raiding by wild animals (see Chapter 8) and a lack of cash were the two most frequently mentioned livelihood challenges. Other commonly mentioned challenges were related to natural resources. These included lack of oxen, lack of farmland, and low soil fertility. These common challenges were often simultaneously encountered. It was common to hear of households losing a significant fraction of their crop harvest due to wild animals, while being constrained by small landholdings with decreasing soil fertility. Land scarcity resulted from, among other things, landholdings being further sub-divided with every generation (see Chapter 12 on population growth in the study area). With less land available, farmers typically found themselves unable to leave their land to fallow in some years, resulting in declines in soil fertility and crop yields.

The government's approach to addressing declining soil fertility has been to require farmers to apply inorganic fertilizer. However, widespread lack of cash meant that many households were unable to afford inorganic fertilizer. In many cases, households coped by liquidating capital assets such as livestock in order to purchase fertilizer. Even then, the use of fertilizers had varied results with some households reporting an improvement in harvest, but many others experiencing no increase in harvest while having lost capital assets to buy fertilizer.

Apart from liquidating capital assets such as livestock, drawing on social capital to address a challenge was also a common coping strategy. For example, households took informal credit in the form of coffee or cash from a better-off farmer in their locality. Informal borrowing was preferred over formal credit because it did not require a capital asset guarantee and because payment time was often more flexible. As explained in Chapter 8, the local practice of *didaaro* as a way to mitigate the negative effects of crop raiding was another example of drawing on social capital to cope with a livelihood challenge. In the *didaaro* arrangement, households with adjacent farms synchronized the types of crops they plant and their farming activities (e.g. sowing, harvesting). This facilitated the pooling of labour, where one household took responsibility for guarding a certain edge of their farm fields, while another household guarded another edge.

We found that when households liquidated capital assets to address a challenge, their capital asset base was likely to be eroded. Conversely, when they drew on their social capital to address a challenge, they were better able to maintain their capital asset base and maintain their ability to cope with future challenges.

Supporting livelihood strategies for better food security

Presently, the Ethiopian government, through its Growth and Transformation Plan II (Ethiopia National Panning Commission 2016) and Agriculture Sector Policy and Investment Framework, aims to "sustainably increase rural incomes and national food security" (Chipeta et al. 2015). While there is recognition that not all smallholder farmers have the capacity to benefit from the type of agricultural transformation envisioned by the Ethiopian government (e.g. intensified, commercialized farming, with the private sector playing a more active role), there is a lack of commensurate recognition of the distinct livelihood strategies that support numerous smallholder farming households. In particular, subsistence farming is often perceived as an inferior approach rather than as an important strategy for many farmers to access food in a context of widespread lack of capital assets and limited market access. Consequently, the current agricultural transformation plan aims to increasingly reduce subsistence farming in favour of commercial production.

The findings of this study indicate an urgent need to rethink the current agricultural development policy and to broaden its recognition of alternative pathways to food security, particularly for the poorest. At the kebele level, households are diversifying their farm production and are taking advantage of the complementarity between food crops and cash crops in order to meet their needs, especially when faced with various livelihood challenges.

Existing livelihood strategies can be more effectively supported by the government through some key actions. One possible action is to expand the suite of extension services provided to cover the production of diverse crops and to distribute knowledge on modern agroecological approaches to farming. Another possible action is to strategically prioritize the issues of wild animal pests, land scarcity, and decreasing soil fertility. Moreover, existing capitals that have been beneficial for many households – such as social capital – need to be protected and strengthened. The constraints, opportunities, strategies, and benefits to local households need to be at the centre of planning processes for food security. This means recognizing what works for local households and then building on locally grounded information when designing interventions.

Key insights for policy and practice

- Government policies and investments are needed to support diversified livelihoods combining food crops and cash crops as a pathway to food security.

- Policies and interventions for supporting smallholder farming livelihoods should consider how access to key capital assets (e.g. land, extension services, livestock) can be improved, particularly for the poorest.

- Easing pressure on land (e.g. by addressing population growth or enhancing off-farm diversification opportunities), enhancing soil fertility through environmentally sound agroecological approaches, and curbing losses from wild animal pests need to be prioritized.

Further reading

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CHAPTER 10

Traditional institutions

Summary

- There are different traditional institutions in the context of small-scale farming – here we study two institutions (*daadoo* and *daboo*) used to organise collective work.
- Farmers that participate in *daadoo* and *daboo* tend to have higher crop yields, better time management, and a more diverse diet than those who do not.
- However, some people are not able to participate in *daadoo* and *daboo* due to time constraints, ill health, the absence of the institutions in their area, or due to gender related issues.
- While social capital is built by participating in *daadoo* and *daboo*, social capital is also a precondition for the functioning of these institutions.

Introduction

In the last chapter we learned about the relevance of social capital to deal with livelihood challenges. One way of enhancing social capital is through so called traditional institutions. Institutions can be understood as the combination of written and unwritten rules and patterns of behaviour in a given society or community. Often these patterns of behaviour are coordinated (or organized) within a community to achieve a common interest of its members. In this chapter, we look in some more detail at two traditional social institutions that organize collective work in Ethiopia, namely *daadoo* and *daboo*. We asked two questions: What factors influence whether a household participates in *daadoo* and *daboo*, and what benefits do households obtain through participation?

Methods

Location: The study was conducted in six kebeles in Jimma Zone, namely *Kuda Kufi, Bere Weranigo, Difo Mani, Gido Bere, Kela Harari,* and *Borcho Deka.*

Data collection: In two phases, structured interviews with follow up-questions were conducted in the study area in 2016. First, a pilot study was conducted with 33 households and then a main study with 151 households. The interviews where held in the local language. The households included in the survey were chosen randomly but with the criterion that surveyed households were always at least 400 meters apart. Data was collected on the impact of *daadoo* and *daboo* on a given household's food security.

Data analysis: The interviews were analysed qualitatively. In a first step, relevant data from the interviews was coded, and in a second step, the resulting categories were transferred into a causal loop diagram to help understand how *daadoo* and *daboo* work.

Types of traditional institutions

There are numerous types of traditional institutions in the study area and we studied two of them. *Daadoo* and *daboo* can be described as local institutions that organise collective work and labour exchange among smallholder farmers in rural Ethiopia. They are used mainly for agricultural activities on private land, and there is no payment for participating in them. Normally around five households are organised in one *daadoo* or *daboo*. The people working together are

mostly *shane* (local network) members but are often also friends, neighbours or relatives. The participants in a *daadoo* or *daboo* usually have similar ethnicities, religious beliefs and economic assets. Normally, there are separate *daadoos* and *daboos* for men and women but they are, in general, more common for men.

Daadoo is a rotational labour system in which all members help each member in turn with labour intensive agricultural work such as harvesting. *Daboo* differs from *daadoo* because it is not organised as a rotational system, but serves rather as source of help for people in need such as the sick or elderly, and for labour-demanding activities such as house construction. In *daboo* there is not necessarily a direct reciprocation for the rendered labour and, unlike *daadoo*, it is not restricted to agricultural activities.

Factors affecting participation

There are multiple factors that affect smallholders' participation in *daadoo* and *daboo* (Fig. 10.1). Factors that were frequently mentioned by the farmers interviewed here were a lack of time to participate, a lack of the institutions in the area where the interviewees were living, old age, and poor health.

The lack of time to participate in *daadoo* and *daboo* was mainly due to oth-

Fig. 10.1. Factors affecting participation in *daadoo* and *daboo*.

er activities that had to be done. These included particularly working in the house or home garden, taking care of children and the protection of crops against wild animals (see Chapter 8). In some kebeles, the culture of *daadoo* and *daboo* is not common. Therefore, there is no *daadoo* or *daboo* in those areas, resulting in people not having the possibility to participate. This may be related to people's preferences. If most people in the area prefer to work alone or only with other family members, the institutions may not be present. Some farmers interviewed also mentioned that they could not participate in *daadoo* or *daboo* because they were ill, injured or too old.

Moreover, there are gender related reasons that inhibited women's participation in these two traditional institutions. In general, *daadoo* and *daboo* were less common for women. Men's participation rate in *daadoo* was twice as high as women's, and five times as high in *daboo*. Moreover, the lack of time for participation was partly gendered. Only women mentioned that they had no time to participate because of activities in the house or because they had to take care of children. This is related to local gender roles. Because of their double working burden, which involved caring for the home, children, homegardens, and engaging in livelihoods, women were more time-restricted than men. In addition, in many cases, cultural or religious norms and beliefs influenced women's engagement in activities outside of their home, thereby restricting their ability to participate. Gender-related issues in the study area are further discussed in Chapters 11 and 12.

Impact on food security

Around 80% of all households that participated in *daadoo* or *daboo* stated that help from these institutions had a positive influence on their food security. Most of them stated that this influence was substantial. *Daadoo* and *daboo* influenced food security in several ways (Fig. 10.2). Two frequently mentioned mechanisms were improvement in time management and increased yield or productivity as a result of additional help. Moreover, several households mentioned that their dietary food consumption diversity improved due to the additional help. They were able to grow a larger variety of crops, or crops they preferred over others, because the additional labour enabled them to harvest crops on time and to grow more labour-intensive crops. Furthermore, the additional yield they obtained could be exchanged for other crops or sold on the market to obtain cash to buy other products. One crop that was grown particularly frequently by participants of *daadoo* and *daboo* was the traditional local crop teff. Several households stated that they would not have been able to grow teff if not for the help enabled by the traditional institutions.

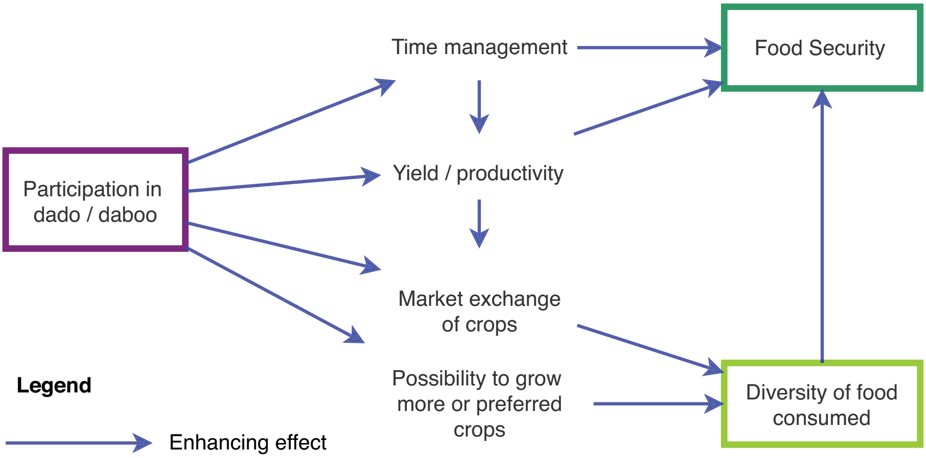

Fig. 10.2. Impacts of participation in *daado*o and *daboo* on household food security.

Linking traditional institutions and social capital

Not only does participation in *daadoo* and *daboo* improve food security, it also improves the social relationships within the community by supporting a culture of helping one another. A strong culture of help can contribute to coping strategies for communities in times of food insecurity (see Chapter 9). Furthermore, many households mentioned that they could learn from each other and exchange experiences while participating in *daadoo* or *daboo* (Fig. 10.3). Such social benefits are often referred to as social capital, that is, the social resources of an individual or a group that can be used to increase well-being. Social capital includes the relationships and connections among individuals and groups, as well as the attitudes and values that influence these relationships.

While social capital is built through participation in traditional institutions, this relationship is twofold: Social capital is also a factor that facilitates the participation in *daadoo* and *daboo*. There are no payments or laws to force people to engage in these institutions. Rather, participation hinges on trust that everyone involved will do their part. In a community with a high level of social capital, there are close relationships among its members, and people are more likely to trust each other. Therefore, a certain level of social capital is needed for these institutions to work.

The participation in *daadoo* and *daboo* and the improvement of social capital thus reinforce each other (Fig. 10.3). By practicing *daadoo* and *daboo*, people learn from each other, social relations improve, and a social safety net is created. Thus, social capital as well as community cohesion improve.

