MARTIN-LUTHER-UNIVERSITÄT
HALLE-WITTENBERG

The environment-migration nexus: Transferring knowledge from local to global scale

Dissertation
zur Erlangung des
Doktorgrades der Naturwissenschaften (Dr. rer. nat.)
der
Naturwissenschaftliche Fakultät III
Agrar- und Ernährungswissenschaften, Geowissenschaften und Informatik
der Martin-Luther-Universität Halle-Wittenberg

vorgelegt von
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geb. am 11.10.1991 in Heidelberg

Leipzig, den 9. Juni 2021

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Zweitgutachter: Prof. Dr. Patrick Sakdapolrak
Datum der Disputation: 24. Januar 2022

Acknowledgements

First and foremost, I want to thank Kathleen Hermans and Ralf Seppelt, who made this dissertation possible, for their excellent supervision. Being an incredibly enthusiastic, reliable and competent working group leader, Kathleen has provided me with crucial guidance and motivation during my time as doctoral researcher. Ralf has always been available for experienced advice and open for ideas and fruitful discussions, no matter which research topic and despite his duties as department head. Both of them have always given quick and constructive feedback when needed. I'm very grateful for their valuable and ongoing support.

I also want to thank the MigSoKo team, especially Juliane Groth, Hanna Friedrich and Jule Thober. Working together with them has really been a pleasure and an enriching experience. I am glad to have shared the office (as well as the ups and downs of everyday PhD life) during the past four years with my dear "PhD twin", Juliane – this has been an unforgettable time!

I am also grateful to Micha Beckmann, Matthias Schröter, Helen Adams and Tobias Ide who contributed to parts of this dissertation as co-authors and provided essential conceptual and methodological advice. I enjoyed the opportunity to exchange ideas with them and learn from their expertise. Thanks also go to my former research assistants Kate Tyndall and Lena Hubertus for their reliable and efficient support of the tedious process of data selection and collection for Chapter 3 and 4.

In addition, I would like to thank my colleagues from the Computational Landscape Ecology Department at UFZ. The friendly and relaxed working atmosphere there is priceless and I've made many good friends. The past four years wouldn't have been the same without my (work)mates Lisanne, Jolle, Kathi, Lukas, Anne, Philipp, Sophie and Niklas (to name but a few).

Last but not least, I want to thank my family and friends, especially my parents, Heike and Wolfram, and my childhood friends, Hannah and Ren, who have always encouraged me. A big thanks also to my wonderful flatmates and Ole, who kept me great company during the tough phases of the PhD and endless weeks of home office.

Summary

The dynamics between environmental change and human migration have become a highly politicised and hotly debated topic at both national and international level. Simplified and deterministic assumptions of climate change causing mass migration and of immigration promoting resource scarcity and conflict have generated alarmist narratives of migration as security threat. However, scientific evidence shows that environment-migration linkages are complex, multidirectional and context-specific. There is a broad spectrum in terms of people's capacities to deal with environmental change as well as of human agency in migration decision-making. Besides, case studies have revealed multiple factors which influence social dynamics and resource use in destination areas.

Drawing from the growing body of case studies in this research field, I apply different synthesis approaches to contribute to a generic understanding and trans-regional picture of the environment-migration nexus. In this dissertation I aim to address the following overarching questions: (i) How can the diverse mechanisms through which environmental change influences human mobility be disentangled? (ii) What is the role and relative significance of migration as adaptation strategy to environmental change? (iii) Which contexts are conducive to violent resource conflicts in rural immigration areas?

In Chapter 1, I provide a concise overview of the state of research on the environment-migration nexus. I introduce key facts on environment-related migration and outline the debate on migration as adaptation strategy and the influence of migration on natural resource use and conflict. In addition, I highlight the research gaps which I address in the three core chapters of this thesis.

In Chapter 2, I propose an innovative framework that combines the novel concept of Nature's Contributions to People (NCP) with the triad of migration need, ability and aspiration. Here, I pay particular attention to crucial, yet rather understudied cultural and subjective aspects, including place attachment. I argue that this framework enhances our understanding of why different types of mobility and immobility evolve under conditions of environmental change. Based on a qualitative review of 20 case studies, I apply the framework to the southwestern Bangladeshi coast and the northern Ethiopian highlands. The analysis mostly reveals links

between lacking or declining material and regulating NCP and increasing migration need. Although there are some indications of non-material NCP contributing to lower migration aspirations, information on this link is comparatively scarce. Beyond this, my results underline the fundamental role of non-environmental factors, such as gender norms and landownership, in mediating environmental influence on human mobility.

In Chapter 3, I collate qualitative and quantitative data from 63 systematically selected studies covering more than 9,700 rural households in drylands south of the Sahara. On this basis, I explore the range of adaptation and coping strategies used by households in response to different types of environmental change and the relative significance of migration in this context. Different types of migration are reported as strategy by about 23% of the households under study. However, agricultural strategies related to crop and livestock management and soil and water conservation are much more common, illustrating the prevalence of in-situ adaptation in rural areas. Furthermore, my findings emphasise the importance of locals' perception of environmental change, persistent adaptation barriers as well as the question of long-term impacts of adaptation strategies, including migration.

In Chapter 4, I present a comparative meta-study that integrates comprehensive qualitative and quantitative data from 20 immigration areas in rural Asia, Latin America and Sub-Saharan Africa. Using Qualitative Comparative Analysis (QCA), I identify and elucidate two combinations of conditions under which violent conflict over renewable resources involving migrant groups occurs: (1) a high reliance of local livelihoods on natural resources and the negative othering of migrants regarding resource use, and (2) government policies supporting parts of the migrant group paralleled by limited resource use possibilities due to conservation or industrial activities. Moving beyond these findings, I discuss the crucial role of grievances related to perceived unfair resource access and the decisive influence of government interests and actions on migrant-host dynamics.

Lastly, in Chapter 5, I summarise the key insights and contributions of this dissertation, reflect upon methodological challenges and the geographical focus, and provide suggestions for future research and policy-making. Put together, my results clearly refute alarmist assumptions of direct causal links between environmental change and migration and between immigration and resource competition. My findings illustrate how these processes are shaped by a variety of factors at different

scales; in particular, underlying structural inequalities that cause vulnerability in the first place and power relations fuelling tensions between population groups. Environmental change can impact people's migration need, ability and aspiration in multiple ways. Migration is not necessarily the preferred strategy to deal with environmental stress nor accessible to everyone. Furthermore, even under conditions of degrading natural resources, immigration does not automatically lead to violent clashes over resources. Governments play a key role in this context by defining resource access and thereby fostering a climate of either competition or cooperation. Future research should guide policy-making towards empowering marginalised groups to take self-determined migration decisions and to facilitate peaceful co-existence and resource sharing in receiving areas.

Zusammenfassung

Die Dynamik zwischen Umweltwandel und menschlicher Migration ist zu einem hochpolitisierten und heiß diskutierten Thema auf nationaler und internationaler Ebene geworden. Vereinfachte und deterministische Annahmen, wonach der Klimawandel Massenmigration verursacht und Einwanderung Ressourcenknappheit und Konflikte fördert, haben Narrative von Migration als Sicherheitsbedrohung hervorgebracht. Forschung auf diesem Gebiet zeigt jedoch, dass die Zusammenhänge zwischen Umwelt und Migration komplex, multidirektional und kontextspezifisch sind. Es gibt ein breites Spektrum bezüglich der Fähigkeiten von Menschen, mit Umweltveränderungen umzugehen, sowie unterschiedlich viel Spielraum in Migrationsentscheidungen. Darüber hinaus weisen Fallstudien auf eine Vielzahl von Faktoren hin, die soziale Dynamiken und Ressourcennutzung in Einwanderungsgebieten beeinflussen.

Angesichts des stetig wachsenden Wissensstands in diesem Forschungsfeld wende ich verschiedene Syntheseansätze an, um zu einem generischen Verständnis und einem überregionalen Bild des Umwelt-Migrations-Nexus beizutragen. In dieser Dissertation konzentriere ich mich auf die folgenden übergreifenden Fragen: (i) Wie können die verschiedenen Mechanismen, durch die Umweltveränderungen menschliche Mobilität beeinflussen, differenziert werden? (ii) Was ist die Rolle und relative Bedeutung von Migration als Anpassungsstrategie an Umweltveränderungen? (iii) Welche Rahmenbedingungen fördern gewaltsame Ressourcenkonflikte in ländlichen Einwanderungsgebieten?

In Kapitel 1 gebe ich einen prägnanten Überblick über den Forschungstand zum Umwelt-Migrations-Nexus. Ich stelle wichtige Fakten zur umweltbedingten Migration vor und skizziere die Diskussionen über Migration als Anpassungsstrategie und den Einfluss von Einwanderung auf die Nutzung natürlicher Ressourcen sowie auf Konflikte. Darüber hinaus hebe ich die Forschungslücken hervor, die ich in den drei Kernkapiteln dieser Arbeit adressiere.

In Kapitel 2 stelle ich einen innovativen theoretischen Rahmen vor, der das Konzept „Beiträge der Natur für den Menschen“ (*Nature's Contributions to People, NCP*) mit der Trias von Notwendigkeit, Fähigkeit und Wunsch zur Migration kombiniert. Dabei lege ich besonderes Augenmerk auf entscheidende, aber bisher wenig

untersuchte kulturelle und subjektive Aspekte. Ich argumentiere, dass der hier vorgestellte Rahmen unser Verständnis für die Prozesse erweitert, in denen verschiedene Arten von Mobilität und Immobilität im Kontext von Umweltwandel entstehen. Basierend auf einer qualitativen Analyse von 20 Fallstudien wende ich den Forschungsrahmen auf die südwestliche Küste Bangladeschs und das nördliche Hochland Äthiopiens an. Die Analyse zeigt vor allem Zusammenhänge zwischen fehlender oder abnehmender materieller und regulierender NCP und steigender Migrationsnotwendigkeit. Obwohl es einige Hinweise darauf gibt, dass nicht-materielle NCP zu einem geringeren Migrationswunsch beitragen, sind Informationen über diesen Zusammenhang vergleichsweise selten. Darüber hinaus heben meine Ergebnisse hervor, dass nicht-umweltbezogene Faktoren, wie Geschlechternormen und Landbesitz, maßgeblich den Umwelteinfluss auf die menschliche Mobilität mitbestimmen.

In Kapitel 3 trage ich qualitative und quantitative Daten aus 63 systematisch ausgewählten Studien zusammen, die mehr als 9.700 ländliche Haushalte in Trockengebieten südlich der Sahara abdecken. Auf dieser Grundlage untersuche ich das Spektrum der Anpassungs- und Bewältigungsstrategien, die genutzt werden, um auf verschiedene Umweltveränderungen zu reagieren, und die relative Bedeutung von Migration in diesem Zusammenhang. Migration wurde von etwa 23% der untersuchten Haushalte als Strategie genannt. Landwirtschaftliche Strategien, die sich auf Getreideanbau- und Viehzuchtmanagement sowie Boden- und Wassererhaltungsmaßnahmen beziehen, sind jedoch viel häufiger, was zeigt, dass sich die Menschen in den Untersuchungsgebieten in erster Linie vor Ort anpassen. Zusätzlich unterstreichen meine Ergebnisse die Bedeutung von Anpassungsbarrieren, der lokalen Wahrnehmung von Umweltveränderungen sowie der Frage nach den langfristigen Auswirkungen von Anpassungsstrategien, einschließlich der Migration.

In Kapitel 4 beschreibe ich eine Metastudie, die umfassende qualitative und quantitative Daten aus 20 Einwanderungsgebieten im ländlichen Asien, Lateinamerika und Afrika südlich der Sahara integriert. Mit Hilfe der Qualitativen Vergleichenden Analyse (*Qualitative Comparative Analysis, QCA*) identifiziere und erkläre ich zwei Kombinationen von Rahmenbedingungen, unter denen gewaltsame Konflikte um erneuerbare Ressourcen, in denen Einwanderungsgruppen involviert sind, auftreten: (1) eine hohe Abhängigkeit der lokalen Lebensgrundlagen von

natürlichen Ressourcen und die negative Wahrnehmung und Darstellung von Migrant*innen bzgl. Ressourcennutzung und (2) eine Regierungspolitik, die, bei gleichzeitig eingeschränkten Möglichkeiten der Ressourcennutzung aufgrund von Naturschutz oder industriellen Aktivitäten, Teile der Einwanderungsgruppe unterstützt. Basierend auf diesen Ergebnissen diskutiere ich den wichtigen Einfluss von Regierungsinteressen und -maßnahmen auf die Dynamik zwischen Einwanderungsgruppen und lokaler Bevölkerung.

Abschließend fasse ich in Kapitel 5 die wichtigsten Erkenntnisse und Beiträge dieser Dissertation zusammen, reflektiere über methodische Herausforderungen sowie den geografischen Fokus und gebe Anregungen für zukünftige Forschung und Politikgestaltung. Zusammengenommen widerlegen meine Ergebnisse eindeutig Annahmen über direkte kausale Zusammenhänge zwischen Umwelt-veränderungen und Migration sowie zwischen Einwanderung und Ressourcen-konflikten. Meine Arbeit macht deutlich, wie diese Prozesse durch eine Vielzahl von Faktoren auf verschiedenen Ebenen beeinflusst werden; insbesondere durch zugrundeliegende strukturelle Ungleichheiten, die Verwundbarkeit überhaupt erst verursachen, und durch entsprechende Machtverhältnisse, die Spannungen zwischen Bevölkerungsgruppen schüren. Umweltwandel kann sich auf die Notwendigkeit, die Fähigkeit und den Wunsch zur Migration auf vielfältige Weise auswirken. Migration ist nicht unbedingt die bevorzugte Strategie, um mit Umweltstress umzugehen, und auch nicht für alle Menschen gleichermaßen möglich. Darüber hinaus führt Migration – selbst unter Bedingungen degradierender natürlicher Ressourcen – nicht automatisch zu gewaltsamen Auseinandersetzungen um Ressourcen. Regierungen spielen hier durch ihren Einfluss auf Ressourcenzugang und -verteilung eine zentrale Rolle. Zukünftige Forschung sollte die Politik dabei unterstützen, marginalisierte Gruppen zu befähigen, selbstbestimmte Migrationsentscheidungen zu treffen und eine friedliche und gemeinsame Ressourcennutzung in Einwanderungsgebieten zu erleichtern.