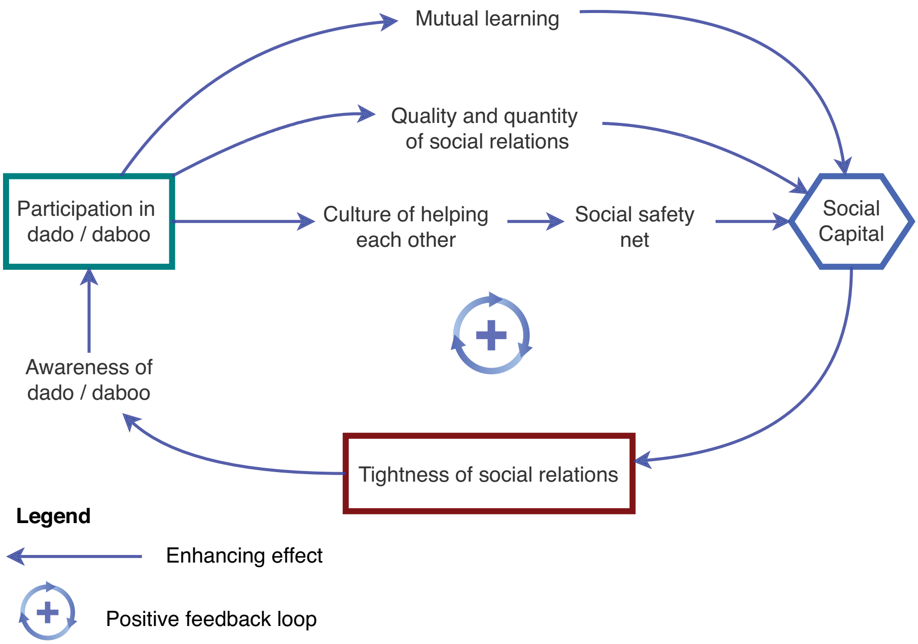

Fig. 10.3. Social capital feedback loop.

Key insights for policy and practice

- Strengthening and supporting traditional local institutions can help to improve food security and enhance the social capital of a community.

- Possible exclusion from traditional institutions, for example, due to gender roles, should be kept in mind when strengthening traditional institutions.

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CHAPTER 11

Social and gender equity as a foundation for livelihoods and food security

Summary

- Inequalities are maintained through formal and informal rules as well as settled ways of thinking about what men and women can do, or how they should behave.
- This means that better-off men, worse-off men, better-off women, and worse-off women benefit to different extents from smallholder farming livelihoods.
- Breaking patterns of social inequality, be it on the basis of gender or other social categories, is fundamental to improving people's abilities to improve their livelihoods and food security.
- Changing rules and attitudes can have major benefits for improving equality, but even smaller interventions to reduce gender gaps can be useful.

Introduction

Smallholder farming livelihoods are not just technical processes of production. Rather, they are embedded in social relations whether at the household or community level, and are strongly influenced by social rules. Such rules include formal rules such as policies and laws, and informal rules such as social norms. Social norms are important because they provide the basis for a society's collective understanding of acceptable ways of doing, being and behaving, and are often entwined with individuals' sense of identity. Because social norms give people a powerful template for how they should behave, they can be important to uphold social order and justice. However, on the flipside, some social norms can also lead to the entrenchment of social inequalities.

Social norms around gender define what is acceptable and not acceptable for women to do, and which roles are exclusively attributed to men. This influences smallholder farming in a variety of ways. For example, social norms determine the terms of ownership of capital assets, who gets a say in decision-making processes, modes of participation in livelihood activities, and distribution and control over benefits. In the last two decades, the Ethiopian government has implemented policy changes to empower women and promote gender equality. Despite changes in formal rules, entrenched patriarchal practices in various parts of the country have meant that gender inequality remains widespread. This influences the conditions of smallholder farming, resulting in a large fraction of the population – mainly women but also poor men – being systematically disadvantaged and unable to realise certain livelihood options.

This chapter provides a brief overview of the social context within which smallholder farming livelihoods are embedded in southwestern Ethiopia. Focusing on social and gender equality, we describe some of the changes perceived by locals to have occurred in the last ten years, as well as areas that still require intentional and careful engagement to further advance social and gender equality.

Methods

Location: The study was conducted in three kebeles namely, *Kuda Kufi, Difo Mani, and Kela Harari.*

Data collection: The qualitative data used for this chapter was collected through (i) 15 key informant interviews with local residents who have lived in their respective kebeles for at least 20 years, (ii) 20 focus group discussions involving a total of 153 women and men from different socioeconomic backgrounds, and (iii) 30 semi-structured interviews with men and women to further explore the themes that emerged from the focus groups. All activities were conducted in *Aafan Oromo* with the assistance of a translator.

Data analysis: Responses from the data collection activities were transcribed into English and were subjected to content analysis.

Positive gender-related changes

The coming to power of the current Ethiopian political coalition in 1994 (Ethiopian People's Revolutionary Democratic Front) saw policy reforms that were intended to promote women's rights. These included the requirement that wives' names should be included in land certificates for usufruct (i.e. land use) rights, where before the certificates only carried men's names. The reformed family code was also passed to protect women's rights to conjugal property in case of divorce or bereavement. In terms of direct interventions, locals reported that development agents (DAs) had been active in encouraging women's attendance at meetings, trainings, and livelihood activities as well as educating people about gender equality.

Local residents expressed an improvement in the scope of activities that women have been allowed to do in the last ten years. Owing largely to encouragement by government actors, there has been a reported increase in women's participation in public activities such as meetings and trainings, which were previously closed off to them. Through their participation in such activities, women have been able to access information directly, instead of relying on their husbands to share new information. Women also reported involvement in soil conservation activities as well as increasing involvement in many farming-related activities, with the exemption of ploughing. A wide range of practices has become acceptable for women to do, such as holding larger amounts of money as savings than in the past. Shared decision-making between women and men is also being practiced by more households than in the past, when most decisions were taken exclusively by men in the majority of households.

Attitudes about women are also showing a small and tentative, nevertheless, existing shift. Men commented that contrary to their previous beliefs that women were incapable and weak, they were beginning to see that women are

in fact capable of doing farm work, manage livelihoods, and take on leadership roles. Men further commented that they should also accept women's ideas in the same way that women accept theirs. People further reported there was an emergence of trust between husbands and wives as a result of making decisions together and working together. Local residents associated more equal gender relations with improved abilities to undertake livelihoods and better food security. For example, the emergence of trust was linked with a decreased incidence of husbands and wives prematurely harvesting and selling coffee separately of each other, in order to each get access to cash. Rather, spouses now frequently discussed and coordinated their actions, thereby averting loss from premature harvesting and maximizing benefits for their households.

According to local men and women, these positive changes were mainly driven by the government's recognition of gender equality, in combination with concrete actions on the ground. But it is also important to note that different types of changes have interacted (Fig. 11.1). For example, women's increased involvement in livelihood activities has provided new opportunities for them to showcase their abilities. This, in turn, has begun to challenge long-held views that women are incapable of farming.

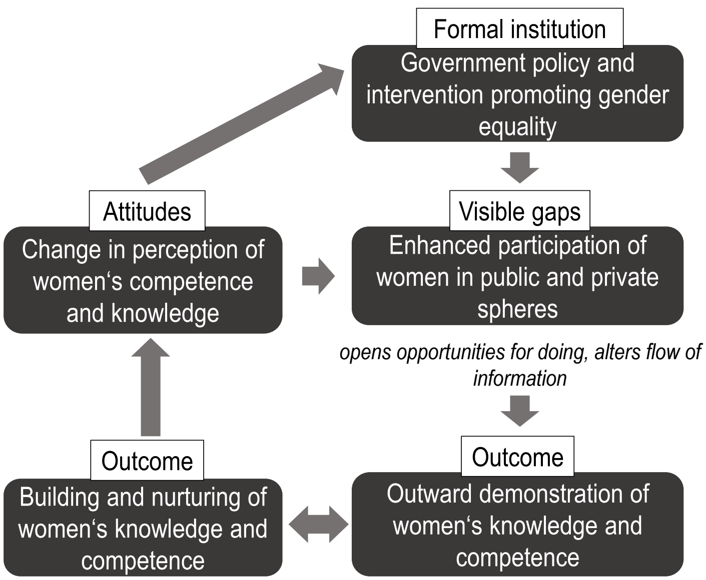

Fig. 11.1. Gender equality has improved as a result of interactions among changes in visible gaps, formal and informal rules, and attitudes.

How gender norms influence livelihoods

Despite improvements in gender equality, we found that many social norms persist that limit the ability of women to participate in and benefit from smallholder farming livelihoods. Such norms strongly influence practices regarding access and control of capital assets, household decision-making, and allocation of activities.

In terms of accessing and having control of capital assets, women remained disproportionately disadvantaged relative to men. Despite the existence of a formal rule that gives daughters the right to inherit land, inheritance of farmland remains patrilineal in practice. Daughters are expected to access land through marriage and not otherwise. Thus, most women enter into marriage in a position of lower capital endowment relative to their husband. The primary avenues for women to gain a land certificate to their names is either divorce or widowhood.

Prior to marriage, women receive a *nika* or a wedding gift, which can be in the form of coffee or livestock. A *nika* is considered to be under the full dispensation of women, and several women have used their *nika* as a way to negotiate their asset position in their household. For example, some have used it to set up their own livelihoods (e.g. petty trade). In certain cases, where women receive livestock as a *nika*, they have the possibility of increasing their capital assets by keeping the livestock for reproduction.

Livestock ownership was also gendered. Oxen for ploughing were primarily men's property while cows for dairy, small ruminants, and poultry can be owned by women. In terms of decision-making, local residents reported that about three-quarters of households now engage in shared decision-making. However, on further probing we found that most of what local residents called shared decision-making is a process commonly initiated by husbands to transmit information to wives and ensure cooperation in the implementation of pre-set plans concerning the use of capital assets and the implementation of livelihoods. Most women were able to decide on the allocation of harvest in terms of how much should be set aside for household consumption, but were not as free to decide on other matters in male-headed households.

Allocation of activities was similarly gendered. For example, ploughing was exclusively a male activity, which in turn, made women perpetually dependent on men's labour. Even those women who managed to secure a land certificate either through divorce or widowhood often had to resort to sharecropping. In sharecropping arrangements, female heads who depended on sharecropping for labour reported delays in key cropping activities (ploughing and sowing), which led to reduced harvest because male sharecroppers had other farm fields to work in. Interestingly, this is a problem that male landowners did not mention. Taken together, these gender norms, which manifested in various practices related to livelihoods, distinctly constrained women's ability to participate and benefit from smallholder farming.

How socioeconomic differences influence livelihoods

The effect of social norms was not only experienced by women, but also by men. For men however, being disadvantaged was mostly experienced within sharecropping arrangements involving other men of different socioeconomic backgrounds.

In sharecropping arrangements, those who hold land usufruct rights tended to have more decision-making power than landless sharecroppers. They were better able to decide on the type of crops to plant. This is crucial because better-off and worse-off farmers often have different priorities and therefore, different preferences for crops with respect to those priorities. Better-off farmers tended to prefer teff because of its higher price in the market. Most better-off farmers have other farm fields from which they could produce food crops for household consumption. On the other hand, most worse-off farmers do not have their own farm fields for food production. They therefore depend on the sharecropped fields for their food. Worse-off farmers therefore tended to prefer maize over teff because maize from a given plot is more filling and lasts longer than teff would. When farmers do not have decision power over the type of crop to plant, this impacts on their ability to be food secure by affecting their ability to implement their plans for livelihoods and food sourcing.

Moreover, differences in socioeconomic status in sharecropping arrangements were also associated with different proportions of risk borne in relation to wild animal pests. Landless sharecroppers who were responsible for providing labour, tended to carry more risk. They spent lengthy hours guarding farm fields from wild animal pests, resulting in a loss of opportunity for undertaking other livelihood activities (see Chapter 8). Sharecroppers whose fields had high crop losses also faced the possibility of losing the opportunity to sharecrop in the next farming season, thereby losing access to farmland. Interventions for a more equal decision-making process and more equal distribution of risks among participants to a sharecropping arrangement could be entry points for making such arrangements more equitable.