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List of publications and author contributions[1]

Chapter 2:
In a modified version published as Wiederkehr, C., Schröter, M., Adams, H., Seppelt, R., Hermans, K., (2019). How does nature contribute to human mobility? A conceptual framework and qualitative analysis. *Ecology and Society* 24 (4). https://doi.org/10.5751/ES-11318-240431

- CW: Conceptualisation, Writing – original draft, review & editing, Methodology, Investigation, Formal Analysis, Visualisation
- MS: Writing – review & editing
- HA: Writing – review & editing
- RS: Writing – review & editing, Supervision
- KH: Writing – review & editing, Supervision, Funding acquisition

Chapter 3:
In a modified version published as Wiederkehr, C., Beckmann, M., Hermans, K., (2018). Environmental change, adaptation strategies and the relevance of migration in Sub-Saharan drylands. *Environmental Research Letters* 13 (11). https://doi.org/10.1088/1748-9326/aae6de

- CW: Conceptualisation, Writing – original draft, review & editing, Methodology, Investigation, Formal Analysis, Visualisation, Data curation
- MB: Methodology, Writing – review & editing
- KH: Conceptualisation, Writing – review & editing, Supervision, Funding acquisition

[1] This is oriented towards CRediT (Contributor Roles Taxonomy, see also Allen et al., 2019).

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1. General Introduction

With this dissertation I want to address a current and highly politicised topic: human migration in the context of global environmental change, the mechanisms underlying this nexus and potential associated impacts. While attracting growing political and academic interest over the past decades, views on environment-migration links are often substantially oversimplified and deterministic. Moreover, narratives of migration as security threat tend to dominate public discourse and have promoted increasingly strict border policies of regions and countries in the Global North (Boas et al., 2019; McLeman, 2019). In the following sub-chapters, I provide a brief but nuanced overview of the state of research on the environment-migration nexus and introduce the three pieces of work that constitute the core of this dissertation.

1.1 Human migration in the context of environmental change

Environment-related migration is a dynamic, complex and multi-causal process. Environmental change[2] influences migration both directly and indirectly in various ways and often manifests itself via other existing drivers, in particular socio-economic factors which are known to play a key role in migration decisions (Black et al., 2011a; de Longueville et al., 2019; Foresight, 2011; McLeman & Smit, 2006; Neumann & Hermans, 2015). Importantly, environmental change does not only have the potential to motivate migration but can also inhibit movement, for instance by reducing agricultural productivity and the financial resources required for moving (e.g., Cattaneo & Massetti, 2015; Gray & Mueller, 2012; Suckall et al., 2017). In line with this, concerns have been raised about vulnerable population groups being unable to move and becoming 'trapped' in hazard-prone areas (Black et al., 2013; Nawrotzki & DeWaard, 2018). However, if there is a surplus or abundance rather than scarcity, the availability of natural resources can also enable migration for those who have access (e.g., Hunter et al., 2017; Leyk et al., 2012; van der Geest

[2] In this dissertation, environmental change is understood as encompassing both climate-related stressors and human-made processes, e.g. changes in temperature and precipitation, sea-level rise, extreme weather events, land degradation.

et al., 2010). Despite the considerable increase in publications on the topic, evidence on the direction and magnitude of environmental impacts on migration remains inconclusive and reveals a high context dependence (Borderon et al., 2019; Hoffmann et al., 2020). Environment-migration links are mediated by a myriad of factors at various scales, including the pace of and exposure to environmental change, social networks, and demographic characteristics (e.g., Call et al., 2017; Groth et al., 2020; Perch-Nielsen et al., 2008; Rabbani et al., 2013).

Migration under conditions of environmental change has multiple facets in terms of time spans (temporary, seasonal or permanent migration) and geographical distances covered (short-distance and internal or international migration, rural or urban destinations), as well as actors involved (individual persons, households or entire communities) (e.g., Afifi et al., 2016; Hermans & Garbe, 2019; Penning-Rowsell et al., 2013). This is also reflected in the broad working definition of environmental migrants suggested by the International Organization for Migration (IOM, 2007). Yet, in contrast to widespread alarmist predictions of mass migrations to the Global North due to climate change, evidence shows that environment-induced migration takes place predominantly within countries and regions (Cattaneo et al., 2019; Hoffmann et al., 2020; Rigaud et al., 2018; Hunter et al., 2015). Furthermore, the decision to migrate (or not to migrate) involves varying degrees of voluntariness and coercion (Erdal & Oeppen, 2018; Hunter, 2005), meaning that moving can be a rather proactive or desirable strategy in some cases and forced in others (e.g., Arnall, 2014; Dun, 2011; Martin et al., 2014). The same applies to immobility, although especially motives for staying put, which often involve socio-cultural factors, are much less well explored (Adams, 2016; Schewel, 2020; van Praag, 2021). Migration and mobility are used complementarily as umbrella terms in this dissertation covering all of the above listed types of movement, independent of the spatial and temporal scale and level of agency.

The complex interlinkages of drivers and multitude of migration types partly explain the terminological fuzziness as well as fundamental challenges of this research field. Attributing population movement and changes thereof primarily to environmental factors is difficult both conceptually and in terms of existing data and methods (McLeman, 2019; Neumann & Hilderink, 2015; Piguet, 2010). Accordingly, the notions of environmental migrants and refugees, that imply evident causalities and have evoked alarming security threat narratives in the media and political

discourse, have been subject to heighted debate (Baldwin, 2013; Bettini, 2013; Boas et al., 2019; Piguet, 2013). The refugee term has been particularly contentious in this context – not least due to its legal and political dimension (Biermann & Boas, 2010; Kälin & Schrepfer, 2012; Schraven, 2021) – and been severely criticised inter alia for victimising those affected and assuming passivity (Farbotko & Lazrus, 2012; McNamara & Gibson, 2009). Furthermore, estimates of migrant numbers attributed to environmental change diverge[3] and have been questioned, especially for making simplistic and linear assumptions and lacking scientific rigour (Gemenne, 2011; Tacoli, 2009). Also recent projections as suggested by the World Bank, estimating 143 million internal climate migrants within Sub-Saharan Africa, Latin America and South Asia by 2050, are inherently characterised by high uncertainty (Rigaud et al., 2018). The Internal Displacement Monitoring Centre (IDMC) reports 24.9 million new displacements worldwide in 2019 due to geophysical and weather-related disasters (2020). This is useful as rough indicator of the relative influence of certain climate stressors on global migrant stocks, but does not capture the entire spectrum of environment-related migration. There have been significant cross-disciplinary advancements in terms of data sets, statistical tools and methods over the past decades (Fussell et al., 2014; Hermans & Ide, 2019; Hunter et al., 2015; McLeman, 2013) and the number of case studies on the topic is growing constantly (Piguet et al., 2018). In spite of this, the general lack of sufficient data comprising both environmental aspects and migration at consistent and comparable spatial and temporal scales continues to be an important hurdle (Bilsborrow & Henry, 2012; Eklund et al., 2016).

1.2 Migration as adaptation to environmental change

Migration is known to be a long-standing and important strategy used by humans throughout the world to deal with different environmental and non-environmental risks and crises (Hunter et al., 2015; Kelly, 2011; Tacoli, 2009). In connection with growing concerns about future impacts of global environmental change, the potential of migration for adaptation has been increasingly recognised by academics

[3] Frequently cited estimates of the number of people that will be forced to migrate mainly because of climate change by 2050 range between 200 million (Myers, 2002) and 1 billion (Christian Aid, 2007). According to a recent report by the Institute for Economics and Peace (IEP, 2020), that figured prominently in the media but was also heavily contested, even 1.2 billion people are estimated to be at risk of displacement due to ecological threats by 2050.

and policy-makers (Black et al., 2011b; Felli, 2013; Foresight, 2011; Vinke et al., 2020). Different types of migration have been cited as adaptation options in the IPPC's Fifth Assessment Report, amongst others (Noble et al., 2014). In contrast to the environmental or climate refugee framing, the migration as adaptation narrative emphasises the agency of migrants and possible benefits associated with migration and labour market opportunities (Bettini et al., 2016; Sakdapolrak et al., 2016). This is also mirrored in various strategic documents of the United Nations, including the Cancún Adaptation Framework (UNFCCC, 2010) und the Global Compact for Migration (UNGA, 2018). Nonetheless, concerns have been raised that the focus on adaptation reinforces a neoliberal rationale, leaves aside questions of (in)justice and places disproportionate responsibility for self-help onto those already heavily burdened by climate change (Bettini et al., 2016; Bettini & Gioli, 2016; Sakdapolrak et al., 2016; Vinke et al., 2020).

Evidence suggests that migration can contribute to increasing resilience[4] of households and communities as insurance strategy and by enabling livelihood diversification and asset accumulation (Tacoli, 2009). Especially financial remittances sent by migrants to their origins seem to play a key role for spreading risks and supporting agricultural innovation and production in rural areas (e.g., (Ng'ang'a et al., 2016; Scheffran et al., 2012a; Tiffen, 2003; VanWey et al., 2012). According to the World Bank, remittance inflows to developing countries comprised 431 billion US$ in 2014, i.e. more than three times the volume of official development aid (2016). Given that this figure only includes formal remittance flows from international migration, numbers can be expected to be much higher. However, due to the selectivity of migration, remittances may not necessarily benefit the most vulnerable and even reinforce existing inequalities (Adger et al., 2002; Le Dé et al., 2015; Mazzucato et al., 2008; Su & Le Dé, 2021). Besides, the transfer of social remittances, including for instance new ideas, knowledge or social practices, may face various additional barriers, especially when the livelihood context at the sending area differs considerably from the working context at the destination (Peth & Sakdapolrak, 2020).

[4] In the context of social–ecological systems, resilience is understood as the capacity of a respective system to cope with change and continue to develop at the same time. Accordingly, resilience is associated with "the degree to which the system is capable of self-organization, learning and adaptation" (Sterk et al., 2017, p.109; see also Cumming & Peterson, 2017)

The question of whether – or rather when and for whom – migration constitutes a sign of resilience and successful adaptation or a failure to adapt is still subject to debate (Afifi et al., 2016; Bardsley & Hugo, 2010; Gemenne & Blocher, 2017). In contexts of high social and ecological vulnerability[5], migration is perceived as 'strategy of last resort', i.e. the least preferred option (e.g., Meze-Hausken, 2000; Paul & Routray, 2011). Evidence exists that hints at potential detrimental effects of migration, such as labour shortages and increased divorce rates in sending areas (e.g., de Bruijn & van Dijk, 2003; Jacobson et al., 2019; McKune & Silva, 2013), and risks afflicting the migrants themselves (e.g., Mersha & van Laerhoven, 2016; Yaffa, 2013). Furthermore, movement that entails the loss of traditional livelihoods and place-based cultural identities may also adversely affect people's wellbeing (Adger et al., 2011). Recent research suggests that it is the level of agency in the decision to move or stay that is decisive for household's resilience (Tebboth et al., 2019). Beyond this, scholars have repeatedly underlined that migration constitutes just one of several adaptation options and thus needs to be considered within the broader context of other strategies and potential in-situ alternatives (Perch-Nielsen et al., 2008; McLeman & Smit, 2006; Piguet, 2010). Yet, there is little systematic knowledge on migration in the context of adaptation that goes beyond the level of individual case studies.

1.3 Migration, natural resource use and conflicts

As outlined above, a broad range of factors, including environmental change, generate different types of migration. Impacts of these population movements, especially regarding natural resource use and the risk of conflict, which may themselves generate new out-migration drivers, are a highly controversial issue (e.g., de Sherbinin et al., 2008). This is inter alia related to sustainability concerns (e.g., Lambin & Meyfroidt, 2011). Migration-induced population growth at destination areas and agricultural intensification are, for instance, considered significant contributing factors to tropical deforestation (Carr, 2009; Hermans-Neumann et al., 2016; López-Carr & Burgdorfer, 2013; Ouedraogo et al., 2009). On

[5] According to the definition proposed by the IPCC, vulnerability can be understood as "[t]he degree to which a system is susceptible to, or unable to cope with, adverse effects of climate change, including climate variability and extremes" (2012, p.995). Risk exposure, sensitivity and adaptive capacity of a system are regarded as key parameters of vulnerability (Adger, 2006).

the other hand, certain types of migration, in particular forced movement, have been found to be an important mechanism of conflict diffusion across borders (Rüegger, 2018; Salehyan & Gleditsch, 2006). Environment-related migration has also been ascribed the potential to play a role in violent conflict, including competition over resources (Hendrix & Glaser, 2007; Reuveny, 2007).

The narrative linking migration to resource scarcity and conflict, formerly endorsed by scholars like Homer-Dixon (e.g., 1994, 1999), goes back to the Neo-Malthusian notion that population pressure (which may be enhanced by immigration) coupled with adverse climatic conditions contributes to diminishing resources (Gleditsch, 2020). This, in turn, allegedly intensifies resource competition, leading to instability and conflict. This thesis, however, has been heavily criticised for overemphasising the impact of demographic growth and environmental scarcity as well as lacking empirical support, amongst others (e.g., Gleditsch & Urdal, 2002; Theisen, 2008). Numerous studies assessing migration-environment relationships over the past decades reveal diverse outcomes contingent on context-specific factors, thus rejecting the idea that immigration necessarily contributes to enhanced resource degradation or competition (e.g., Black & Sessay, 1998; Carr et al., 2005; Codjoe & Bilsborrow, 2011; Curran & Agardy, 2002; Hartter et al., 2015; Kibreab, 1997; Maystadt et al., 2020). In the same vein, whether migrant receiving areas generally experience tensions or not is considered dependent on location-specific factors, such as previous inter-ethnic relations between migrants and hosts, resource use regimes and government policies (Barnett & Adger, 2007; Brzoska & Fröhlich, 2016; Martin, 2005; Mitchell & Pizzi, 2020; Seter et al., 2018). In sum, grasping the pathways between migration and resource conflicts on an aggregate level continues to be a key challenge.