Equitable livelihoods development

Social and gender equality are important for better livelihoods and improved food security. While their achievement is a challenge in its own right, there are synergies between better equality and improving smallholder farming livelihoods. To integrate gender into livelihoods development, gender analysis may be used to inform planning and design for interventions targeted at supporting local livelihoods. Trained facilitators could catalyse processes of social change by organizing small groups and fostering reflections and critical discussions about gendered social norms, including the identification of which people are disadvantaged, how people are disadvantaged, and what could be changed. This may provide a basis for building community-owned visions of the future and developing locally-led processes to realise desired changes. Such discussions should simultaneously focus on gender and other relevant social categories such as socioeconomic status, age, religion, and ethnicity, where applicable.

Key insights for policy and practice

- Social and gender analysis should be used to generate understanding of underlying social norms that govern collective practices and individual behaviour.
- Innovative processes that facilitate critical reflection and questioning of prevailing norms should be integrated into local livelihood interventions.
- Implementation of gender-sensitive policies should be cognisant of social norms in specific contexts, and should consider how these norms can impede or promote gender-equal policy goals.

Further reading

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CHAPTER 12

Population growth and family planning

Summary

- Human population growth poses challenges for both food security and biodiversity conservation.
- Rural women who received little schooling desire much larger families than women studying at nearby Jimma University.
- Preliminary analyses suggest that socio-cultural and religious norms are related to the desired number of children, and hence also the use of family planning.
- Access to family planning services has improved, but deficits remain with respect to gender equity and female education.

Introduction

The previous chapters discussed how biodiversity is affected by landscape management and how different livelihood strategies influence food security outcomes. In this chapter, we focus on human population growth, another key aspect influencing biodiversity and food security. A growing human population inevitably represents more pressure on natural resources, including both forest and farmland.

Ethiopia's population doubled in the last 25 years. In 1990, Ethiopia had a population of 50 million people, but this had increased to 100 million people in 2015. By 2050, Ethiopia's population is expected to nearly double again as a result of high fertility rates. Since 1994, the Ethiopian government has implemented reproductive health policies that attempt to slow down population growth, and that include family planning services and a series of specific actions to reduce maternal deaths and infant mortality.

Family planning refers to the services and the supplies that allow individuals to plan and to attain their desired number of children and to space births.

It contributes to prevent unintended pregnancies, delay motherhood and improves both children's and mothers' health, and also plays a pivotal role in long-term fertility reduction. The voluntary use of family planning is also linked to the empowerment of women and girls, which is a central aspect of gender equity (see previous chapter).

Women's fertility decisions and their reproductive behaviour (including the use of family planning) are influenced by the specific and often complex socio-political and cultural contexts in which they are embedded. This chapter provides an overview of the factors influencing women's fertility decisions, namely with respect to the desired number of children and the use of family planning. The chapter also touches on the roles of perceptions, education, religion and socio-cultural norms in women's fertility decisions.

Methods

Location: the study was conducted in four kebeles, namely *Gido Bere*, *Kela Hahari*, *Difo Mani* and *Kuda Kufi* and at Jimma University.

Data collection: The quantitative and qualitative data for this study was collected through a survey of 272 women (122 in the kebeles and 149 at the university), aged between 18 and 47 years old. The survey included closed and open-ended questions, and was conducted in Afaan Oromoo, with the assistance of female translators. Three health extension workers from the kebeles and two nurses from one woreda were also interviewed. Additional contextual information was gathered from an informal conversation with a nurse. Interviews with health professionals were conducted in English.

Data analysis: Quantitative responses from the questionnaires were analysed using summary statistics and qualitative data was subjected to content analysis.

Do perceptions of food security, environmental degradation and population growth influence fertility decisions?

Perceptions, that is, the way we organize and interpret information, can shape our attitudes and ultimately determine our behaviour. The ways in which perceptions influence behaviour are complex and possibly reciprocal. For instance, for households that are dependent on forest resources, the perception of deterioration and degradation of forests may be related to the need to invest in large family sizes (more labour available to collect scarce forest resources), but alternatively, it could also be related to a lower demand for children, due to the perceived scarcity of resources to support the family. Moreover, individuals might perceive a future in which their immediate environment is troubled by food insecurity and land scarcity. Such concerns about the future may contribute to a small desired number of children, or even to the desire of having no children at all, out of concern of not having enough means to adequately provide for a large family.

In our study we focused on women's perceptions regarding trends in food security, environmental degradation, land scarcity and human population growth in the next ten years. We were interested in how these perceptions might influence women's reproductive decisions (Fig. 12.1). Overall, perceptions of women regarding the different trends were similar. Women in both rural and university settings perceived an improvement in food security, increasing land scarcity, an increasing human population, and they perceived mixed trends in environmental degradation. Perceptions of university students about environmental degradation and food security were correlated, with these students associating environmental degradation with greater food insecurity. Interestingly, however, our preliminary findings suggest that there was no strong relationship between how women perceived environmental change and their desired number of children or the use of family planning methods. Fertility decisions thus appeared to be driven by factors other than perceptions about environmental change.

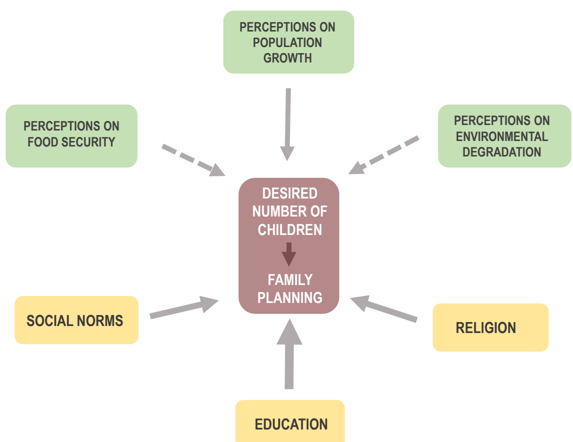


Fig. 12.1. Possible factors influencing the desired number of children and the use of family planning. Full arrows represent factors that were found to be related to the desired number of children, whereas dashed arrows illustrate factors found to be unrelated.

Drivers of fertility decisions: education

Education is a well-known element influencing reproductive behaviour. As women's education attainment increases, their age at marriage, age when the first child is born, and the use of family planning methods tend to increase as well. In our study, the desired number of children was significantly different between women living in rural communities and women attending university. Respondents from Jimma university reported nearly half of the desired number of children (3.3 children on average) than respondents from the rural areas (5.98 children on average) (Fig. 12.2). The majority of women in the rural communities were illiterate or had received very little schooling, suggesting this could be a possible reason for the observed difference in the desired number of children. However, there were also other differences between our urban and rural respondents, and these could also be important factors explaining differences. University students were on average ten years younger than women from rural areas, and the majority was Orthodox or Protestant, whereas in rural areas the dominant religion was Islam.

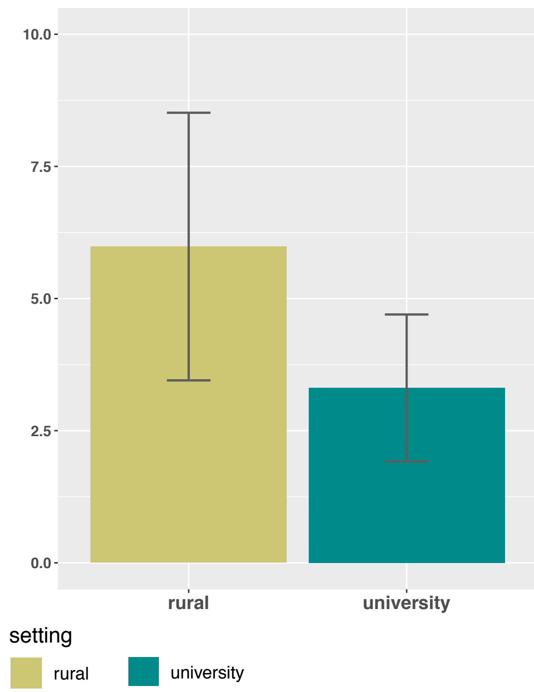


Fig. 12.2. Mean desired number of children (plus and minus standard errors) reported by women in rural and university settings.

Interestingly, the use of family planning methods was reported by more women in rural areas than by university students. This is most likely a result of most women at the university being single and reporting no need to use family planning methods without having a partner. However, most university students reported the desire to use family planning once they start a relationship, and the desire to discuss their fertility decisions with their partners.

Drivers of fertility decisions: religion and socio-cultural norms

Religion and socio-cultural norms emerged as key drivers that influenced the desired number of children and the acceptance and use of family planning methods. Rural women stated they wanted many children because of the traditional roles of children in rural areas, as labour assistants in farming activities, and as future providers of income and support for the elderly. They also mentioned that children made them happy, were the will of God or Allah, and were a sign of social status.

In terms of aspirations and expectations for existing and future children, there were major differences between respondents from the university and from the rural communities. In the rural areas, many women reported the wish for their daughters to get married between 12 and 18 years old (27% reported an age between 12 and 15 years old), despite acknowledging the existence of a governmental law that forbids underage marriages. Reasons given for this preference included respect of and obedience to religious laws and social norms and traditions, in which girls are expected to be married soon after reaching puberty. For sons, the reported desired age for marriage was older, with both women from the kebeles and university students highlighting the need for their sons (or future sons) to have enough economic means to support their family.

Most female students at the university reported that if they have daughters in the future, they would wish for them to marry between 19 and 25 years old, only after completing their education (including university degrees), and only after they have secured a job and regular income. While some reported their plan to advise and guide their children regarding important life decisions (such as marriage and birth), others expressed that they will not interfere in such issues, because their children, once adults, will be able to decide by themselves.

Availability of family planning services in rural areas

Health extension workers from the surveyed kebeles indicated that family planning methods have been freely accessible at the health clinics for at least 10 years. However, they also reported that the clinics occasionally run out of contraceptive supplies, a situation that can last several days. Because we sampled only few extension workers, we cannot say whether this situation is widespread or an exception.

Reports regarding major constraints to the use of family planning methods and outreach activities differed between woredas. Two nurses from one woreda health centre identified religious rules as possible constraints to the use of family planning methods – but as above, we cannot comment on whether this perception is widespread or was only held by these particular nurses. Health extension workers reported outreach activities that include work with community and religious leaders, and the use of school media from elementary education and high school for use of family planning. Importantly, a kebele health worker from the same woreda reported signs that unsupportive social norms were changing, and that the community and its leaders were beginning to gain a better understanding of the side-effects and of the advantages of family planning. Interestingly, a health worker from a remote kebele in a different woreda identified male dominance in decision-making at the household level as the major constraint regarding the use of family planning methods. A high unmet need for family planning and a lack of en-

gagement regarding reproductive health issues among the community and religious leaders were reported for the same kebele.

Additionally, misinformation and the fear of side-effects as well as a low level of awareness by users on the advantages of family planning methods were identified by all interviewed health workers as other factors influencing the use of family planning methods. One of the identified problems regarding the effectiveness of family planning use was the lack of consistent use by women, especially regarding short-term methods (e.g. injections or pill). This lack of consistency was reported to be associated with illiteracy, because many women could not read their health schedule and therefore ended up missing their appointments at the clinic.

Key insights for policy and practice

- Female education and access to adult training programs that eliminate illiteracy would improve gender equity and likely lead to a more widespread uptake of family planning.

- Given the critical challenges related to population growth, it would be useful to widely implement awareness programs that engage rural community and religious leaders.

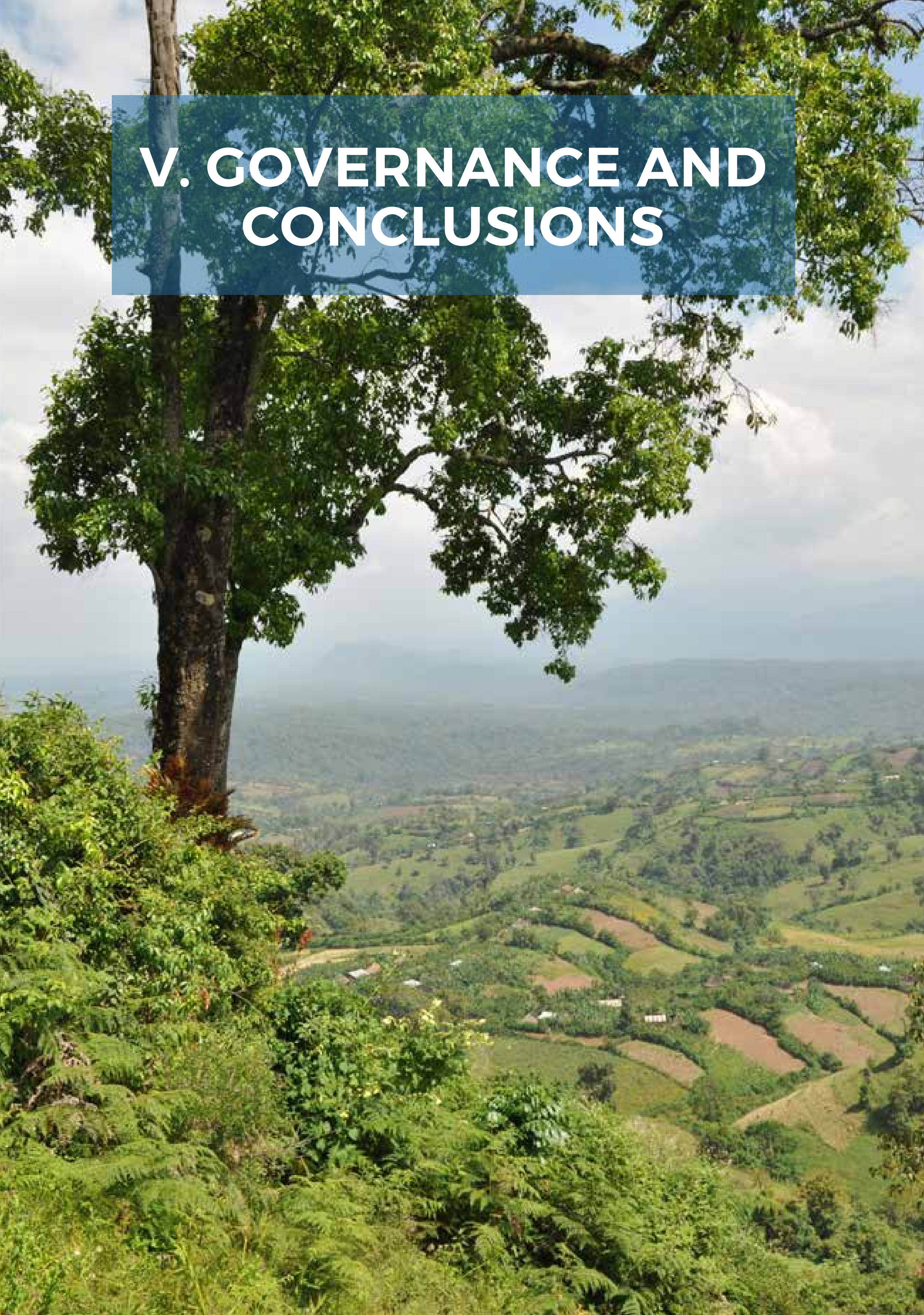
- It would also be beneficial to more actively engage men in issues of reproductive health and family planning.

- Children's rights should be enforced, including with respect to underage marriage.

Further reading

A PhD thesis and journal article describing this work in more detail will be completed by P. Rodrigues in 2020.
If you have trouble accessing references, please email Joern Fischer at joern.fischer@uni.leuphana.de, or visit our project website at https://foodandbiodiversity.wordpress.com.

V. GOVERNANCE AND CONCLUSIONS



CHAPTER 13

Different discourses and approaches towards food security and biodiversity

Summary

- Different discourses for how to achieve food security are put forward by different governance actors.
- For example, some actors emphasize agricultural intensification and commercialization, while others emphasize agroecological methods and community resilience.
- The different approaches towards improving food security have different strengths and weaknesses.
- Existing differences in approaches need to be carefully navigated to effectively govern food security and biodiversity.

Introduction

The previous chapters showed that the benefits and disbenefits from biodiversity, as well as people's abilities to be food secure, are not evenly distributed. Outcomes related to both food security and biodiversity are shaped by governance strategies and interventions. Finding ways to effectively govern food security and biodiversity requires understanding the different perceptions and preferences for certain development pathways among different governance actors.

This chapter presents the different perspectives of government and non-government stakeholders on food security, as well as their preferences for how to integrate food security with biodiversity conservation. To elicit the perspectives of stakeholders, we used two different methods. One method involved a technique where stakeholders ranked statements relating to certain principles or ideas around food security according to their preference. Another method involved semi-structured interviews to determine how stakeholders think about bringing together food security and biodiversity conservation.

Below, we describe the diversity of existing perspectives and then outline steps for how to navigate this diversity.

Methods

Location: This study involved governance stakeholders from different levels within the food security and biodiversity sectors. Fifty stakeholders from the woreda (i.e. *Gumay, Setema,* and *Gera*) to the federal level were included in the investigation of discourses around food security, and 81 stakeholders from the kebele (i.e. *Kuda Kufi, Bere Weranigo, Difo Mani, Gido Bere, Borcho Deka, and Kela Harari*) to the federal level were included in the investigation about preferred approaches for the integration of food security and biodiversity conservation.

Data collection: To determine existing discourses, the so-called "Q method" was used. That is, purposively selected stakeholders ranked a total of 32 different statements relating to food security and biodiversity conservation according to their preferences, and explained their rankings. Semi-structured interviews, which typically lasted an hour, were used to investigate preferences for integrating food security and biodiversity. Here, the interviewees were selected through snowball sampling, that is, interviewees were asked to mention other stakeholders whom they knew were also working in the food security or biodiversity sector.

Data analysis: Statistical cluster analysis was used to derive distinct discourses.

Discourses on food security

Preferences for approaches to achieving food security vary, and this manifests in different ways in which people discuss food security. For example, one stakeholder may consider the problem of low food security to be mainly technological. This then leads to a focus on improving fertiliser application to increase yield, or the need to develop new, high-yielding crop varieties. Another stakeholder may perceive the problem to be an issue of social justice that is interlinked with the challenge of environmental degradation. This stakeholder may then prioritise socially just development policies over improved crop varieties. These simple examples show that different ways of thinking about a problem result in varied framings. From this, different discourses or narratives emerge.

Based on an exercise of getting stakeholders to rank statements according to their perceived importance (Fig. 13.1), we identified four distinct discourses around food security in Ethiopia. These were *smallholder commercialisation*, *agroecology and resilience*, *balanced growth*, and *market liberalisation*. Below we provide a brief description of each of these discourses and the actors that prioritised each. We note that each discourse comes with its distinct set of assumptions and arguments, and has unique strengths and weaknesses.

The first discourse we identified is *smallholder commercialisation*. It focuses on increasing production through agricultural intensification of commercial crops. Food production is prioritised over biodiversity conservation in this discourse, and the primary governance mechanism is the market. Support for this discourse is mainly from government stakeholders, especially in the food security sector, and more specifically, in the production, market, and finance sub-sectors. Relatively wealthy smallholders are likely to benefit from this approach.

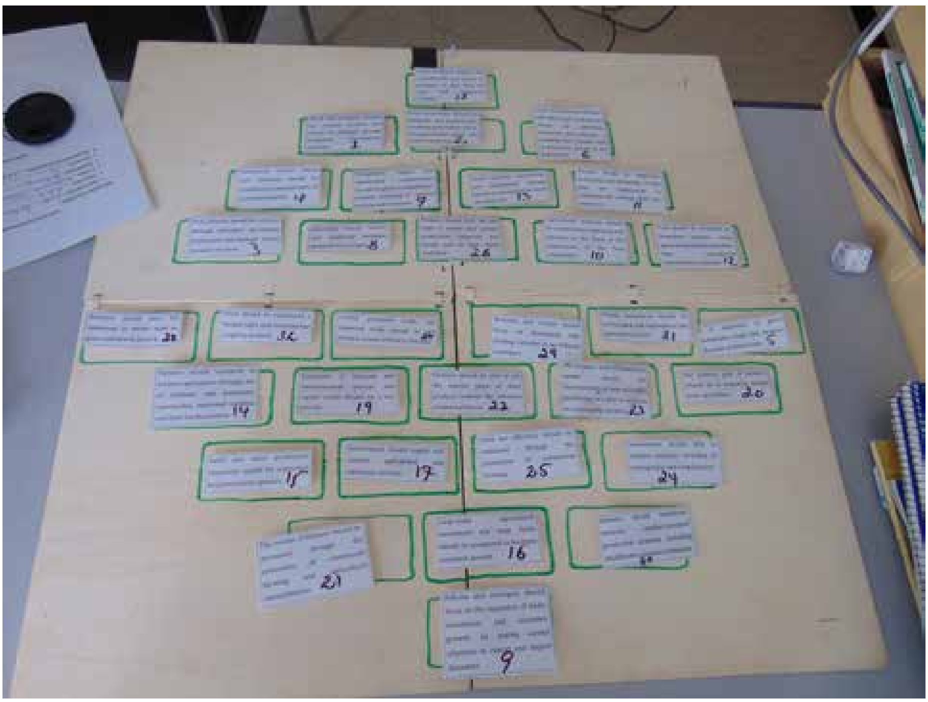


Fig. 13.1. Scoreboard used by stakeholders to rank a set of statements on food security governance.

The second discourse on *agroecology and resilience* focuses on environmentally friendly production methods. The preferred governance mode is participatory and includes strong bottom-up elements. Support mainly comes from smallholder farmers and actors working in the biodiversity sector, especially non-government organisations. This discourse focuses strongly on the socially equitable distribution of benefits and prioritises smallholder farmers. It also emphasises sustainable management of social-ecological resources in order to improve resilience.

The third discourse – *balanced growth* – draws on elements of both of the above two discourses. It focuses on the protection of smallholder farmers from international market competition and prioritises production for domestic consumption. The primary governance mechanism is state-centred, such that the government controls important resources including land. This discourse was supported by stakeholders from various sectors and levels, with the exception of stakeholders from the federal level.

The last discourse we identified is *market liberalisation*. It supports opening to global markets as well as intensive production and specialisation. This discourse is supported by stakeholders within the market sector and government administration stakeholders. Governance is regulated through markets, and equity concerns are not of primary importance in this discourse.

The existence of these four different discourses shows that there is no single agreed upon pathway to achieving food security. In some instances, the discourses could even lead to conflicting policy agendas – for example, *balanced growth* prioritises the protection of smallholder farmers, whereas *market liberalisation* could easily lead to the opposite outcome.

Perceptions on how to integrate food security and biodiversity conservation

Achieving food security and safeguarding biodiversity have often been perceived as two competing goals. The two goals have often been couched in terms of there being a trade-off in outcomes – such that improving one of the two outcomes would necessarily involve a decline in the other. More recently, scholars have begun to debate whether and how these goals can be integrated instead.

In our study, we found varying opinions in relation to how food security and biodiversity goals can be brought together. Two contrasting types of land use strategies have been debated by conservationists in the last several years – *land sparing* and *land sharing*. *Land sparing* is a land use strategy that favours intensive agricultural production and the setting aside of large areas of land for the protection of biodiversity. The argument for this strategy is that if agricultural production is increased in a designated production area, the need to expand production into other areas will likely be reduced, thereby making space for designated areas for biodiversity conservation. On the other hand, the *land sharing* strategy recognizes that in many cases, land serves multiple functions. Therefore, this strategy tries to bring together biodiversity conservation and food production on the same piece of land. It emphasises that while land allocated for biodiversity is important, other land uses such as farms and grazing areas can be managed – and in fact have been managed by farming communities all over the world – in ways that also support high biodiversity while meeting the production needs of those communities.

Prior to our research, these two strategies had been debated largely from a biodiversity perspective but not yet from a governance perspective. Our study demonstrated that stakeholders hold different views and preferences concerning land use, with some preferring the land sparing strategy and others preferring the land sharing strategy (Table 13.1). The land sparing strategy was preferred mostly by conservationists working in the biodiversity sector and by stakeholders working at the policy level. The stakeholders explained this preference on the basis of the benefits for conservation and food production – which they perceived as necessary for economic growth, as well as in the light of population growth (see Chapter 12). Some of the challenges identified for implementing a land sparing strategy included high fertiliser cost. This may mean that poorer farmers might not have the means to implement this strategy and therefore may be left behind (see Chapter 9).

Table 13.1. Stakeholders' land use preferences and justifications.