In the debate on climate change impacts, migration has been increasingly addressed as potential driver of violent conflicts by academics, high-level policy-makers and the media alike over the past two decades (Abel et al., 2019; Barnett & Adger, 2007; Foresight, 2011; Hartmann, 2010). Associated security concerns rest upon the assumption that climate change will impact renewable resource availability and dramatically increase migration, therewith aggravating conflict risk in destination areas. Nonetheless, scholars emphasise that this issue is far more complex than usually portrayed in the media and fraught with high uncertainty (Burrows & Kinney, 2016). This is especially due to the inherent challenges of projecting climate

change and migration and depicting the relative significance of climate change and migration compared to other forces that are at play in the evolution of conflicts (ibid., Hermans & Ide, 2019; Koubi, 2019; Theisen et al., 2013). Besides, results from large-N studies on links between climate, migration and conflict (e.g., Bernauer et al., 2012; Bosetti et al., 2020; Koubi et al., 2021; Petrova, 2021) are inconclusive thus far.

Recent discussions about the crises in Syria and Darfur, often cited as illustrative examples of the climate-migration-conflict nexus, are a case in point (Kelley et al., 2015; Selby & Hoffmann, 2014). Regarding Sudan it has been suggested that, by affecting the distribution of arable land, over time climate change has contributed to migration to areas with relative resource abundance, therewith amplifying the risk of violence in Darfur (De Juan, 2015). Others have argued that the extreme drought in Syria (that preceded the civil war and is supposedly in part attributable to climate change) triggered large-scale movement, which subsequently aggravated socio-economic stresses and contributed to conflict escalation (Ash & Obradovich, 2020; Ide, 2018b). These claims remain severely contested though in the academic community; points of criticism include the ignorance of the fundamental role of political-economic processes in the case of Sudan (Selby & Hoffmann, 2014; Verhoeven, 2011) and an overestimation of the scale and impact of migration in the case of Syria (Fröhlich, 2016; Selby et al., 2017).

1.4 Objectives and structure of the thesis

The rapidly growing and increasingly complex body of evidence on environmental change and migration processes calls for synthesis approaches to integrate existing knowledge and make full use of the rich insights offered by local case studies (Neumann & Hilderink, 2015). Besides, given the cross-border nature of these phenomena and resulting challenges, knowledge that is informed by but goes beyond the micro-scale is indispensable to support political action at supranational level (Magliocca et al., 2015a; Magliocca et al., 2018; Rudel, 2008). In order to address these needs, a trans-regional perspective is taken in this thesis. Different synthesis

approaches[6] are used to provide generic insights that can help guide future research and decision-making (see Figure 1.4).

As outlined above, the environment influences migration decisions and outcomes thereof in manifold ways. Despite empirical and theoretical advances in this field, however, there is still a need to better understand the role of place-related socio-cultural factors in this context (as opposed to e.g. income differentials). Especially causes for voluntary immobility in hazard-prone places remain comparatively neglected in research thus far (Adams, 2016; Mallick & Schanze, 2020). In **Chapter 2**, I therefore suggest and explore a novel framework that conceptualises nature's contributions to human mobility at the level of the individual, whilst acknowledging the multitude of non-environmental influence factors and the subjective dimension of migration decision-making.

Although political and academic interest in the topic of migration as adaptation has been increasing, the relative importance of migration vis-à-vis other strategies constitutes a notable research gap. Starting from the premise that a constructive debate on the adaptive potential of migration relies on knowledge of how common migration as adaptation actually is, in **Chapter 3** I systematically assess the broad range of household strategies used to deal with environmental change and the role of migration in this context. I hereby concentrate on rural livelihoods in Sub-Saharan African drylands, which are known to be extremely vulnerable to environmental change (Serdeczny et al., 2017).

Despite the controversy surrounding the role of migration as a trigger of resource-related tensions in the Global South, there is still little understanding of the contexts which are actually conducive to resource competition and violence in immigration areas (Mitchell & Pizzi, 2020). Building upon the vast scholarship emphasising the key role of mediating factors in this respect, in **Chapter 4** I apply Qualitative Comparative Analysis (QCA) to detect configurations of conditions under which violent renewable resource conflicts occur in migrant hosting areas in various world regions.

[6] Here, synthesis is understood as "a research method that draws from many sources, including researchers and/or multiple fields of inquiry, accelerating knowledge production by distilling data, ideas, theories, or methods" (SESYNC, 2012).

In **Chapter 5,** I summarise and integrate the key findings and main contributions of this dissertation. In addition, I provide a brief overview of the main methodological challenges which I encountered, and reflect upon the geographical focus of the work presented here. Lastly, I outline avenues for further research building upon this dissertation and conclude with last remarks on policy.

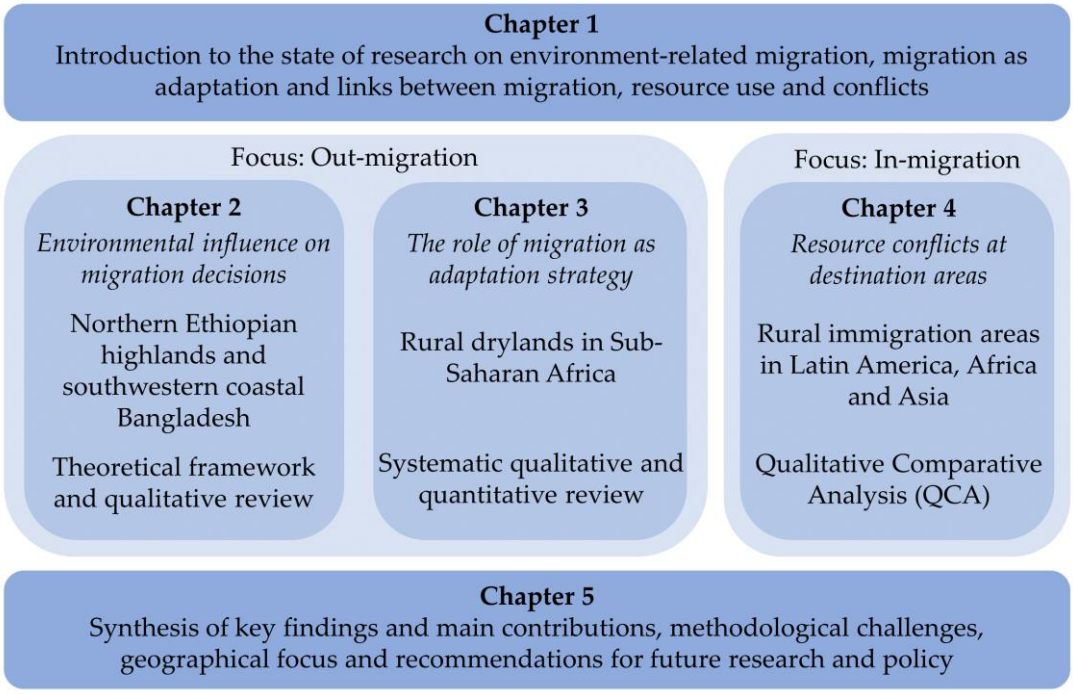

Figure 1.4 Overview of the structure of the dissertation.

2. Environmental Influences on Human (Im)Mobility[7]

2.1 Introduction

In light of global environmental change, in-depth knowledge is urgently needed on human immobility and, more specifically, on why people decide to remain in vulnerable places (Findlay, 2012). Not moving is often considered as a societal norm, thus attracting less political and academic attention than migration (Zickgraf, 2018). Yet, it is equally relevant in the context of environmental stress as population groups may be at considerable risk but unable to leave. So-called "trapped populations" are typically characterized by significant vulnerability resulting from a high level of poverty (and low adaptive capacity) combined with a high exposure to environmental risk (Ayeb-Karlsson et al., 2018; Black et al., 2013; Foresight, 2011; Nawrotzki & DeWaard, 2018). However, households might also decide to stay, for instance because of strong emotional ties to their area of origin, despite significant risks or possessing the resources to migrate (e.g., Adams & Kay, 2019; Artur & Hilhorst, 2014; see also Mortreux & Barnett, 2017). Perceptions of environmental change and migration aspirations are highly subjective, and especially motivations to stay under unfavourable environmental conditions are not well explored yet (Adams, 2016; Jónsson, 2011). Despite a growing awareness of the relevance of immobility, a framework that explicitly considers both mobility and immobility, including varying degrees of agency, as possible and equally important outcomes including the contribution of environmental factors is still lacking.

The role of place-related cultural factors in migration decision-making deserves more attention in general (e.g., Adger et al., 2013). Various authors have pointed at the potential for drawing more from the substantial migration literature and well-established concepts of social theory to enhance the theoretical foundations of the research field of environmental migration (e.g., Hunter et al., 2014; Piguet, 2013). For instance, concepts such as sense of place or behavioural approaches can serve to put an explicit emphasis on cultural and socio-psychological factors in migration

[7] In a modified version this chapter is published as Wiederkehr, C., Schröter, M., Adams, H., Seppelt, R., Hermans, K., (2019). How does nature contribute to human mobility? A conceptual framework and qualitative analysis. *Ecology and Society* 24 (4). https://doi.org/10.5751/ES-11318-240431

decision-making, but are excluded from migration theories that tend to dominate in the environmental migration field, e.g., the gravity model, neo-classical economic models, the new economics of labour migration and sustainable livelihood approach (see also Adams & Adger, 2013; Fresque-Baxter & Armitage, 2012; Martin et al., 2014).

The notion of nature's contributions to people (NCP) has recently been coined by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems (IPBES) and strives to approach nature-society-interactions in a more holistic way than, for instance, the well-known ecosystem service concept (Díaz et al., 2018). NCP explicitly refers to different knowledge and value systems and acknowledges the crucial role played by culture in defining all nature-society-links instead of confining it to one subcategory. In this regard, NCP reflects a response to some common points of criticism of the ecosystem service approach (Chan et al., 2012; Ellis et al., 2019; Kirchhoff, 2019; Schröter et al., 2014). For instance, the notion of nature as a "service" provider is rejected in different cultural contexts (Borie & Hulme, 2015; Kohler et al., 2019). The NCP concept is built on the premise to capture a broad range of worldviews and values (Díaz et al., 2018; Kadykalo et al., 2019), potentially facilitating the analysis of multiple social relations (Ellis et al., 2019) that are of importance for environment-related migration.

In order to address the above mentioned gaps, I propose to conceptually integrate NCP with the triad of migration need, ability, and aspiration. The distinction between people's need, ability, and aspiration to migrate (based on Black & Collyer, 2014; Carling, 2002) is a useful perspective on varying degrees of pressure and agency in the context of population movement. Thus, I argue that combining these concepts allows us to account for both cultural facets of natural resource use and the subjective dimension of migration decision-making, and therewith move beyond existing works in this research field. Operationalising agency as the sum of migration need, ability, and aspiration and, hence, along a continuum better reflects people's reality on the ground (Erdal & Oeppen, 2018; Hunter, 2005) and can take us one step further toward providing the scientific basis for appropriate policy measures in the field of migration and disaster management. I specifically assess how declining and lacking NCP contribute to migration need, ability, and aspiration at the individual level in highly resource-dependent livelihood contexts. While acknowledging the multi-causal nature of migration and its embeddedness within

larger societal processes, the purpose of this chapter is to further disentangle the diverse environment-related mechanisms contributing to different mobility and immobility outcomes.

In the following, I provide a concise overview of recent theoretical approaches to immobility and identify entry points for further conceptual work. Subsequently, I introduce the conceptual framework based on NCP and my methodology. In order to substantiate the framework I apply it using literature-based evidence, drawn from the published literature on climate-related migration in southwestern coastal Bangladesh and the northern Ethiopian highlands. My findings illustrate the broad spectrum of nature-mobility-interactions and the crucial influence of non-environmental factors. In this chapter I offer a novel perspective on the topic and define a research agenda by deriving hypotheses and questions on the NCP-mobility relationship.

2.2 Recent conceptual approaches to characterise immobility

The Foresight Report (2011) presents a conceptual framework that outlines migration drivers at various levels, therewith highlighting the complex and multi-causal nature of migration. In addition, the framework illustrates how environmental change can act as indirect migration driver by influencing other drivers. The report was seminal for highlighting that most people stay and that these populations require policy focus. However, although the report mentions the possibility of people choosing to stay under environmental change, this aspect is not discussed further whereas the risks and challenges related to trapped populations are emphasised. This observation also applies to Black et al. (2013) who propose a framework that distinguishes between three interrelated mobility outcomes (displacement, migration, immobility) under extreme weather events, depending on vulnerability before, exposure during, and recovery after the event. Based on reviewed evidence, the authors underline that both populations who move and who remain may become trapped and vulnerable in the context of extreme events.

Drawing on Bangladesh and Kiribati as examples of low-elevation coastal zones, Murphy (2015) suggests a social-ecological-systems-based resilience framework to disentangle the climate change-mobility nexus. The framework comprises four resilience dimensions (personal, institutional, household, structural) that influence

migration decision-making and are subject to change as part of an adaptive cycle. The author exclusively states trapped populations as possible immobility outcome.

Although referring to the same theoretical basis as Black et al. (2013) and Murphy (2015), the model of migration as response to climate change by McLeman and Smit (2006) sheds a different light on immobility. In this model, "no out-migration" is included as potential outcome, not only in cases where, depending on capital endowments, migration is not viable (in analogy with trapped populations) but also where other adaptation options are preferred. This points to the fact that migration is just one out of a range of adaptation strategies, and that immobility is not inextricably linked to lacking resources and high vulnerability but may just as well result from a high capacity to adapt in-situ.

Nawrotzki and DeWaard (2018) analyse different characteristics of places that shape populations' mobility potential under climate change by using a combination of climate and census data from Zambia. In line with earlier assumptions on trapped populations, the authors indicate the link between poverty and immobility under climate stress, but emphasise the influence of both population and place vulnerability (Nawrotzki & DeWaard, 2018). In this context, the authors use the concept of the "holding power of places," which relates to place-based factors that presumably trap people.

Adams (2016) argues that trapped populations exist along a continuum and constitute just one type of immobility. Based on empirical data from the Peruvian highlands and behavioural migration theory, the author indicates that the concept of place attachment, and resulting residential (dis)satisfaction, can offer more explanatory power for why people choose to remain in times of environmental stress than merely resource barriers. Accordingly, it is crucial to also consider the role of non-economic benefits in migration decision-making (Adams, 2016; Adams & Adger, 2013). In a similar vein, Thompson (2017) argues in favour of a "geographical imaginations approach" toward migration decision-making. Originating in cultural geography and defined as "the mental images we hold of different places and of the people living there" (Thompson, 2017, p. 79), "geographical imaginations" shed light on the influence of place and culture on migration decision-making. Based on interview data from the UK and Philippines, the author shows how a holistic and cultural approach can help to better understand the motivations behind non-migration. This more recent body of work has provided nuance to why people

remain in location and illustrates that the consideration of socio-cultural factors is indispensable, especially for a better understanding of the motives behind voluntary immobility.