Preference	Justification	(%)
Land sparing (n = 27)	Best for biodiversity conservation and protection	100
	Good to increase yields via agricultural intensification	89
	Land sparing has formal institutional support through government policy, strategy and plans	78
	There is good access to agricultural technologies for intensification	70
	There is an increase in population and demand for food	52
	There are possible gains from forest conservation through emerging carbon markets	41
	Land use specialization is better	33
	Land sharing will not work to feed the population	9
	Clear separation of land uses reduces conflict between stakeholders	8
Land sharing (n = 32)	Land sharing is consistent with traditions and local institutional support: cultural relevance, traditional farming knowledge, ancestral human-nature connections	56
	Land sharing is preferable for cost-benefit considerations: livelihood benefits of farm diversification outweigh the high costs of intensification (e.g. fertilizer)	56
	Land sharing is consistent with biophysical constraints and existing production systems: settlement structure, landscape and land ownership fragmentation, widespread shade coffee production	41
	Resource conservation: importance of sharing for the conservation of forest and farm biodiversity	31

On the other hand, the land sharing approach was preferred by many small-holder farmers, particularly those who were poor. This preference was due to the complementarity of this strategy with the farmers' traditional diversified land management practices. Moreover, the land sharing strategy emphasises the importance of trees in the farmland, and this is a management practice that is culturally valued in the local area. Farmers also valued having trees in their farmland because of the many uses and benefits that they derive from these trees (see Chapter 6). However, continued implementation of the land sharing strategy has faced challenges because traditional land use practices have been met with pressure from the government to change and intensify production. This is consistent with the government's narrative of increasing production as a way to improve food security.

Notably, emphasising a land sparing strategy over a land sharing strategy is likely to have a negative impact on local farmers, whose farming practices have developed over a long time in a way that is attuned to their needs as well as environmental conditions. Which strategy to implement where, or how the two strategies can be combined, is a question that governance actors will need to navigate in the future – paying particular attention to the fact that not everybody wants the same thing, and that good reasons are being put forward for both types of approaches.

Navigating a diversity of perspectives

As shown above, there is not a single preferred way to govern food security and biodiversity conservation. Rather, a diversity of stakeholders means there is a diversity of perspectives and approaches. Navigating these differences requires active exchange among actors, including those at different levels of governance (i.e. from local to national levels). It will also require bridging different sectors such as groups of stakeholders working on food security and those working on biodiversity conservation. Suitable processes need to be designed and put in place to facilitate exchange that can foster understanding and acceptance of other perspectives. This will involve recognising that various stakeholders have different goals, and that depending on the goals, a combination of strategies and approaches may be required.

Due to the complexity involved in realising food security and biodiversity conservation goals, governance needs to be agile, adaptable, and open. A key step towards this is that of enabling active and frequent exchange between different actors. Exchange and substantive collaboration can help actors understand areas of convergence and divergence, and thus identify opportunities for synergies and potential obstacles. Arguably, such learning can best

take place within networks of actors who actively collaborate and communicate in various different ways. For this reason, networks of governance actors are the focus of the next chapter.

Key insights for policy and practice

- Global food security discourses unfold into multiple and partly overlapping approaches at the landscape scale. Local interventions need to consider local dynamics including diverse stakeholders' interests.

- A production-oriented paradigm is the dominant approach to try to alleviate food insecurity. While this may increase food production, it neglects the key issues of social justice, dietary diversity, and biodiversity loss.

- The extent to which biodiversity conservation and food production can be integrated within the same parcel of land depends on many factors, and is highly context-specific.

- Respectful communication among stakeholders is needed to learn about the benefits of different perspectives on how to best integrate food security and biodiversity conservation.

Further reading

Jiren, TS (2019) Institutional prospects and challenges in the governance of food security and biodiversity: a case in southwestern Ethiopia. Doctoral thesis. Leuphana University Lueneburg, Germany.

Jiren, TS, Dorresteijn, I, Hanspach, J, Schultner, J, Bergsten, A, Manlosa, AO, Jager, NW, Senbeta, F, Fischer, J (in preparation) Alternative discourses around the governance of food security: a case study from Ethiopia.

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CHAPTER 14

Structures and processes in the governance of food security and biodiversity

Summary

- Current governance structures for food security and biodiversity are highly hierarchical with top-down interactions and a lack of collaboration between stakeholders operating in nearby woredas.
- Governance processes are characterised by various types of mismatches and incoherence that can jeopardise the achievement of food security and biodiversity conservation.
- Collaborative governance across levels and sectors is required to meet the complex, multidimensional challenges of ending hunger and averting further loss of biodiversity.

Introduction

One central aspect of understanding governance is recognizing that different actors or stakeholders have different perspectives on key challenges, and different preferences for approaches to addressing those challenges. This was demonstrated in the previous chapter, which discussed existing discourses around food security and biodiversity. For actors to successfully navigate such differences, find synergies, and work together towards finding solutions to complex problems, in turn, requires appropriate structures and processes – together, such structures and processes make up the governance system.

This chapter analyses the governance of food security and biodiversity conservation in southwestern Ethiopia. In terms of governance structure, we show patterns of interactions among stakeholders within and between the food security and biodiversity sectors, from the local kebele level to the national policy level. In terms of governance processes, we analysed policy documents and elicited perspectives of representatives from a number of stakeholder organisations. We drew on the insights thus generated to re-imagine how governance in Ethiopia could better respond to the complex challenge of achieving food security while maintaining biodiversity.

Methods

Location: This study spanned multiple levels of governance, involving stakeholders from six kebeles, three woredas, the zone, region, and the federal level. Governance structure was assessed through a network analysis involving 244 stakeholders from the kebele to the federal level. The investigation focusing on governance processes included 201 stakeholders from the kebele to the federal level.

Data collection: The data used for network analysis was collected through semi-structured interviews, which typically lasted for one hour. The stakeholders were selected through snowball sampling. The interviews elicited information on linkages between stakeholders with regard to food security and biodiversity conservation. In addition to an analysis of policy documents, the same procedure was used for collecting data related to governance processes.

Data analysis: Social network analysis was used to quantify governance structure, and content analysis was used to distil key challenges around governance processes.

Governance structures

Our study identified a large number of stakeholders in the food security and biodiversity sectors. These stakeholders interacted either for administrative or substantive purposes. Stakeholders were dominated by government organisations (80%), but also included community groups (11%) and non-government organizations (9%). The majority of stakeholders (71%) were involved in the governance of both food security and biodiversity. A smaller fraction, with 23% of stakeholders, focused only on food security, and 6% of stakeholders focused only on biodiversity conservation. This indicates that there is a large overlap between stakeholders working on food security and on biodiversity. In terms of linkages, on average each stakeholder had twice as much interactions focusing on food security compared to interactions focusing on biodiversity. In aggregate, half of all interactions among stakeholders were related to food security, 16% were concerned with biodiversity, and 34% were related to both food security and biodiversity conservation.

The governance structure was found to be highly hierarchical, with many top-down linkages, and very few horizontal linkages (Fig. 14.1). For example, stakeholders from different woredas or kebeles did not indicate any collaboration or communication, despite being at the same governance level and despite their geographical proximity. Vertical linkages were very common, but typically, stakeholders only interacted with those at the same governance level or with those at the nearest level up or down the hierarchy. For instance, there was no direct interaction between stakeholders at the woreda level and

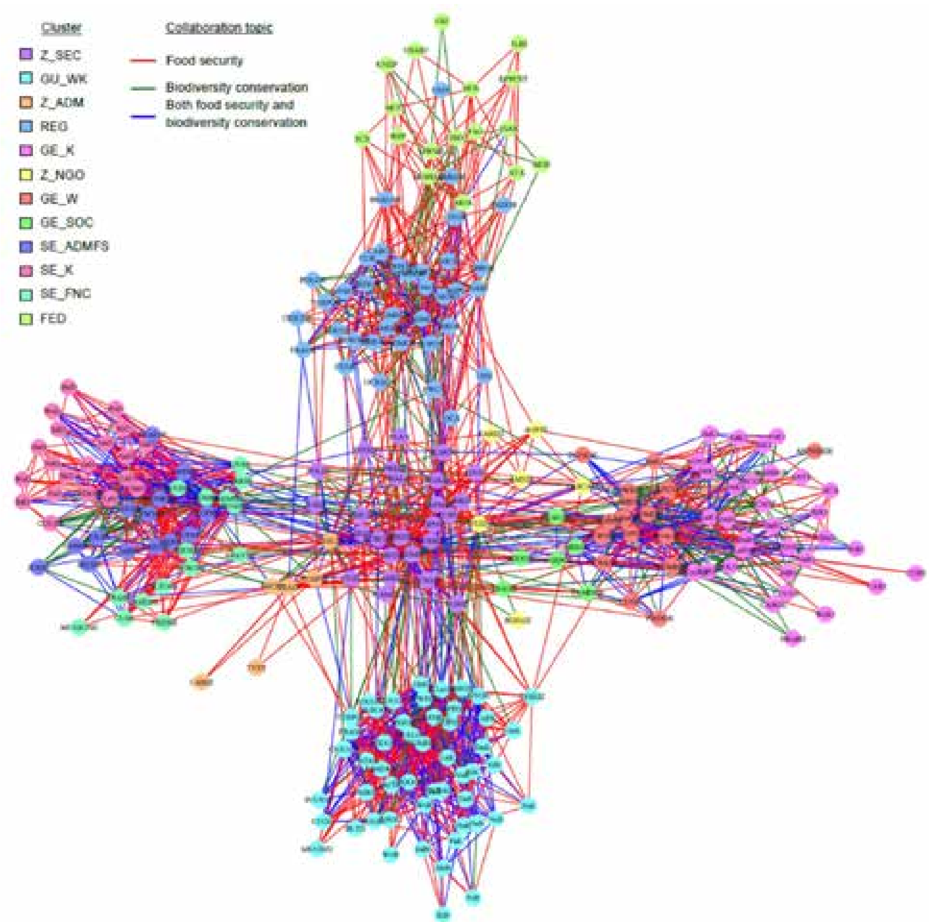

Fig. 14.1. Visualization of the actor network of food security and biodiversity governance.

those at the regional level – these were only linked indirectly through zonal level stakeholders. Administrative stakeholders at the levels of woreda, zone, and region played highly prominent roles both in the area of food security as well as biodiversity. These administrative stakeholders also played a connecting role between different stakeholders.

Current governance structures give a very powerful position to administrative stakeholders. Their power emerges both from having a central position in the governance network structure, and from their formal authority as administrative entities. Such a concentration of power implies opportunities, but could also have serious drawbacks. On the one hand, the central position of those with power provides a valuable opportunity to facilitate the integration of food security and biodiversity through various means such as fostering collective action and mobilizing resources. Powerful stakeholders can also play an important role in developing institutions that facilitate the building of stronger horizontal linkages and more collaborative rather than top-down linkages between stakeholders. On the other hand, the present situation also has a high potential for power capture by a small number of stakeholders – which would not only prevent integration, but further exacerbate potential governance problems such as highly centralized decision-making or a tendency for more powerful stakeholders to impose their own interests onto others.

Governance processes

We found three key challenges relating to governance processes namely institutional misfit, institutional interplay, and policy incoherence. We found various manifestations of institutional misfit. One example is widespread overlap in the mandates of various stakeholders working in the area of food security. This overlap resulted in multiple stakeholders pursuing intersecting tasks and responsibilities. In this case, overlap in institutional mandates was perceived to make coordination difficult and to reduce cooperation instead of promoting it.

In the area of biodiversity, an institutional gap was identified owing to a focus on forest and wildlife biodiversity, with missing institutions for managing farmland biodiversity. Furthermore, institutional misfits exist owing to incompatibilities in the characteristics of the institutions and the nature of biodiversity and food security challenges on the ground. For instance, mul-

tiple stakeholders are working with a focus on agricultural production. This addresses the dimension of food availability in relation to food security. However, other dimensions of food security such as access, stability, and utilisation are left largely unaddressed.

Effectiveness of governance was further hampered by institutional instability. Frequent restructuring, whether in terms of revising mandates or changing staff, made collaborations difficult to undertake. The instability caused by frequent changes was also associated with fragmented delivery of services and interventions. The Institute of Biodiversity for example, was restructured three times in the last six years alone.

There were also challenges identified in the area of institutional interplay. Institutional interplay pertains to patterns of interactions between institutional actors. A key challenge in this area is the limited coordination between stakeholders. In consequence, plans, strategies, and resources are not synergised towards the achievement of certain outcomes. The lack of coordination, in turn, could partly be attributed to a lack of effective "bridging institutions" whose function it is to connect relevant actors. Moreover, individual institutions are frequently assessed based on how they deliver on their specific mandate, without attention to how well their work is coordinated with other stakeholders. Thus, incentives are poor to improve institutional coordination.

Contradictions and incoherence in policy documents presents a third class of governance challenges. A number of national policy documents (e.g. the Agricultural Development-Led Industrialization Strategy and Growth and Transformation Plans) frame the achievement of food security in terms of increasing agricultural production. On the other hand, the National Biodiversity Strategy and Action Plan identifies the protection and conservation of biodiversity as an important policy goal. While these two goals are coherent within the sectors in which they were formulated, how actions are implemented on the ground causes incoherence that can jeopardize the achievement of both goals. Incoherence was also observed in the governance of food security and biodiversity separately. Specifically for biodiversity, a community-based biodiversity management strategy versus a stricter biodiversity preservation approach present conflicting strategies. Under the community-based biodiversity management strategy, communities are involved in participatory forest management and are officially recognized as responsible for managing forest and wildlife in collaboration with government actors. On the other hand, under the biodiversity preservation approach, communities are marginalized from forest management decisions and activities.

Overcoming existing obstacles

Problems with institutional structures and processes can pose obstacles to the successful and effective governance of food security and biodiversity. To address existing shortcomings, several aspects of governance require attention.

Key focal areas should be to build horizontal linkages through better communication between woredas and kebeles; provide better incentives for collaborations; make the most relevant policies coherent within and between sectors not only in principle but also in implementation; and build on existing institutions to foster new types of substantive interactions across governance levels and sectors. These action points necessitate recognition of the central role of good governance in ending hunger and conserving biodiversity. As a corollary, they also require investment of time, effort, and resources to establish governance structures and processes that are suitable and responsive to the complexities of food security and biodiversity challenges.

Key insights for policy and practice

- A good governance structure needs a diversity of stakeholders as well as a diversity of linkages, both across sectors and governance levels.
- Improvements to governance processes are needed particularly in the areas of coordination, participation, and policy coherence.
- Breaking through traditional hierarchies is extremely important. This should include listening to everyone involved, including and particularly to those who are at lower levels of the hierarchy.

Further reading

Jiren, TS (2019) Institutional prospects and challenges in the governance of food security and biodiversity: a case in southwestern Ethiopia. Doctoral thesis. Leuphana University Lueneburg, Germany.

Jiren, TS, Bergsten, A, Dorresteijn, I, Collier, NF, Leventon, J, Fischer J (2018) Integrating food security and biodiversity governance: a multi-level social network analysis in Ethiopia. Land Use Policy 78, 420-429.

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CHAPTER 15

Envisioning the future of southwestern Ethiopia

Summary

- Scenarios provide a means to envision the future, determine potential desirable and undesirable outcomes, and can help identify the actions needed to realize certain outcomes and avoid others.
- In collaboration with diverse local stakeholders, four scenarios were created for southwestern Ethiopia, which we entitled *Gain over grain*, *Mining green gold*, *Coffee and conservation*, and *Food first.*
- Each of these scenarios is associated with certain risks and opportunities for food security and biodiversity conservation.
- These risks and opportunities need to be carefully considered as stakeholders join forces to create a sustainable future for southwestern Ethiopia.

Introduction

The preceding chapters showed that land use practices, natural resource use, livelihood strategies, equity issues, and governance all shape biodiversity and food security in southwestern Ethiopia. In this chapter, we integrate all these insights and explore how the future may unfold in the area. For example, depending on changes in landscape composition, crop raiding may worsen or be reduced in the future, and this will affect people's ability to achieve food security through their farming livelihoods. Landscape change, in turn, will be driven by the policies and governance structures around biodiversity and food security, including the degrees to which future governance will be collaborative and how well institutional mismatches will be harmonised. To explore potential future social-ecological dynamics for southwestern Ethiopia, we applied participatory scenario planning. In this chapter, we first explain the process for developing scenarios, and then describe four unique scenarios, including their respective opportunities and risks.

Methods

Location: *Gumay*, *Gera* and *Setema* woredas were targeted for data collection, but the resulting scenarios are intended to be representative for the entire coffee growing area of Jimma zone.

Data collection: Workshops were held with 29 different stakeholders including local people, governmental and non-governmental organizations, and civil society organizations from the kebele, woreda and zonal levels. Workshops sought to identify key changes in the past and the future, as well as the main drivers and uncertainties associated with such changes.

Data analysis: We analysed the workshop results qualitatively and developed a social-ecological systems diagram. We identified the most important and most uncertain drivers of change, and developed draft scenario narratives. We then evaluated the findings through six further stakeholder workshops, in which we refined the scenarios. Finally, we visualized the scenarios through artwork.

Scenario development

We do not know what the future will be, but envisioning what the future might look like can help to explore desirable and undesirable outcomes and to think about actions that would be required to achieve or avoid certain outcomes. Scenario development is a structured approach to implement such a visioning exercise. The scenarios presented here were developed in a participatory process through a series of workshops with 29 stakeholders from different backgrounds.

In the workshops, stakeholders first identified the most important social, economic and ecological changes that had occurred in the area in the last two decades, as well as changes that were considered likely to happen in the future. Second, stakeholders assessed how specific changes have led to certain outcomes or may trigger other changes in the study area. For example, population growth is expected to increase land scarcity, and land scarcity in turn will reduce people's ability to produce food or other farming products. Knowledge of such cause-and-effect chains is useful to understand the dynamics in a given area.

To then develop scenarios for a given area, identifying "critical uncertainties" is a key task, because such uncertainties are the reason for potentially vastly different outcomes in the future. For example, stakeholders considered changes around the future state of forests and farmland as highly uncertain. Also, the extent to which food or cash crops would be grown in the area was deemed uncertain. We therefore focused on uncertainties in these two dimensions – land uses and crop types – as defining features setting apart the different scenarios.

Scenario descriptions

The four scenarios presented below describe alternative development trajectories for southwestern Ethiopia in the next 20 years. They do not predict what will necessarily happen, but rather explore four different directions in which the social-ecological system of southwestern Ethiopia might evolve (Fig. 15.1, 15.2).

Gain over grain: local cash crops. Under this scenario, the government prioritises farmer specialisation and commercialisation as a pathway for development. Farmers focus on cash crops such as coffee and khat and fast-growing trees such as eucalypts. As a result, the landscape mainly consists of coffee forests that are being intensively managed, and these are interspersed with khat and tree plantations. Food crop production is limited. Farmland and forest biodiversity have declined as a result of intensive management and simplified habitats. Forest wildlife still persists. Wildlife raids of the remaining food crops continue to impact farmers, especially the poorest. In terms of socioeconomic aspects, the benefits from this development trajectory are unevenly distribut-

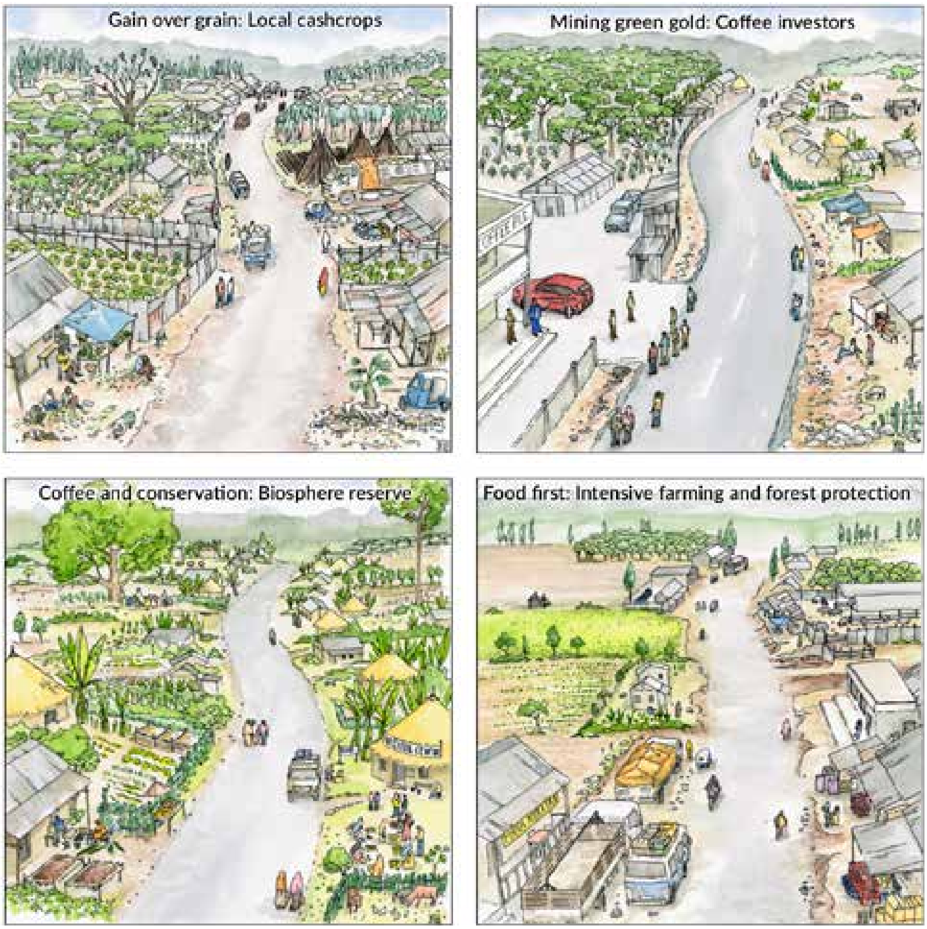

Fig. 15.1. Alternative futures for southwestern Ethiopia – this is what a typical street scene might look like under the four different scenarios.

ed with improvements in the living standards of relatively wealthy farmers but marginalisation of the poorer ones. Social cohesion is eroded, and there is a decline in traditional cooperative management. Khat consumption and general levels of mistrust have increased.

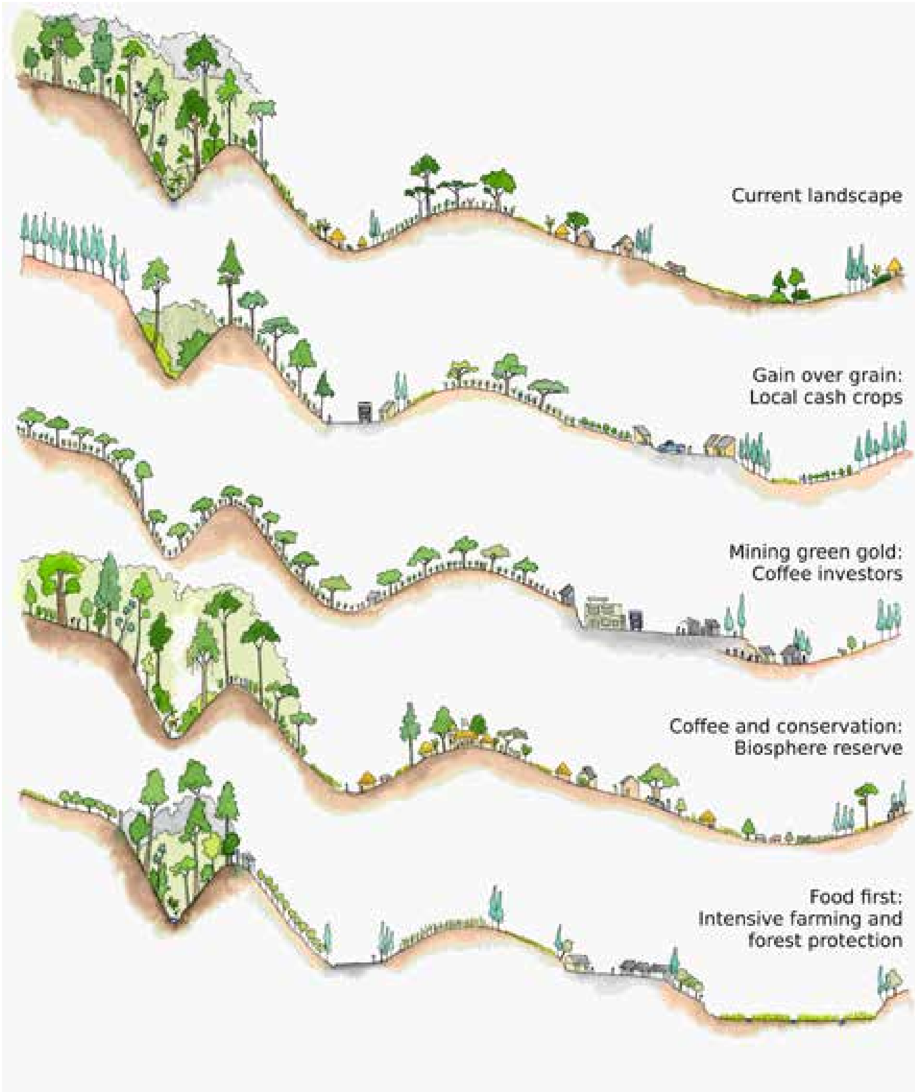

Fig. 15.2. Alternative futures for southwestern Ethiopia. The image shows stylised cross-sections of the landscape under the four different scenarios in comparison to the present.