2.3 Conceptual framework elements

2.3.1 Nature's contributions to people (NCP)

Migration is known to be a significant livelihood strategy in response to changes in ecosystem service availability, stability, and access, or to prevent ecosystem service overexploitation (Adger & Fortnam, 2018; Black et al., 2011a). Not surprisingly, the ecosystem service concept has been employed by some environmental migration scholars to tackle the complex links between changing environmental conditions and human mobility. Renaud et al. (2011), for instance, propose a decision framework based on coupled social-ecological systems and ecosystem services, that offers a categorisation of environmentally induced migrants; yet, immobility is not included. Adams and Adger (2013) use ecosystem services to discuss the contribution of environmental factors to place utility and their role in the migration decision-making process, indicating that environmental migration studies have been largely limited to provisioning ecosystem services. Beyond these applications, however, Adger and Fortnam (2018) highlight the lack of consistent and comprehensive conceptualisations of the links between environmental change, ecosystem services, and migration.

The framework proposed in this chapter draws on the concept of nature's contributions to people (NCP) that has been developed as part of a conceptual framework by the Intergovernmental Science-Policy Platform on Biodiversity and Ecosystems (IPBES). NCP are defined as "all the contributions, both positive and negative, of living nature (diversity of organisms, ecosystems, and their associated ecological and evolutionary processes) to people's quality of life" (Díaz et al., 2018, p. 270). These contributions are further subdivided into material ("substances, objects, or other material elements from nature that directly sustain people's physical existence and material assets" Díaz et al., 2018, p. 271), non-material ("nature's effects on subjective and psychological aspects underpinning people's quality of life, both individually and collectively" Díaz et al., 2018, p. 271), and regulating ("functional and structural aspects of organisms and ecosystems that modify environmental conditions experienced by people and/or regulate the

generation of material and non-material contributions" Díaz et al., 2018, p. 271) contributions. IPBES distinguishes 18 reporting categories of NCP (for explanations of each category see Supplementary Material of Díaz et al., 2018), which I use as a basis for this study (see also Table A2 in the Appendix). The IPBES conceptual framework illustrates nature, the benefits that humans derive from nature, and a good quality of life as key components (Díaz, et al., 2015a; Pascual et al., 2017). Furthermore, Díaz et al. (2018) suggest a "context-specific" perspective on NCP next to a "generalizing perspective." Whereas the generalising perspective, as applied in this chapter, focuses on systematic assessments according to defined reporting categories, the "context-specific perspective" allows for inclusions of indigenous and local knowledge, which could be applied to environmental migration work in the future.

The IPBES framework, and related key terms developed from it, can be understood as a "Rosetta Stone" (Díaz, et al., 2015b) enabling to translate between different understandings of the value of nature in different cultural settings. I propose that this characteristic is of particular value for migration research across different cultures. Through this interdisciplinary translation function the NCP concept is also intended to include a range of disciplines from the social sciences and humanities (Díaz et al., 2018), which fits well with the interdisciplinary environmental migration community. Overall, I suggest that because of its inclusive approach and the stronger emphasis on culture, the NCP concept can help reveal highly relevant mechanisms, especially drivers of voluntary immobility, which are largely missing in current conceptualisations of environmental change and migration.

2.3.2 Migration need, ability, and aspiration

In conceptual terms, human mobility and immobility can be conceived as the outcome of the interplay between the need, the ability, and the aspiration to migrate (see also Ionesco et al., 2017). The distinction between wanting to migrate and actually migrating goes back to the link between intentions and behaviour central to micro-level migration decision research (e.g., de Jong et al., 1985; Speare, 1974; Wolpert, 1965) and, in particular, Carling's aspiration/ability model (2002). While covering varying degrees and balances between choice and coercion, aspiration is here understood as "a conviction that migration is preferable to non-migration" (Carling & Schewel, 2018, p. 946), which, depending on a person's abilities, may or may not result in migration. Adding the 'need' to move "based on some well-

founded fear of the consequences if movement does not take place" as proposed by Black and Collyer (2014, p.52) can provide a conceptually more clear-cut distinction of especially vulnerable groups and help us understand why some people move despite low migration aspirations.

In this study, the triad of migration need, ability, and aspiration is operationalised as follows:

1. Migration need ('must migrate'): resulting from a person's vulnerability[8]
2. Migration ability ('can migrate'): a person's capacity to leave based on individual characteristics and resources
3. Migration aspiration ('want to migrate'): a person's motivation to leave based on risk perception, self-efficacy, and place attachment

While acknowledging the relevance of household-level decision-making, I focus on the level of the individual as embedded in and influenced by household dynamics. I claim that connecting migration need, aspiration, and ability with NCP offers a valuable perspective on how a decrease in or lack of NCP can influence human mobility and immobility in various ways.

Although seemingly straightforward, migration ability is a complex indicator because it depends on multiple factors at different scales, such as national migration laws and regulations, available infrastructure, and personal and household characteristics including age, health, and educational background (e.g., Zickgraf, 2018). Different kinds of capital, such as financial resources or social networks at destination regions, can influence people's ability to move directly or indirectly (Black & Collyer, 2014; Tebboth et al., 2019). Furthermore, environmental change processes may simultaneously increase the need for migration and reduce people's ability to do so – the "immobilising effect" of environmental change described in the Foresight Report (2011).

Migration aspirations, in turn, may be strongly influenced by how people perceive their own capacities, i.e., what they think they are capable of (sometimes termed 'self-efficacy'); those who believe they face high migration barriers or that they are able to adapt in-situ may be less inclined to leave their land, for instance (Grothmann & Patt, 2005). In addition, aspirations are shaped by people's subjective evaluation

[8] Composed of risk exposure, sensitivity, and adaptive capacity (Adger, 2006).

of environmental change and risk, which may, and in fact often does, deviate from objectively measured data (ibid.; Hunter, 2005; Koubi et al., 2016). Beyond self-perceived adaptive capacity and risk perception, it is clear that aspirations are formed in line with social norms, values, and traditions (e.g., mobile vs. sedentary lifestyle, migration narratives, gender roles) and, thus, need to be assessed within the larger societal context (Hunter & David, 2011; de Jong, 2000; Martin et al., 2014). The recognition that culture shapes all nature-society links, as exemplified by the NCP concept, is growing among scholars concerned with people's behaviour under environmental change, counterbalancing a research paradigm that has prioritised objective and material dimensions of adaptive capacity and wellbeing (Adger et al., 2011, 2013; Stedman, 1999). Here, I understand 'culture' as "the symbols that express meaning, including beliefs, rituals, art and stories that create collective outlooks and behaviours, and from which strategies to respond to problems are devised and implemented" (Adger et al., 2013, p. 112). This may entail both material and non-material aspects, and is often associated with places that are given meaning by people (Escobar, 2001).

Various concepts from place identity theory that describe humans' relationship with their environment have been proposed to better understand how people perceive risks and respond to environmental changes by bringing a more subjective socio-cultural dimension into play (Devine-Wright, 2013; Fresque-Baxter & Armitage, 2012; Quinn et al., 2018). In this chapter, I concentrate on the notion of place attachment, defined as the "emotional bonds which people develop with various places" (Lewicka, 2011, p. 219). De Dominicis et al. (2015), for instance, found a weaker relationship between the perception of flood risk and coping action in the case of households that displayed strong place attachment in comparison to less place attached households. Cultural and place-based factors are often key to the aspirations to stay despite climate change impacts (e.g., (Arnall, 2014; Artur & Hilhorst, 2014; McNamara & Gibson, 2009; Mortreux & Barnett, 2009; Nielsen & Reenberg, 2010). Beyond this, Dandy et al. (2019) suggest that place attachment may also influence environment-related migration by triggering the decision to leave when (place-based) loss of contributions becomes unbearable, or by shaping people's choice of destination and post-migration experience.

2.4 Targeted selection of case studies and data collection on migration processes

This chapter focuses on two regions, the southwestern coast of Bangladesh and the northern Ethiopian highlands, to test and substantiate the framework elements with concrete examples. These regions constitute archetypal examples of the climate change-migration nexus that are present in public discourse and imagination. In addition, their selection was motivated by data availability and the observation of various significant fast- and slow-onset hazards affecting local livelihoods as well as different migration processes. Using snowballing technique, I selected peer-reviewed literature on environment-related migration for both regions. Criteria for selection included sufficient detail to be assigned to at least one of the subcategories of NCP and migration need, ability, or aspiration through qualitative analysis. I identified 11 relevant case studies from the Bangladeshi coast and nine from Ethiopia (see Tables 2.4.1 and 2.4.2).

I applied the novel framework as an analytical lens, meaning that the different elements were used as search categories for extracting relevant information and structuring the findings. Thereby, I assigned information on environmental stress to the different sub-categories of NCP stated above and information that relates to or can be transferred to different aspects of the migration decision and outcomes to migration need, ability, and aspiration. Note that I interpreted different indications of declining or lacking NCP and that these could result from environmental stress, such as climatic changes, overuse and degradation of ecosystems resulting from management decisions, or pollution, for instance. In addition, I distinguished between 'indicators' of migration need, ability, and aspiration as factors that can be linked with NCP and 'moderators', i.e., factors mediating the relationship between NCP and migration need, ability, and aspiration but not directly linked to NCP (see also Table A2).

Table 2.4.1 Selected case studies from coastal Bangladesh and the respective types of migration considered in each study.

Reference	Types of migration considered
Bernzen et al., 2019	Migration (defined as "any move from the household in which the person no longer ate meals at the household table, including moves bot within the same union and outside the union", p.6),

	including both domestic and international moves and temporary (<= 6 months of absence) and permanent (> 6 months of absence)
Call et al., 2017	Temporary migration (defined as "an absence from the MDSS study area by any individual for more than one month, followed by a return to the study area by 2003", p.159)
Islam & Herbeck, 2013	Permanent and seasonal migration
Kartiki, 2011	Seasonal, temporary and permanent migration
Mallick & Vogt, 2012	Rural-urban migration ("caused by natural hazards which involves both permanent and temporary moves in search of employment and livelihoods as a factor of natural calamities", p.219)
Mallick, 2019	Seasonal migration (refers to "those who migrate once or twice at a particular period of the year, usually when there is no available employment in their native communities", p.10) and circular migration (refers to "those who migrate regularly to earn money so that their families can stay in their place of origin", p.10), also temporary and permanent, internal and international migration considered
Martin et al., 2014	Different types of mobility and immobility ("The decision to migrate could mean different scales of movement across time and space, and not to migrate could mean choosing to do so, or being unable to move or, to put it bluntly, being 'trapped'", p.92)
Paul & Routray, 2011	Temporary and permanent migration
Penning-Rowsell et al., 2013	Evacuation, temporary, seasonal and permanent migration ("These movements may have been either permanent or temporary, very localised or over relatively longer distances (e.g. 200km)", p.1)
Rabbani et al., 2013	Temporary and permanent (within the home district, to another nearby district or the capital)
Saha, 2017	Post-cyclone rural-urban migration by entire households; also seasonal migration, internal and international migration to India

Table 2.4.2 Selected case studies from the Ethiopian highlands and the respective types of migration considered in each study.

Reference	Types of migration considered
Asfaw et al., 2010	Seasonal labour migration, both rural-rural and rural-urban
Bantider et al., 2011	Permanent migration
Gray & Mueller, 2012	Distinction between moves within and outside the district and related to labour, marriage or other reasons; migration ("referring exclusively to long-distance moves", p.144); mobility ("referring collectively to all changes of residence", p.144)
Hermans & Garbe, 2019	Permanent migration (defined as "migration of household members who left their household and had not yet returned to their household at the time of the survey (and in most instances were highly unlikely to return as indicated by the respondent)", p.5), temporary migration (defined as "migration of household members who left their household at least for a month, but ultimately came back to join their household again", p.5), resettlement, directly drought-related migration, opportunity seeking migration by young people, international migration to the Gulf States
Mersha & van Laerhoven, 2016	Internal and international migration, temporary migration; mobility (defined as "the distribution of risk across spaces", p.1704)
Meze-Hausken, 2000	Drought-induced migration; distress migration referring to specific emergency situations
Morrissey, 2013a	Rural-urban mobility
Weldegebriel & Prowse, 2017	National and international migration, seasonal labour migration
Wondimagegnhu & Zeleke, 2017	Rural out-migration, internal and international

2.5 Focal study regions

2.5.1 Rural dwellers on the southwestern coast of Bangladesh

Bangladesh is typically characterised by high climatic variability as well as a particularly high exposure of the population at the coast to environmental risks such

as cyclones and floods, aggravated by sea-level rise and the subsidence of the Ganges-Meghna-Brahmaputra delta (e.g., Call et al., 2017; Nicholls et al., 2018; Roy et al., 2017). The socio-economic context is shaped by food insecurity, political instability, and poverty. Population density remains high and, despite an ongoing rural-urban migration trend, predominantly rural (e.g., Hossain et al., 2016). The population is primarily Muslim, with certain Hindu-dominated villages, particularly fishing villages (e.g., Mallick & Vogt, 2012). Societal norms remain conservative, including traditional gender-based division of labour. Housing of those living in coastal villages tends to be structurally weak (e.g., Akter & Mallick, 2013; Kartiki, 2011). Landownership is highly concentrated. The majority of households are landless or functionally landless with insufficient land to support a livelihood. Although agriculture and open access natural resources, e.g., fishing, form a key part of the rural economy, not everyone is able to access their benefits (e.g., Adams et al., 2018). Fisheries and farming activities are constrained by, inter alia, limited market access and irrigation water availability as well as increasing salinization of water and soils (e.g., Nicholls et al., 2018). Shrimp farming, although capital-intensive, has become a particularly popular activity because of high economic returns and, as such, has expanded considerably. However, aquaculture has degraded coastal embankments, water quality, and wetland biodiversity (e.g., Kartiki, 2011). Besides, some households have had to take on large amounts of debt to enter the industry. People residing near the Sundarban mangrove forest may also depend on forest resources for subsistence and income, e.g., honey and wax production, eco-tourism, and fuelwood extraction, in addition to protection from storm surges (e.g., Akter & Mallick, 2013; Hossain et al., 2017). Medium-sized urban centres, e.g., Khulna, are growing rapidly leading to an expansion of periurban areas that can draw on both rural and urban modes of living and offer opportunities for livelihood diversification. Different forms of mobility already constitute an integral part of households' livelihood strategies (e.g., Afsar, 2003). Temporary migration of family members to urban areas during the agricultural low season is common, which reduces the food burden on the household or generates remittances that enable relatives to remain in their area of origin (e.g., Mallick, 2019).