Mining green gold: coffee investors. This development trajectory is based on the government's designation of coffee as a priority crop for southwestern Ethiopia in response to high demand from international markets. Major coffee investors are key actors in this scenario, while smallholder farmers play a rather limited role. Large amounts of land have been given to investors, and the landscape is transformed into a monoculture of intensively managed, high-yielding coffee plantations. Food production is low under this scenario. Because of intensive coffee management, biodiversity in farmland and forests has declined. The influx of high-yielding varieties has caused traditional, native varieties of coffee to disappear. While smallholder farmers were given compensation for loss of their access to land, the compensation is inadequate.

Coffee and conservation: a biosphere reserve. In this scenario, land degradation has made conventional agricultural approaches untenable, and the government has responded by prioritising sustainable farming approaches. This coincides with an increasing international demand for sustainably grown coffee. Hence, a biosphere reserve has been established which combines sustainable agriculture, ecologically-friendly coffee production, and eco-tourism. The landscape is characterised by diverse land uses, including a core area of sustainably managed forest and a mosaic of diversified farmland and forests. The presence of different habitats and the practice of sustainable farming practices have enabled farmland biodiversity to recover. Forest biodiversity is also high. The community plays a strategic role in managing forests and wildlife. Most of the food consumed is produced locally but local farmers also produce for export (e.g. coffee). Practices around food production and coffee production maintain traditional cooperative farming arrangements. While economic growth is slow, its benefits are distributed fairly, and resilience is high owing to the maintenance of strong communities and diversification of livelihoods.

Food first: intensive farming and forest protection. This scenario involves increasing the production of food crops and economic gains through commercialisation. Due to climate change, parts of southwestern Ethiopia that were previously suitable for coffee are no longer able to support coffee production, and food production in drier areas of the country is also failing. Thus, the southwestern part of the country now plays a key role in growing food. Food production is undertaken intensively and at a large scale. The landscape is characterised by some fruit and vegetable plots, maize and teff fields in the wetlands, pastures for beef fattening, and other intensively managed fields. Forest areas are strictly protected, and local residents are highly restricted from accessing the forest. While forest biodiversity remains high, biodiversity in the farmland is significantly reduced. Some farmers become significantly better-off but many others lose land and are unable to meaningfully participate in the development process. As a consequence, the food security of many households is low. Resilience is also low due to fluctuations in the climate and in markets. People respond to the increasingly difficult conditions by moving to towns where they look for alternative livelihood opportunities.

Opportunities and risks

Each of the scenarios described above is associated with a set of opportunities and risks. We summarise these in Table 15.1.

Table 15.1. Overview of key characteristics of the four scenarios developed for the Jimma coffee landscape.

	Gain over grain: local cash crops	Mining green gold: coffee investors	Coffee and conservation: a biosphere reserve	Food first: intensive farming and forest protection
Central narrative	Because of problems with crop raiding by wildlife, local people focus on the cash crops coffee, fast-growing trees and the stimulant khat.	Major coffee investors convert large parts of the landscape into coffee plantations, displacing local people.	Organic products and agroecological methods are fostered via the establishment of a locally managed biosphere reserve, which also brings eco-cultural tourism.	Driven by climate change, the region becomes the core food production zone of Ethiopia, and agriculture is heavily intensified.
Key actors	Local farmers, middlemen, cooperatives	Investors, government	Locals, scientists, NGOs, government	Government, local farmers, cooperatives

	Gain over grain: local cash crops	Mining green gold: coffee investors	Coffee and conservation: a biosphere reserve	Food first: intensive farming and forest protection
Key governance mecha-nisms	Markets (local-national)	Markets (export)	Cooperative management plan and local community-based institutions	Markets (national) with government intervention
Connect-edness to remote locations	Low-medium	High	Low-high	Medium
Stabilising feedbacks	Commercial-isation and intensification of farming by locals	Profits by investors	Multilevel governance and maintenance of social and natural capital	Government policy, com-mercialisation and intensifica-tion of farming
Opportuni-ties	Increased income, im-proved infra-structure and public services	National export earnings, infrastructure improvements	Sustainable development, resilience and social justice	Increased income, im-proved infra-structure, for-est protection
Risks	Market de-pendence, social inequali-ties, excessive khat use	Equity chal-lenges, loss of natural capital	Economic viability	Land degra-dation, market dependence, social inequal-ities
Outcome for food security	High availabil-ity of imported food in mar-kets with vary-ing degrees of access	Reduced food production and poor access to food	Food sover-eignty, good access to lo-cally produced food, dietary diversity	High availabili-ty of processed food with vary-ing degrees of access
Outcome for biodiver-sity conser-vation	Decline of farmland and forest biodiver-sity but some landscape heterogeneity maintained	Landscape homogenisa-tion and decline of forest and farmland biodi-versity	Heterogene-ous landscape with high forest and farmland bio-diversity	Loss of farm-land biodi-versity and forests except for strictly pro-tected forest remnants

In sum, the scenario *Gain over grain* has possible benefits for income but is likely to come with undesirable impacts on social relationships and the natural environment. The second scenario *Mining green gold* can potentially benefit the national trade balance. However, there is a high risk that benefits to the local population would be very marginal. The third scenario *Coffee and conservation* holds the potential of balancing social, economic, and environmental priorities and promises the achievement of equitable and sustainable development. However, the pace of economic growth under this scenario is likely to be slow relative to the other scenarios. The scenario *Food first* may provide surplus food not only for southwestern Ethiopia but also for elsewhere in the country. However, in this scenario, the risks of aggravating land degradation and eroding resilience are high.

Several of the scenarios are implicitly underpinned by a productivist narrative and involve reinforcing feedback mechanisms around the intensification and commercialisation of farming. This is consistent with patterns of agricultural intensification observed in the last years as described in Chapter 2 outlining the history of the landscape, as well as with narratives around commercialisation as discussed in Chapter 13 on governance discourses. In light of our overall research findings, the *Coffee and conservation* scenario appears to be most suitable to synergistically address biodiversity and food security goals, while other scenarios will be likely to address only biodiversity or only food security, at the expense of one another. *Coffee and conservation* will be likely to facilitate biodiversity conservation by maintaining a mix of a core protected area needed for specialist species (see Chapters 3, 4, and 5) as well as a multifunctional agricultural landscape that harbours farmland biodiversity (see Chapters 3, 4 and 5) and can support diversified farming livelihoods, which benefit food security (see Chapter 9). Furthermore, the combination of a core protected area with a multifunctional agricultural landscape is also most likely to ensure that people have access to vital ecosystem services needed to sustain their livelihoods and well-being (see Chapters 6, 7).

Key insights for policy and practice

- Given the combinations of opportunities and risks, we make the following recommendations for national and local actors:
- Treasure and protect the unique biodiversity hotspot in Ethiopia's southwest.
- Intensify farming primarily via modern organic and agroecological methods, and support diversified cash and food crop production.
- Draw on the strengths of local communities and further build local capacity and awareness via outreach programs.
- Bring together multiple stakeholders when working towards a better future, and ensure that the benefits from development are equitably distributed.
- Intensify efforts to slow down population growth.

Further reading

Fischer, J, Senbeta F, Dorresteijn I, Hanspach J, Jiren TS, Schultner J (2018) Envisioning the future for southwestern Ethiopia. Pensoft. Available at: https://books.pensoft.net/books/13101

Jiren, TS (2019) Institutional prospects and challenges in the governance of food security and biodiversity: a case in southwestern Ethiopia. Doctoral thesis. Leuphana University Lueneburg, Germany.

Jiren, TS, Hanspach, J, Schultner, J, Fischer, J, Bergsten, A, Senbeta, F, Hylander, K, Dorresteijn, I (in preparation). Reconciling food security and biodiversity conservation: Participatory scenario planning in southwestern Ethiopia.

If you have trouble accessing references, please email Joern Fischer at joern.fischer@uni.leuphana.de, or visit our project website at https://foodandbiodiversity.wordpress.com.

CHAPTER 16

Conclusion

The information and insights presented in this book were based on a collaborative and interdisciplinary investigation of the interlinkages between biodiversity conservation and food security in southwestern Ethiopia. The general aim was to determine whether synergies exist between the desirable outcomes of conserving biodiversity and achieving food security. The focus on synergies was adapted as an alternative to the widely adapted perspective of trade-offs, which views biodiversity and food security as two dichotomous and necessarily competing goals. This chapter concludes by highlighting three key messages from this compendium of studies and by identifying actionable recommendations that policymakers and practitioners can use to inform their discussions and planning. These messages and recommendations are likely to be relevant and useful not only for those working in Ethiopia, but also for those working in other parts of the world facing comparable challenges.

1. A small-scale mosaic of sustainably managed family farms in a tree-rich landscape, in combination with large, undisturbed patches of forest will best conserve biodiversity and support local food security.

Agricultural production has been known as one of the most important drivers of land use change, causing disappearance of forests and decline in biodiversity all over the world. But it is also highly important for the survival of people anywhere in the world. Due to its purpose for food production and its negative effect on biodiversity, agriculture has largely been perceived in terms of causing a trade-off with biodiversity. According to that view, farms are a threat to biodiversity, and largely unmodified areas with high biodiversity are an impediment to meeting people's food needs.

In contrast to this widespread perception, our research showed that the link between biodiversity conservation and food security is not necessarily a straightforward trade-off. On the one hand, our ecological studies demonstrate that diversified farming in a heterogeneous landscape with many different types of tree cover (including coffee patches) can be beneficial for biodiversity. Findings summarised in this book consistently pointed to the role of small and diversified farms in supporting a diversity of trees, birds, mammals and insects. Different parts of the landscape in southwestern Ethiopia have distinct biodiversity value, with forests being particularly important for sensitive specialist species, but farmland also supporting many less specialised forest species. Together, the landscape mosaic of forests and farmland provides a diverse suite of conditions and thus habitat for a rich array of plants and animals. The current high levels of biodiversity in the farmland of southwestern Ethiopia are directly linked to existing management and farming practices including the retention of trees in farmland and the farming of diverse crops – characteristics that are distinctly different from large, intensively managed monoculture farms that are found in many other parts of the world.

On the other hand, the social science research summarised in this book also demonstrates the benefits of such diversified farms on household food security. The latter half of the book discussed how diversity in food crops in combination with economically important cash crops such as coffee enables households to be more food secure than they would be by focusing only on food or only on cash crops. Findings also highlight how trees in the farmland provide important ecosystem services such as honey which are important for food security as source of calories or income.

The defining feature of *diversity* in Ethiopian small-scale family farms therefore generates synergies for biodiversity conservation and food security. However, there is a risk that the existing benefits of a highly heterogeneous landscape mosaic might be lost and give way to industrial agriculture, with more intensified and commercialised farming. Such development pathways are typically favoured by those who see farms as contributing food, and forests as contributing biodiversity – but this view misses key aspects of real world complexity. Indeed, small and diversified farms not only provide food but also habitat for biodiversity, as forests not only host biodiversity but also provide ecosystem services or benefits that are critical for people's survival and well-being. Ethiopia is likely to improve its chances of meeting biodiversity and food security goals if its policies recognise that the landscapes in the southwest are highly multifunctional. Policies, in turn, need to support and help improve local management practices that promote landscape multifunctionality.

2. A more even distribution of benefits from the environment, more effective mitigation of disbenefits from the environment, and a diversity of crops within local livelihood strategies are required for improving the food security of households.

Results from our research highlight several critical priorities that need to be included in policy-making and in program implementation for food security. While findings do not discount the necessity of improving production and income levels for households in this part of Ethiopia, our findings call attention to the need to re-embed production and income priorities within the wider issue of distribution and equity. The livelihoods of the majority of the population are hugely dependent on the benefits that flow from the environment and are significantly impacted by the disbenefits that they are exposed to. The close relationship between people's food security and their livelihoods, and in turn, the direct dependence of livelihoods on the surrounding ecosystems, behoves reconnecting agricultural and food security policies to the environment. This requires expanding the question from *How can agricultural production and profit be increased*? to *How* can *the environment, including forest and farmland, be managed in a way that distributes the benefits to local households more evenly*? and *How can disbenefits from living close to the forest be mitigated for all groups of households*? Answering these questions will need the involvement of local residents, and local government and non-government actors to plan and design appropriate courses of action. To this end, local initiatives will require resources, legitimacy, and momentum from supportive policies. Additionally, the findings of our work are consistent with those found in other contexts in various parts of the world, highlighting the importance of diversified cropping for subsistence and local food security.

3. Food security and biodiversity conservation are more likely to be achieved if governance of these issues is carefully coordinated and integrated.

Whether food security and biodiversity conservation are harmonised in practice will depend to a large extent on how these issues are governed. Because a number of government and non-government stakeholders work on both food security and biodiversity, there is a significant overlap in the point of focus of stakeholders. This overlap is indicative of an opportunity to harmonise governance of the two sectors. However, the long-standing mindset and practice of dichotomising forest and farmland instead of developing policies on the basis of a strong recognition of overall landscape multifunctionality present an impediment to integrated governance. Moreover, governance actors are currently kept separate through structures that are hierarchical, and numerous processes that cause friction and mismatches.

Improved governance of food security and biodiversity thus requires interventions that foster mutually beneficial collaboration among governance actors across scales and sectors. Such collaborative linkages can be a site of exchange and mutual learning – characteristics that are important in agile and adaptive governance systems that are able to deal with complex challenges such as the ones addressed in this book. To be more democratic and effective, stronger bottom-up elements are also needed, such that stakeholders at lower levels (e.g. in the kebeles and woredas) can give substantive input into policymaking and program design, rather than being merely responsible for the implementation of pre-defined programs.

In closing, by bringing together the analytical lenses from both the ecological and social sciences, our research was able to provide deep understanding of a wide range of interlinked dimensions that are relevant to address current challenges around food insecurity and biodiversity decline – dimensions such as plant and animal diversity, ecosystem services and disservices, livelihoods, and governance. We hope that both the specific knowledge offered in the individual chapters of this book, as well as our overall synthesis in this chapter will help stakeholders in southwestern Ethiopia to successfully work towards a better future for both people and the environment.

APPENDIX

List of species names

Latin name	Common name
PLANTS	
Acacia abyssinica	flat top acacia
Albizia gummifera	peacock flower
Allium cepa	onion
Brassica napus ssp. napus	rapeseed
Brassica oleracea	cabbage
Carica papaya	papaya
Cassipourea malosana	pillarwood
Catha edulis	khat
Chionanthus mildbraedii	fringetree
Coffea arabica	coffee
Colocasia esculenta	taro
Cordia africana	sudan teak
Croton macrostachyus	broad-leaved croton
Cucurbita pepo	pumpkin
Cupressus spp	cypress
Daucus carota ssp. sativus	carrot
Dracaena fragrans	cornstalk dracaena
Dracaena steudneri	northern large-leaved dragon-tree
Ehretia cymosa	- - -
Ensete ventricosum	ensete
Eragrostis tef	teff
Erythrina brucei	- - -
Eucalyptus spp	eucalypt
Euphorbia abyssinica	- - -
Ficus sur	cape fig
Hordeum vulgare	barley
Mangifera indica	mango
Maytenus arbutifolia	- - -
Millettia ferruginea	- - -
Ocimum lamiifolium	- - -
Olea welwitschii	- - -
Persea americana	avocado
Piper nigrum	pepper
Podocarpus falcatus	common yellowwood

Latin name	Common name
Pouteria adolfi-friederici	- - -
Schefflera abyssinica	- - -
Solanum lycopersicum	tomato
Sorghum bicolor	sorghum
Syzyium guineense	waterberry
Triticum aestivum	wheat
Vernonia amygdalina	bitter leaf
Vernonia auriculifera	- - -
Zea mays	maize
BIRDS	
Apaloderma narina	narina trogon
Camaroptera brachyura	grey-backed camaroptera
Centropus senegalensis	senegal coucal
Cinnyris venustus	variable sunbird
Colius striatus	speckled mousebird
Cossypha spp	robin chat
Laniarius aethiopicus	Ethiopian boubou
Lanius collaris	common fiscal
Melaenornis chocolatinus	abyssinian slaty flycatcher
Melaenornis pallidus	pale flycatcher
Nectarinia tacazze	tacazze sunbird
Passer swainsonii	Swainson's sparrow
Ploceus baglafecht	baglafecht weaver
Pseudoalcippe abyssinica	African hill babbler
Pycnonotus barbatus	common bulbul
Streptopelia semitorquata	red-eye dove
Tauraco leucotis	white-cheeked turaco
Turtur tympanistria	tambourine dove
MAMMALS	
Atilax paludinosus	marsh mongoose
Canis adustus	side-strpied jackal
Canis mesomelas	black-backed jackal
Caracal caracal	caracal
Cercopithecus aethiops	vervet monkey
Cercopithecus mitis	blue monkey
Cercopithecus neglectus	De brazza's monkey
Chlorocebus aethiops	Grivet monkey
Civettictis civetta	African civet
Colobus guereza	mantled guereza

Latin name	Common name
Crocuta crocuta	spotted hyena
Felis lybica	African wildcat
Galago senegalensis	northern lesser galago
Genetta genetta	common genet
Genetta maculata	blotched genet
Heliosciurus gambianus	Gambian sun squirrel
Herpestes ichneumon	Egyptian mongoose
Herpestes sanguinea	slender mongoose
Heterohyrax brucei	bush hyrax
Hylochoerus meinertzhageni	giant forest hog
Hystrix cristata	crested porcupine
Ichneumia albicauda	white-tailed mongoose
Lepus capensis	hare
Lepus saxatilis	hare
Lophiomys imhausi	crested rat
Mellivora capensis	ratel / honey badger
Orycteropus afer	aardvark
Panthera leo	lion
Panthera pardus	leopard
Papio anubis	olive baboon
Phacochoerus africanus	warthog
Potamochoerus larvatus	bushpig
Procavia capensis	rock hyrax
Sylvicapra grimmia	bushduiker
Syncerus caffer	African buffalo
Tragelaphus scriptus	bushbuck
INSECTS	
Apis mellifera	honey bee
Chryphiomystis aletreuta	serpentine leaf miner
Crematogaster spp.	- - -
Leucoplema doherthi	skeletonizer
Leucoptera spp	blotch miner
Xylocopa spp.	carpenter bee
FUNGI	
Colletotrichum kahawae	coffee berry disease
Gibberella xylarioides	coffee wilt disease
Hemileia vastatrix	coffee leaf rust

GLOSSARY OF TERMS

Agency: The capacity of an entity or individual to plan and initiate action.

Agent: An entity or individual performing planned actions in a social setting.

Arthropods: An invertebrate animal defined by its exoskeleton, segmented body, and paired jointed appendages. This includes insects, arachnids, myriapods and crustaceans.

Biodiversity: The variability, abundance and variety of living organisms. This includes diversity within a species (genetic diversity), between species as well as between ecosystems and ecological communities.

Capital assets: Valuable goods or conditions that are not immediately consumed but can be employed in the pursuit of additional goods or conditions. Capital assets can be financial (credit, income, savings), human (skills, health, knowledge), built (infrastructure, machinery) and social (bonding, bridging ties).

Cultural services: Benefits provided by ecosystems that are valued in culturally specific ways and create a sense of identity, e.g. serving recreation or spiritual practice.

Daadoo: A traditional system of temporal rotational labour in which members of a community support each other reciprocally in labour intensive agricultural work, e.g. harvesting.

Daboo: A traditional social support system where local community members cooperate to support the needy, e.g. preparing the land or assisting in house construction. Participation is voluntary and unpaid.

Didaaro: A traditional system of agricultural collaboration, where neighbouring farmers coordinate their cropping activities, allowing them to minimize effort by sharing guarding duties against crop raiding animals or labour pooling.

Ecosystem disservices: Functions performed by an ecosystem which lead to disadvantageous consequences for people. Examples include crop losses through pests or crop raiding animals, or insects that act as disease vectors.

Ecosystem services: The benefits that people obtain from ecosystems. These include the provision of consumable goods, like food and water, but also regulating services (e.g. pest control), cultural, recreational and spiritual well-being, as well as supporting services that maintain the basic functioning of ecosystems, such as nutrient cycles.

Food security: A measure for the availability of nutritious and safe food, as well as individuals' capacity to access it. This includes not only dimensions of availability and access, but also utilization, agency, stability and appropriateness.

Governance: The process of regulating human behaviour according to shared objectives. This extends beyond formal governmental rules and laws, and includes nongovernmental mechanisms.

Institutions: Mechanisms of social order that are based on recurring patterns of human behaviour. Institutions can be divided into formal institutions, which are codified by laws and regulations, and informal institutions, which include unwritten customs and traditions.

Kebele: Municipality in Ethiopia. The government levels are the federal level, region, zone, woreda and kebele.

Landscape multifunctionality: A perspective that seeks to include the multiple benefits provided by a landscape into economic analysis. Human-modified or agricultural landscapes typically perform different functions and provide diverse outputs, of which many are not assigned a financial value. Acknowledging and accounting for the existence of non-commodity outputs can lead to improved decision-making by land users.

Livelihoods: The ability of people to sustain and reproduce their lifestyles within their households or communities by using capital assets.

Provisioning services: Material benefits provided by ecosystems that can be consumed directly, e.g. wood, food or fibre.

Regulating services: Benefits provided by ecosystems that enhance human well-being indirectly, by enhancing other ecosystem services, or reduce ecosystem disservices. Examples include pollination or flood control.

Resilience: The capacity of a system to respond to external disturbance in a way that allows for it to return to its initial state.

Scenario: A coherent narrative about a plausible, e.g. logically coherent future state of an entity (e.g. business, region or country).

Scenario planning: A visioning method that uses scenarios in order to navigate long-term uncertainty.

Shane: Government-initiated organizational unit of one to five neighbouring households in a community. It serves the goals of economic development and security by facilitating cooperation among its members.

Social capital: The social resources of an individual or a group that can be used to increase well-being

Social-ecological system: A concept inspired by systems thinking that is commonly employed to investigate sustainability problems. The social-ecological systems perspective serves to conceptualize the interactions and dependencies between societies and the biophysical environment in which they are embedded.

Supporting services: Biophysical processes that enable the basic functioning of ecosystems, e.g. nutrient cycling or photosynthesis.

Traditional institutions: Historically continuous socially shared rules that govern aspects of community life, like marriage customs or economic exchange rules. Traditional institutions are typically informal institutions.

Woreda: Administrative district in Ethiopia. The government levels are the federal level, region, zone, woreda and kebele.

Ensuring food security and halting biodiversity decline are two of the most urgent, interconnected challenges facing humanity in the 21st century. Drawing on both the natural and social sciences, we implemented an interdisciplinary research agenda to address these challenges. This book summarises the findings of five years of research in southwestern Ethiopia. It covers diverse topics, from biodiversity conservation to ecosystem services, livelihoods, social equity, population growth and governance. It concludes with an outlook of what the future may hold for southwestern Ethiopia. Each chapter in the book is based on peer-reviewed empirical science, begins with a summary of key messages, and concludes with a series of recommendations for policy and practice. The book seeks to inspire and inform policymakers, scientists and other stakeholders in Ethiopia and elsewhere, aiming to provide scientifically grounded, tangible insights that can help to harmonise biodiversity conservation and food security.

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