2.5.2 Rural subsistence farmers in the northern Ethiopian highlands

The socio-economic context of this region is shaped by population growth, food insecurity, and endemic rural poverty (Bantider et al., 2011; Ezra & Kiros, 2001;

Morrissey, 2013a). Environmental conditions are characterised by a rugged terrain with high differences in altitude producing various agro-ecological zones, as well as severe land degradation (Hermans-Neumann et al., 2017). Rainfall is bimodal with increasingly variable rainy seasons associated with recurrent drought risk (Hermans & Garbe, 2019; Rosell & Holmer, 2007). Livelihoods are predominantly based on mixed subsistence farming. Given limited water availability, dependence on rain-fed agriculture is high, making households particularly vulnerable to changes and fluctuations in the rainfall regime (e.g., Meze-Hausken, 2000). Although women may participate in some agricultural activities, farming has traditionally been the male domain, whereas women are responsible for domestic activities (e.g., Gray & Mueller, 2012). Female-headed households are on average worse off than male-headed households in terms of land and livestock holdings and thus more vulnerable to economic and environmental shocks (e.g., Little et al., 2006; Mersha & van Laerhoven, 2016). Land scarcity is a major issue in this region (e.g., Asfaw et al., 2010). Because of small farm sizes and declining soil fertility, farm outputs are often insufficient to meet the needs of households and many are reliant on government food aid (e.g., Ezra, 2011; USAID, 2017, unpublished manuscript). These circumstances are reinforced by the rather insecure land tenure and the lack of possibility to acquire additional land (e.g., Ege, 2017). Levels of formal education and livelihood diversification are generally low. Given the lack of infrastructure, credit facilities, and few off-farm employment opportunities in the area (e.g., Weldegebriel & Prowse, 2017), farming households are rather isolated and tend to have no or few off-farm income sources and therewith limited risk-spreading possibilities. If available, remittances from household members who have engaged in labour migration can be a valuable complement of household assets (e.g., Little et al., 2006). Historically, there has been a general migration pattern from the degraded regions in northern Ethiopia to more fertile areas in the south and southwest, including resettlement programs initiated by the national government. More recently, international labour migration to Gulf countries has been increasing (Mersha & van Laerhoven, 2016).

2.6 Qualitative results on linkages between NCP and human mobility

2.6.1 The Bangladesh case study region

Indications of decreasing or lacking regulating NCP were found predominantly in reference to the occurrence of cyclones, tidal surges and flooding, riverbank and coastal erosion, and the salinization of soils and groundwater (e.g., Bernzen et al., 2019; Mallick, 2019; Paul & Routray, 2011; Penning-Rowsell et al., 2013; see Figure 2.6.1[9]). Changes in precipitation and temperature as well as drought and excess rainfall events (e.g., Call et al., 2017) are also mentioned, but figure less prominently. These extreme events and processes affect local livelihoods, inter alia by also impacting material NCP, by contributing to water stress (e.g., Kartiki, 2011), loss of agricultural land (e.g., Islam & Herbeck, 2013), crop failure and food insecurity (e.g., Rabbani et al., 2013), livestock fodder shortage and death (e.g., Saha, 2017), reduced access and availability of mangrove resources (e.g., Martin et al., 2014), damaging of infrastructure, housing, etc. (e.g., Mallick & Vogt, 2012), and health problems (e.g., Saha, 2017).

Regarding indicators of people's migration need and ability, income is repeatedly emphasised as a major factor in migration decision-making (e.g., Penning-Rowsell et al., 2013). A comparative study by Mallick (2019) illustrates the link between regulating and material NCP and migration need via the influence on agricultural income: those communities with lower exposure to extreme events and salinization also depend less on seasonal migration because of the favourable conditions for rain-fed rice production and associated labour opportunities. In general, wealthier households seem to face a lower migration need in situations of decreasing regulating and material NCP than poor households, and are ascribed a higher degree of flexibility and agency in the mobility decision-making (Call et al., 2017; Mallick & Vogt, 2012). In contrast, low-income groups with typically few resources to cope with environmental stress and recovery from shocks face an increased migration need and risk of being forced to leave (Mallick & Vogt, 2012; Saha, 2017) but simultaneously often lack the ability to do so (Kartiki, 2011). In terms of mobility

[9] Arrows drawn in this figure represent indications of connections found in the reviewed studies with bold arrows referring to particularly common and explicit connections, yet, are not to be understood as illustrating direct or mono-causal linkages.

rates of different income groups, findings diverge, hence lending support to both the 'environmental capital' and the 'migration as last resort' thesis (e.g., Paul & Routray, 2011). Beyond this, a recent study by Bernzen et al. (2019) found that individuals who are affected by cyclone-induced damage and not employed in the core agricultural and aquaculture sectors are more likely to migrate, suggesting a link between transferable assets, weaker rural ties, and higher flexibility and mobility.

Gender was found to be a key moderator in the case of both migration need and ability. Women are typically characterised as one of the most vulnerable groups because of gender inequalities and social norms (Martin et al., 2014; Penning-Rowsell et al., 2013), hinting at an enhanced migration need under decreasing or absent NCP, including drought and flood events or water scarcity. However, it seems that the migration decision is usually taken by male household heads, and male household members tend to be the ones engaging in migration, whereas women rarely leave independently (Kartiki, 2011; Mallick & Vogt, 2012). Under certain circumstances, this can even increase both the vulnerability and immobility of women that are left with children in environmentally risky or degraded areas (Martin et al., 2014; Penning-Rowsell et al., 2013). Moreover, the impact of a reduction in NCP, such as decreasing soil fertility due to salinization, appears to be differentiated by both income and gender (Rabbani et al., 2013). Call et al. (2017), for instance, suggest that decreasing agricultural income reduces women's ability to migrate for education purposes or marriage but increases the probability of migration by men.

Another important factor mediating the link between changes in NCP and migration need and ability relates to location, meaning the physical exposure to hazards, the proximity to protection and access to infrastructure. For instance, households located in proximity to the coastline and rivers or in areas dominated by shrimp farming face higher cyclone-induced damage and arable land loss and were found to be more likely to migrate (Bernzen et al., 2019), whereas embankments, for instance, are associated with a lower migration need during flood events (Call et al., 2017). The remoteness of villages can constrain people's migration ability (Paul & Routray, 2011), but does not necessarily result in reduced overall mobility if migration need remains high. In a multisite study by Rabbani et al. (2013), migration in the context of hazards was in fact highest in the most remote village characterised

by higher poverty and lower education levels, less infrastructure, and lower accessibility of up-to-date information than other study sites. Under these circumstances, in-situ adaptation measures were much less common than other strategies, including temporary and permanent migration (ibid.).

A diverse range of moderators influencing migration aspirations are reported in the reviewed studies from Bangladesh. The availability of support from social networks, prior knowledge about the destination area and (positively connoted) migration experiences, and narratives contribute, amongst others, to people's motivation to migrate (e.g., Kartiki, 2011; Mallick & Vogt, 2012; Martin et al., 2014). In addition, adverse working conditions at the area of origin or job opportunities in urban areas can enhance the incentive to favour mobility over rural livelihoods (e.g., Islam & Herbeck, 2013). On the other hand, problems and risks associated with migration, such as health problems resulting from physical labour and poor living conditions in urban slums, or concerns among women regarding space and hygiene in cyclone shelters, discourage people from moving elsewhere (Paul & Routray, 2011; Penning-Rowsell et al., 2013). The prospect of humanitarian aid or local support by affluent households may act as an additional disincentive for poorer groups despite, for example, cyclone-induced risks (Mallick & Vogt, 2012). Furthermore, the lack of information, social networks, or financial capital can hinder people from even considering migration as an option because of costs (e.g., Kartiki, 2011; Mallick, 2019), which I interpret as low self-efficacy. Beyond this, distrust in weather forecasts such as cyclone warnings due to negative experiences with false warnings in the past can bias people's risk perception and induce some not to evacuate despite declining regulating and material NCP (Mallick & Vogt, 2012).

There are a few observations that may be interpreted as indications of place attachment. Both the studies of Kartiki (2011) and Islam & Herbeck (2013) address the common wish expressed among migrants to return home. Penning-Rowsell et al. (2013) mention strong "anchoring factors," including landholdings and houses, which motivate people to stay put despite decreasing material or regulating NCP, e.g., involving food shortages or storm surges. Other factors reducing migration aspirations include the closeness to family and home and perceived advantages of rural livelihood activities (such as income and food security associated with fishing or agriculture), which can be linked to material and especially non-material NCP ("supporting identities"; e.g., Islam & Herbeck, 2013). Importantly, land access and

ownership seem to play a mediating role in this context; the lack of landholdings has been found to be positively associated with migration aspirations because landless households lack the incentive to remain, for instance, in the form of ancestral property or farmland as reliable source of food provision (e.g., Kartiki, 2011).

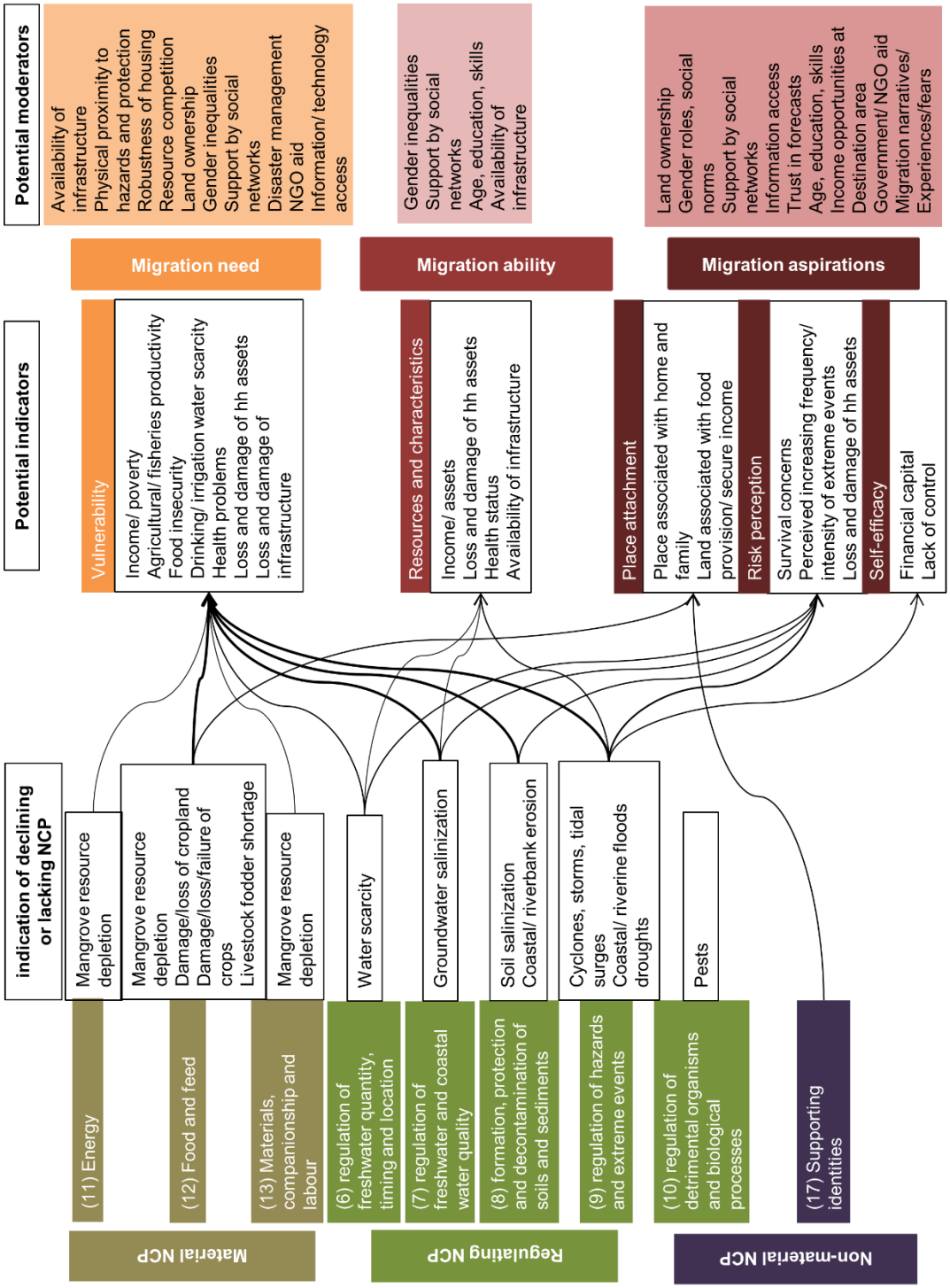

Figure 2.6.1 Links between NCP and migration need, ability, and aspirations in southwestern coastal Bangladesh. Published as Fig. 1 in Wiederkehr et al. (2019).

2.6.2 The Ethiopia case study region

The reviewed studies from Ethiopia mainly focus on changes in temperature and precipitation and in particular drought events (e.g., Gray & Mueller, 2012; Wondimagegnhu & Zeleke, 2017). Flood events and other idiosyncratic shocks, such as frost, pests, wind, and hail, are reported to a lesser extent (e.g., Morrissey, 2013a; Weldegebriel & Prowse, 2017). In addition, water scarcity and soil degradation processes are common phenomena in this region, also hinting at decreasing regulating NCP (e.g., Bantider et al., 2011). Indications of declining or absent material NCP can be found regarding "food and feed" in terms of crop damage or failure, declining availability and quality of livestock feed, and lacking edible wild plants (e.g., Meze-Hausken, 2000). These shocks and processes impact livelihoods mainly by contributing to food insecurity, health problems, and decreasing agricultural productivity and income (e.g., Hermans & Garbe, 2019), which play an essential role for migration need, ability, and aspiration (see Figure 2.6.2[10]).

The Ethiopian case studies comprise a diverse range of moderators shaping people's migration need and ability under declining or absent material and regulating NCP. Amongst others, access to land, microcredit and especially food aid are cited as factors alleviating the "imperative to move" (e.g., Morrissey, 2013a; Weldegebriel & Prowse, 2017). Information access and support by social networks are reported both as factors facilitating mobility and reducing vulnerability (e.g., Asfaw et al., 2010; Meze-Hausken, 2000; Wondimagegnhu & Zeleke, 2017). Furthermore, some studies hint at a positive association between the number of coping strategies employed by households (as well as a higher degree of income diversification in general) and their level of agency because diversification reduces migration need and the risk of "distress migration" (e.g., Meze-Hausken, 2000). Beyond this, Hermans and Garbe (2019) illustrate the antagonistic effect of declining regulating and material NCP on migration need and ability by showing how drought exacerbates local poverty through food shortages and decreasing wealth while constraining people's ability to afford the costs of long-distance migration. Another hindering factor in this context was poor health, which is an important indicator of migration ability influenced by

[10] Arrows drawn in this figure represent indications of connections found in the reviewed studies with bold arrows referring to particularly common and explicit connections, yet, are not to be understood as illustrating direct or mono-causal linkages.

declining material and regulating NCP, such as regulation of freshwater quantity and quality or the provision of food and feed (Hermans & Garbe, 2019).

Gender clearly mediates the influence of changing NCP on migration need and ability. Gray and Mueller (2012), for instance, found a decrease in short-distance and marriage-related migration by women in the context of drought because of their reduced ability to finance wedding expenses and new household formation, reflecting a lower migration ability. Mersha and van Laerhoven (2016) underline the significant role of "gendered institutions" in both increasing women's vulnerability but simultaneously reducing their ability to adapt in-situ and migrate in the face of declining regulating and material NCP. This corresponds to observations by Asfaw et al. (2010) who relate the higher rate of seasonal labour mobility of men inter alia to their lower level of domestic responsibilities in comparison to women. Yet, it appears that no general conclusions can be drawn on gender-based differences in mobility because there is also empirical evidence indicating opposite tendencies (e.g., Wondimagegnhu & Zeleke, 2017).

In line with the observations from Bangladesh, a variety of (both environmental and non-environmental) factors shape migration aspirations. Especially land ownership (or the lack thereof) is an important moderator in this regard (e.g., Morrissey 2013a); in a study by Asfaw et al. (2010) land scarcity was cited by almost 80% of the migrants interviewed as the main reason for mobility. Furthermore, a range of socio-economic motives, including food insecurity (related to declining material NCP), lack of income opportunities, and access to education contribute to increasing aspirations (e.g., Hermans & Garbe, 2019; Morrissey, 2013a). Perception by locals of enhanced livelihood risks and impacts resulting from decreasing material or regulating NCP (e.g., Weldegebriel & Prowse, 2017) is likely to enhance their motivation to employ mobility strategies.

Reported factors serving as disincentives include fears and low expectations associated with moving (Hermans & Garbe, 2019; Morrissey, 2013a), but also certain government policies, for instance, regarding land tenure (migration resulting in a loss of landholdings) and ethnic-based population management (hampering inter-regional migration; Bantider et al., 2011). Further, the better off a household, the more likely it is that mobility can be used for accumulating assets and improving the household's living conditions, therewith contributing to positive migration narratives (Asfaw et al., 2010; Hermans & Garbe, 2019). Indications of place

attachment can be found in the reviewed studies above all in terms of cultural and social bonds with one's birthplace, which I interpret as "supporting identities" (non-material NCP), that induce some people to stay put or to return to their area of origin (Bantider et al., 2011; Hermans & Garbe, 2019; Morrissey, 2013a). Similar to the findings from Bangladesh, some respondents also associate their farmland with secure food provision for their family, which hints at a positive link between material NCP and place attachment (Hermans & Garbe, 2019).

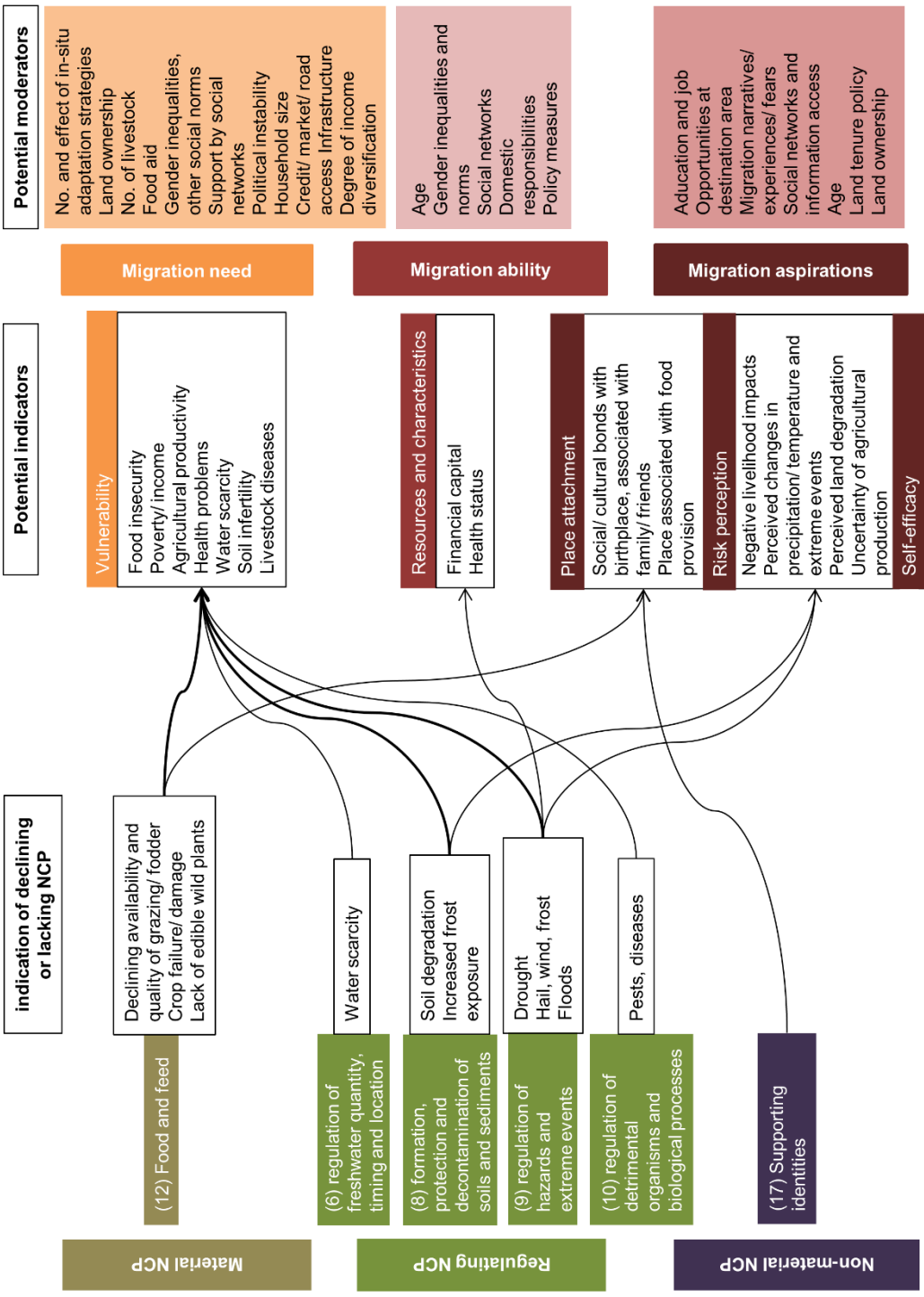

Figure 2.6.2 Links between NCP and migration need, ability, and aspirations in the northern Ethiopian highlands. Published as Fig. 2 in Wiederkehr et al. (2019).

2.7 Discussion of the directional influence of NCP-migration linkages and remaining questions

Two important observations can be made from the above analysis. First, most of the information available from the analysed literature concerns agricultural productivity, food and water provision, and health, that is to say the interactions between material and regulating NCP and migration need. There is some evidence of "supporting identities," which, according to Díaz et al. (2018), may also involve "sense of place," contributing to people's place attachment and, hence, lower migration aspirations. In general, however, information on non-material NCP ("learning and inspiration," "physical and psychological experiences," "supporting identities"), and how a decrease or lack thereof influences migration decision-making, is scarce. Second, despite my focus on environment-related factors, the decisive role of what I call 'moderators' cannot be overstated in this context. Especially factors such as gender or landownership that determine resource access and distribution and reflect multiple dimensions of inequalities among the study populations significantly shape the influence of changing NCP on migration decision-making. This is in line with earlier claims of Black et al. (2011), de Haas, (2010), Oliver-Smith (2012), Renaud et al. (2011), amongst others. The consideration of these factors is thus indispensable for a holistic perspective.

For moving beyond an illustration of the mere linkages between declining or lacking NCP and migration need, ability, and aspiration and taking this discussion one step further, I derived hypothesised potential 'directions' of these linkages at an aggregate level and illustrate those in Figure 2.7. Unlike the previous graphs, this is not exclusively based on literature from the two case study regions, but also draws from other insights of the research field.

Declining material and regulating NCP are generally associated with increasing migration need by adversely impacting livelihoods (Fig. 2.7, graphs 1 and 2). Importantly, some of the analysed studies hint at a threshold at which people's coping or adaptive capacity is exceeded (indicated by a dotted line in graphs 1 and 2), meaning that basic survival needs can no longer be fulfilled and other options for action disappear (e.g., Meze-Hausken, 2000; Paul & Routray, 2011). Under such circumstances, migration, although not the preferred option, becomes the last resort (e.g., Mallick & Vogt, 2012; Penning-Rowsell et al., 2013; Saha, 2017). Thus, I assume

that the greater the lack of material and regulating NCP (and therewith the pressure on livelihoods), the lower the degree of agency in the decision-making process (and the higher the risk of forced migration). The analysed literature shows that a high level of NCP availability is often linked to higher migration ability, and declining material and regulating NCP tend to be associated with decreasing migration ability (Fig. 2.7, graphs 4 and 5), e.g., due to decreasing financial resources (e.g., Gray & Mueller, 2012; Hermans & Garbe, 2019). Therefore, I propose that the greater the lack of material and regulating NCP, the higher the probability of people getting trapped in risky places because of lacking migration abilities. The significance of agency and abilities in this context is corroborated by Tebboth et al. (2019) who found higher resilience levels among people who are able to choose and subsequently enact decisions about migration than others who are not. Graphs 3 and 6 in Figure 2.7 are left blank given the lack of evidence on the relationship between non-material NCP and migration need and ability.

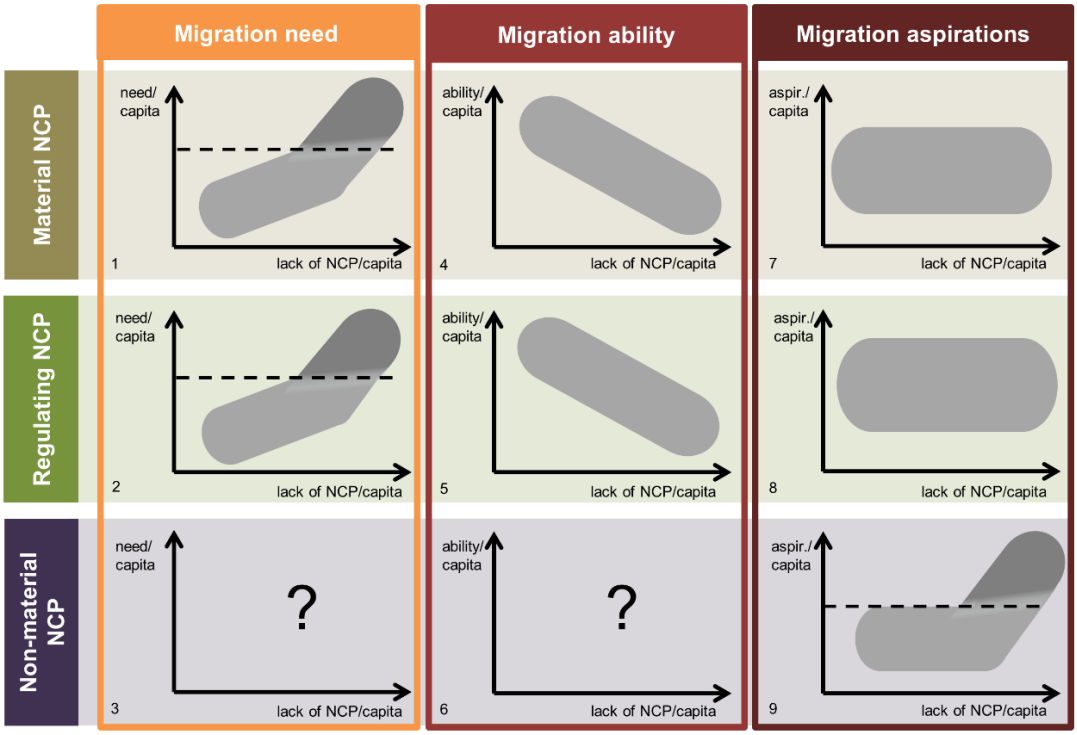

Figure 2.7 Hypothesised 'direction' of the linkages between nature's contributions to people (NCP)/capita and migration need, ability, and aspiration. Published as Fig. 3 in Wiederkehr et al. (2019).

In contrast to migration need and ability where the above illustrated tendencies are apparent, the picture is less clear-cut in the case of migration aspirations. Decreasing material or regulating NCP can provide sufficient incentives to increase people's migration aspirations, but not necessarily, as people may perceive environmental risks differently or think they are unable to move, i.e., low self-efficacy (Fig. 2.7, graphs 7 and 8). Moreover, strong place attachment related to non-material NCP may also counterbalance incentives to leave. This is exemplified by case studies from Mozambique in which planned resettlement by the government due to high flood risk is opposed by many of the farmers who demonstrate a strong place attachment, in terms of traditional lifestyle, sacred sites, etc., and consider the risk less severe (Arnall, 2014; Artur & Hillhorst, 2014). Similarly, in a study by Mortreux and Barnett (2009) on Tuvalu, the majority of respondents prefer to stay for place attachment reasons despite sea level rise and the resulting migration need from an external perspective. Regarding the linkage between non-material NCP and migration aspirations, Dandy et al. (2019) suggest a threshold at which the experienced contributions of a place that underpin place attachment are lost irreversibly, which induces people to move (indicated by a dotted line in graph 9, Fig. 2.7).

It needs to be underlined that my analysis has exclusively concentrated on the areas of origin, i.e., the 'push factor' side of mobility processes. A consideration of NCP at respective destination areas and associated 'pull factors' is surely relevant but beyond the scope of this study. Second, the findings presented here are essentially qualitative. The approach taken has been a first attempt to connect NCP with migration decision-making and not deemed appropriate for quantifying identified linkages. Last, there are certain NCP types that are not addressed above because they were not found in the reviewed literature, but are nevertheless likely to play a role for natural resource-dependent livelihoods. These include inter alia pollination services, energy and materials, and the use of plants for medicinal purposes.

Table 2.7 Key questions for further research.

I identified the following as outstanding research questions to guide future field studies on the NCP-mobility relationship:
1. What are likely hotspots of involuntary mobility and immobility related to declining material and regulating NCP?
2. What are the most urgent policy measures required to enhance people's agency in migration decision-making under declining material and regulating NCP?

3. How can potential thresholds of migration need and aspiration be determined and anticipated?
4. How does a decline in non-material NCP influence migration need, ability, and aspiration?
5. How do NCP at destination areas influence people's migration decision?
6. How do specific moderators affect certain linkages between changes in NCP and migration need, ability, and aspiration?

2.8 Interim Conclusion

I here proposed a novel framework and made a first attempt to conceptualise the relations between material, regulating, and non-material NCP and migration need, ability, and aspirations. My aim was to enhance our understanding of environment-related mechanisms behind people's decision to migrate and to remain in location in contexts of environmental stress and highly resource-dependent livelihoods. A total of 20 case studies from the Bangladeshi coast and Ethiopian highlands have been analysed qualitatively to substantiate my conceptual framework and explore remaining research gaps. Based on the assessed literature I have shown that the most links can be drawn between declining material and regulating NCP and migration need. There is also evidence hinting at links between non-material NCP and migration aspirations; however, the scarcity of information on these means that cultural elements still remain a significant missing piece of the puzzle. Beyond this, the broad range of context-specific moderators that I encountered during the analysis underlines the important role of non-environmental factors in mediating the influence of changes in NCP on mobility decisions. This corroborates the complexity of causal relationships within migration processes and the need for continued efforts, above all on behalf of governments, to also address socio-economic migration drivers resulting from persistent inequalities.

Whereas cautious propositions could be made on an aggregate level regarding the influence of changes in material and regulating NCP on migration need and ability, it is not yet possible to draw equally generic conclusions on declining non-material NCP and migration aspirations in general because of too little evidence. The issue of aspirations deserves particular attention though because their consideration is indispensable to provide for ethically sound policy responses that avoid forcing people to relocate who wish to stay and prioritising in-situ adaptation that hinders those who want to leave. For a more complete picture of the topic, I thus strongly

recommend further research on these aspects as well as potential thresholds of migration need and aspirations. In addition, there is a need to better understand how specific moderators affect specific pathways from changing NCP to mobility decisions to inform policy measures. Last, an examination of NCP at destination areas in addition to areas of origin could both enhance our understanding of environment-related pull factors and help decision makers identify immigration hotspots at risk of resource overexploitation.

Although it remains to be seen which linkages the framework reveals when being applied to other regional contexts, I trust that by highlighting certain sub-dimensions it will help to capture essential cultural aspects, such as place attachment, more systematically in future migration studies than before. In this regard, I believe that, in addition to the generalising perspective applied here, the context-specific perspective on NCP could be particularly beneficial and should thus be explored in further research on the topic.

3. The Role of Migration as Rural Household Adaptation Strategy[11]

3.1 Introduction

In light of their extensive global reach and large number of inhabitants, drylands are considered critically important terrestrial environments. They are home to about one third of the world population and cover approximately 45% of the global land area, most of them being prevalent in Asia and Africa (Prăvălie, 2016; UN, 2011). Due to climate change, scholars expect the total dryland area to increase up to 50% of global land surface by 2100 (Huang et al., 2015). Often referred to as deserts and semi-deserts, drylands are characterised by scarce and variable rainfall and high potential evapotranspiration (Middleton & Thomas, 1997). A wide range of natural hazards occur in dryland environments, with climate hazards such as drought assuming the greatest relative significance in terms of risk (Middleton & Sternberg, 2013). Some 10%–20% of drylands worldwide are estimated to be affected by one or more forms of land degradation associated with both climatic and human factors. Existing water scarcity is projected to further increase in drylands as a result of demographic growth, climate and land cover change (Hassan et al., 2005; UNCCD, 2017).

Rural dryland populations in Sub-Saharan Africa (SSA) are highly vulnerable to climatic fluctuations and environmental change given their strong dependence on rain-fed agriculture or other natural resource-based livelihoods (Juana et al., 2013). In addition, their risk level is often aggravated by challenging socio-economic conditions including high poverty, population pressure, food insecurity, political instability and ethnic tensions (FAO, 2009, 2018; Misselhorn, 2005; Reynolds et al., 2007). Future climate projections do not give reason for hope for an alleviation of these pressures as a general increase in aridity and extreme weather events is expected on the African continent (Boko et al., 2007). Considering the importance of the matter, a comprehensive understanding of coping and adaptation dynamics across these regions is urgently needed. The Intergovernmental Panel on Climate

[11] In a modified version this chapter is published as Wiederkehr, C., Beckmann, M., Hermans, K., (2018). Environmental change, adaptation strategies and the relevance of migration in Sub-Saharan drylands. *Environmental Research Letters* 13 (11). https://doi.org/10.1088/1748-9326/aae6de

Change (IPCC, 2012) defines coping as "[t]he use of available skills, resources, and opportunities to address, manage, and overcome adverse conditions, with the aim of achieving basic functioning in the short to medium term' (p.556), whereas adaptation in human systems is defined as 'the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities" (p.558).

Migration is considered a key livelihood strategy used by different communities in SSA to deal with varying resource availability and diverse types of stressors (Morrissey, 2013b). As indicated in Chapter 1.2, an increasing number of scholars and political decision-makers emphasise the potential of migration as adaptation strategy (e.g., Foresight, 2011; Hunter et al., 2015), whereas environment-induced migration is often portrayed as a major problem in political debates and the media (e.g., Bettini et al., 2016; Tacoli, 2009). More clarity is needed regarding how migration is to be evaluated in relation to other household responses to environmental change.

A considerable scientific data basis exists on the topic of coping with and adaptation to environmental and climate change in SSA (e.g., Juana et al., 2013; Mertz et al., 2009). Especially the extensive wealth of information from local case studies (e.g., Hooli, 2016; Ng'ang'a et al., 2016) is potentially relevant for the strategic development of climate change adaptation measures and natural resource and migration management at the national and international level. However, due to the localised focus and context-specific framework conditions, results from individual case studies are rarely directly applicable to larger regions. This chapter aims to address this knowledge gap by providing a systematic synthesis of comprehensive quantitative and qualitative case study data and a descriptive overview of patterns in the literature.

The overarching objectives of this chapter are to identify relevant household coping and adaptation strategies and, in particular, to assess the role and relative significance of migration as a strategy in the context of environmental change. Here, environmental change is understood as any process concerning the natural environment including climate that implies an alteration in the social-ecological system studied. Coping and adaptation are distinguished in reference to the time scale of measures, meaning that coping refers to spontaneous and temporary adjustments while adaptation is used for rather anticipatory and long-term

adjustments. The analysis focuses on subsistence livelihoods and rural arid and semi-arid lands in SSA. Based on the results, future directions for research needed to support socially and ecologically sustainable household coping and adaption are indicated.

3.2 Systematic synthesis procedure and case sample from sub-Saharan drylands

This chapter adopts a systematic synthesis approach including both quantitative and qualitative data from published scientific peer-reviewed literature. A systematic literature search (see Figure A3) was conducted in June 2017 using the online search engine 'Web of Science'. The search term used included all country names of SSA, different processes of environmental change and associated extreme weather events that are known to be relevant in Sub-Saharan drylands and the terms adapt and cope. The final search with the iteratively optimised search term (see Chapter 6.3) yielded 2,477 papers. These were assessed for eligibility and systematically filtered in a two-step procedure: a screening of paper titles, keywords and abstracts, followed by a more detailed inspection of the full-text articles. Case studies were selected for the analysis if they met all of the predefined eligibility criteria (Table 3.2.1). The final literature sample comprises 63 studies from 39 full-text articles covering 16 SSA countries (Table 3.2.2). Individual studies were determined based on the geographical location of study sites and the aggregation level of the results.

The studies included in this review are rather recent; the majority was published after 2009. In terms of applied methods, the studies are relatively homogenous with household surveys (43 studies) and focus group discussions (43 studies) being most common, often complemented by key informant/expert interviews (33 studies), semi-structured household interviews (24 studies), field observations or reviews of secondary data (see Table A3). In five studies the authors analysed meteorological data from weather stations. The sample size per study differs considerably across the reviewed studies ranging from 16 to 623 households[12]. In total, more than 9700 households are covered by this review. Based on the information on the sex ratio of the interviewees (available for 37 of the studies), on average one-fourth of the

[12] This number refers to survey or household interview participants, not to additional focus groups, workshops or expert interviews.

respondents was female. Three of the studies are located in Central Africa, 20 in East Africa, 29 in West Africa, and 11 studies in Southern Africa. It is worth noting that a high number of studies included in this review focus on relatively few countries such as Ethiopia, Burkina Faso or South Africa whereas several other SSA countries are not included at all[13] (Figure 3.2). Sixteen study sites contain arid lands, 49 semi-arid lands, and five include some dry sub-humid territory.

Table 3.2.1 Eligibility criteria for study selection.

- Only English-speaking literature including primary data from local case studies
- Study sites located in predominantly rural and arid/ semi-arid areas[14] in SSA
- Study populations characterised by subsistence livelihoods or small-scale agriculture
- Data at the household level (given that the coping/adaptation decision-making usually takes place at the household level)
- Information on more than a single coping or adaptation strategy
- Only actually adopted coping or adaptation strategies (not preferred or planned strategies)
- Frequency of adoption of the listed strategies (important indicators of their relative importance)
- Reference to an environmental change process[15]

The information extracted from the studies comprises the conceptual framework, data collection methods, socio-economic household characteristics, reported environmental change processes, other environmental and non-environmental factors shaping the general context of the study, and the coping or adaptation strategies adopted by households. A qualitative content analysis of the selected studies was done in ATLAS.ti to guide the categorisation of collected data and substantiate the interpretation of results. Repeated cross-checking during the data extraction and coding process served to reduce the risk of potential biases.

[13] This uneven country coverage needs to be taken into account as it determines the representativeness of the synthesis results.

[14] The *Global Aridity Index (Global-Aridity) and Global Potential Evapo-Transpiration (Global-PET) Geospatial Database* (Trabucco & Zomer, 2009) was used to determine the aridity for each study site.

[15] (literal interpretation of text-based information, i.e. terms like 'decrease', 'degradation', 'drying' were considered a change, 'climate variability' or 'water scarcity' not per se)

The livelihoods of the studied households were divided into three overarching groups: farmers (crop, vegetable and livestock farmers that are predominantly sedentary), agro-pastoralists (semi-nomadic groups that engage in crop cultivation in combination with livestock herding) and pastoralists (nomadic livestock herders)[16]. Information describing measured or perceived environmental changes in the study areas was grouped into increasing stress related to temperature, rainfall amount, rainfall variability, land degradation, degradation of water bodies, wind, drought and flood events (see footnote 4). In order to assess the relevance of household strategies, three types of information were used: the number of studies in which each of the response strategies was reported (i.e. vote counting); the number of households that adopted each strategy (calculated based on the sample size and frequency of adoption per strategy category and study); and the estimated relevance of each strategy category per study (for each individual study the strategy categories were ranked based on their frequency of adoption by households relative to the other categories). The descriptive statistical analysis of the coded data comprised frequency distribution analyses.

[16] This grouping evolved in the course of the review process.

Table 3.2.2 Studies included in the analysis.

Reference	Country	No. of studies extracted	Rural livelihoods characterised by	Environmental change related to
Padonou et al., 2014	Benin	1	Farming	Land degradation
Oyerinde et al., 2015	Benin	1	Farming	Rainfall, flood, land degradation
Dah-gbeto & Villamor, 2016	Benin	1	Farming	Rainfall
Motsholapheko et al., 2011	Botswana	1	Farming	Rainfall, flood
Motsholapheko et al., 2012	Botswana	1	Farming	Degradation of water bodies
Barbier et al., 2009	Burkina Faso	1	Farming, Agro-Pastoralist	Rainfall, land degradation
Zampaligré et al., 2014	Burkina Faso	2	Farming, Agro-pastoralist, and Pastoralist	Rainfall, land degradation, degradation of water bodies
Okpara et al., 2016	Chad	3	Farming, Agro-pastoralist and Pastoralist	Degradation of water bodies
Gebrehiwot & van der Veen, 2013	Ethiopia	1	Farming	Rainfall, drought, flood
Haile et al., 2013	Ethiopia	1	Farming, Agro-pastoralist	Flood
Ariti et al., 2015	Ethiopia	1	Farming	Rainfall, drought, land degradation, degradation of water bodies
Berhanu & Beyene, 2015	Ethiopia	1	Pastoralist	Drought, rainfall, land degradation

Reference	Country	No. of studies extracted	Rural livelihoods characterised by	Environmental change related to
Feleke et al., 2016	Ethiopia	3	Farming	Temperature, rainfall
Mersha & van Laerhoven, 2016	Ethiopia	1	Farming	Drought, land degradation, rainfall
Ng'ang'a et al., 2016	Ethiopia	1	Agro-pastoralist	Drought, rainfall
Tesfaye & Seifu, 2016	Ethiopia	3	Farming	Temperature, rainfall, drought, flood, land degradation
Yaffa, 2013	Gambia	1	Farming	Rainfall, drought, land degradation
Antwi-Agyei et al., 2014	Ghana	1	Farming	Temperature, rainfall
Dumenu & Obeng, 2016	Ghana	1	Farming, Agro-pastoralist	Temperature, rainfall, degradation of water bodies
Limantol et al., 2016	Ghana	1	Farming	Temperature, rainfall
Tambo, 2016	Ghana	3	Farming	Temperature, rainfall
Smucker & Wisner, 2008	Kenya	2	Agro-pastoralist	Rainfall, land degradation
Silvestri et al., 2012	Kenya	1	Farming, Agro-pastoralist, and Pastoralist	Temperature, rainfall
Opiyo et al., 2015	Kenya	1	Agro-pastoralist, Pastoralist	Drought, land degradation, degradation of water bodies
Sanogo et al., 2017	Mali	1	Farming, Agro-pastoralist	Temperature, rainfall, wind, drought
Hooli, 2016	Namibia	1	Farming	Flood, land degradation

Reference	Country	No. of studies extracted	Rural livelihoods characterised by	Environmental change related to
McKune & Silva, 2013	Niger	4	Agro-pastoralist, Pastoralist	Rainfall
Snorek et al., 2014	Niger	3	Farming, Agro-pastoralist, and Pastoralist	Rainfall, land degradation
Chianu et al., 2004	Nigeria	1	Farming	Rainfall, land degradation
Tambo & Abdoulaye, 2013	Nigeria	2	Farming	Temperature, rainfall
Yila & Resurreccion, 2014	Nigeria	1	Farming	Rainfall, drought, wind, land degradation, degradation of water bodies
Mertz et al., 2009	Senegal	1	Farming	Temperature, rainfall, wind, land degradation, degradation of water bodies
Gbetibouo et al., 2010	South Africa	4	Farming	Temperature, rainfall
Osbahr et al., 2010	South Africa	3	Farming	Wind, drought, flood, land degradation
Rankoana, 2016	South Africa	1	Farming	Land degradation, degradation of water bodies, rainfall
Pauline et al., 2017	Tanzania	2	Farming	Drought, rainfall
Bola et al., 2014	Zimbabwe	1	Farming	Rainfall, drought, flood
Jiri et al., 2017	Zimbabwe	1	Farming	Temperature

Reference	Country	No. of studies extracted	Rural livelihoods characterised by	Environmental change related to
Mertz et al., 2012	Multi-country study (Burkina Faso, Mali, Niger, Nigeria, Senegal)	3	Farming, Pastoralist	Rainfall, temperature, wind, land degradation, degradation of water bodies

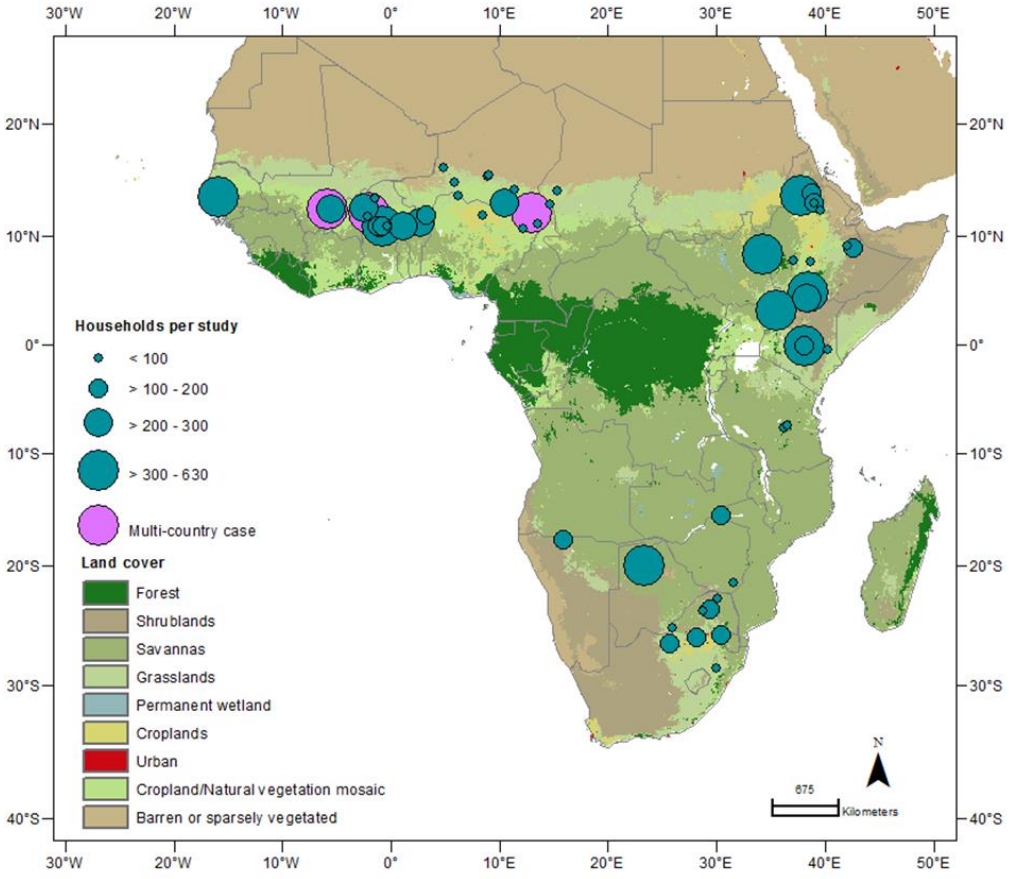

Figure 3.2 Geographical distribution of the 63 reviewed studies. Published as Fig. 1 in Wiederkehr et al. (2018).

3.3 Findings and reflections on household adaptation behaviour in the regional context

3.3.1 Rural livelihoods

The livelihood activities of the study populations are essentially agricultural. Farming is by far the dominant livelihood activity across the studied populations covered by 51 of the studies. Sixteen studies included agro-pastoralists and twelve studies pastoralists. Thereby, livelihood activities are not necessarily mutually exclusive as many population groups analysed comprise a mix of different

livelihoods[17]. Complementary livelihood activities that are often mentioned include petty trading, informal employment, fishing or artisanal work. Based on the literature reviewed here, it cannot be assessed whether this imbalance between the livelihood groups reflects a general dominance of or trend towards sedentary agriculture in SSA or whether this hints at a gap in the research field.

Scholars seem to disagree on which type of livelihood enables households best to deal with environmental change. McKune and Silva (2013), for instance, argue that drought-induced loss of livestock has a more severe impact on livelihood security than the loss of crops as the subsequent rebuilding of a herd takes much more time. In contrast, some studies point at the major advantage of livestock mobility that allows households to relocate herds to higher grounds, for instance to avoid flood damage (Haile et al., 2013), and to use resources more opportunistically (Opiyo et al., 2015). Others suggest that a more diversified livelihood portfolio in general is conducive to a higher adaptive capacity due to the spreading of risk (e.g., Motsholapheko et al., 2012).

3.3.2 Environmental change processes

Increasing environmental stress is predominantly reported in terms of temperature increase, declining precipitation and more variable, unpredictable or erratic rainfall. An increase in stress related to drought and flood events is mostly reported in terms of increasing frequency, magnitude or severity in the reviewed studies. Increasing stress related to wind especially refers to increasing wind speed or dust storms. Examples of increasing stress related to the degradation of land and water bodies include soil erosion, bowalization[18], lake drying and the desiccation of floodplains. As shown in Figure 3.3.1, slow-onset changes relating to temperature, rainfall and soils are more commonly reported in the studies than changes relating to fast-onset extreme weather events. In general, there is a strong emphasis on the context of climate change and variability in the majority of studies. Land degradation—although mentioned in half of the studies—is rarely the focus of the reviewed literature, but often mentioned more as a side note[19].

[17] The share of each livelihood type in the respective sample is not explicitly stated in each of the 63 studies, which is why no total household numbers are presented here for the different livelihood groups.
[18] (A form of land degradation that entails the lateral expansion of ferricrete horizons.)
[19] For a detailed discussion of the state of research on land degradation-migration dynamics see Hermans and McLeman (2021).

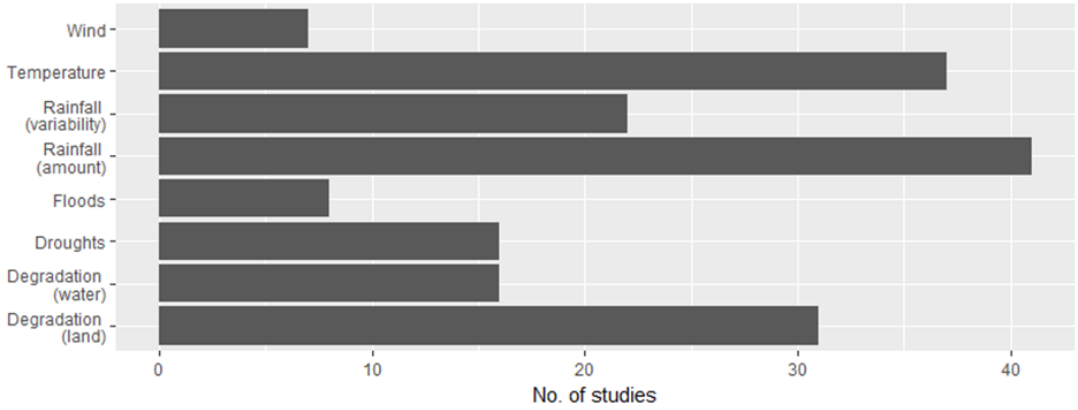

Figure 3.3.1 Environmental change processes reported in the reviewed studies. Published as Fig. 2 in Wiederkehr et al. (2018).

Human perceptions of environmental change play a decisive role in the process of coping and adaptation. Local views on environmental changes are shaped by a number of factors, including farming experience, contact with extension services, or the media, and may not always fully correspond to real changes (e.g., Kosmowski et al., 2016; Mertz et al., 2012; Silvestri et al., 2012). Yet, perception is a prerequisite for coping and adaptation as households are unlikely to take action and change their practices unless they perceive a change and adverse effects in the first place (e.g., Tambo & Abdoulaye, 2013). Nevertheless, instead of reporting local views, meteorological data or secondary sources are often used in the academic literature to underline changing local or regional environmental conditions. However, a solid understanding of household behaviour in this context calls for the consideration of local perceptions, whether (and if, why) they contradict climate data and how they translate into concrete action. Here, perceptual data can act as a valuable complement to climate data as they might reveal important underlying drivers or processes which specific environmental parameters fail to detect (e.g., Mertz et al., 2009).

3.3.3 Contextual factors and barriers

A diverse range of environmental and non-environmental factors that shape the broader contexts in which household coping and adaptation take place are cited in the reviewed studies. Some are based on the perceptions of the local population, whereas others are determined by the respective authors or retrieved from

secondary sources. These factors include characteristics of the study area and population (e.g. infertile soils, land tenure issues, weak infrastructure, illiteracy problems, resource conflicts, ethnic diversity, gender inequalities), causes and impacts of environmental change processes (e.g. land use changes, overexploitation, crop failure, livestock deaths, health issues, food insecurity) and adaptation barriers (e.g. lack of financial capital, farm inputs and information, inaccessibility of markets). However, the reviewed studies partly remain ambiguous about which of these are to be interpreted as factors enabling or constraining coping and adaptation. Moreover, many factors act at different scales and are strongly intertwined which hampers a clear-cut categorisation.

It is important to bear in mind that, even if an environmental change is perceived, households may not be able to adopt adequate measures due to certain constraints (e.g., Ariti et al., 2015; Oyerinde et al., 2015; Silvestri et al., 2012; Tambo & Abdoulaye, 2013). Gebrehiwot and van der Veen (2013) for example show that, despite a high local awareness of climate change, almost half of the Ethiopian study population was unable to adopt any adaptive measure due to lack of information and finance. Gbetibouo et al. (2010) report similar findings from the Southern African Limpopo Basin, where the lack of credit and water access plays a major role for hindering farmers' adaptation. In the case of people wanting to emigrate due to environmental risks but not being able to do so, researchers often refer to so-called 'trapped populations' (e.g., Black et al., 2011b; Murphy, 2015). In general, barriers to adaptation are often not clearly defined in the academic literature, highly context-dependent, interconnected and have a differentiated effect on different actors, such as male- and female-headed households (Biesbroek et al., 2013; Mersha & van Laerhoven, 2016; Yila & Resurreccion, 2014). Moreover, scientific knowledge on how adaptation barriers impact specific adaptation choices, such as migration, is still limited. For a detailed review of climate change adaptation barriers faced by natural-resource dependent communities in SSA see Shackleton et al. (2015).

3.3.4 Coping versus adaptation

In the majority of studies household strategies are framed as 'adaptation', whereas only in about one third the framing of 'coping' is used, either instead of or in addition to 'adaptation'. In about one out of three studies these terms are used without any definition provided; some authors seem to use both terms synonymously. This observation has also been addressed by other scholars, e.g.

Murtinho and Hayes (2012) who advocate greater conceptual and methodological clarity in adaptation field research. Other concepts that were used in the analysed literature include adaptive and buffer capacity, resilience (e.g. climate resilience) and vulnerability (e.g. social or gender-differentiated vulnerability).

It is noteworthy that—despite the 'adaptation' framing in most studies—many authors claim the reported strategies to be reactive and short-term rather than preventative and anticipatory, often due to various barriers (e.g.,Dumenu & Obeng, 2016; Hooli, 2016; Okpara et al., 2016; Opiyo et al., 2015; Tambo & Abdoulaye, 2013). Okpara et al. (2016), for instance, indicate that many adaptive measures to environmental changes require the use, combination or substitution of assets in different ways. Consequently, the low asset profile of parts of the study population at Small Lake Chad has restricted them to actions that are largely reactive (ibid.). According to Pauline et al. (2017), many coping strategies could be transformed into longer term adaptation strategies but are limited by non-climatic factors. Whereas coping strategies tend to depend on locally available resources, such as labour, many longer term adaptation methods in the farming sector require financial capital or government support, which are often unavailable to smallholder farmers (ibid.). This generally supports findings from other studies, such as Berrang-Ford et al. (2011) who point at the reactive adaptation profile of low income countries.

3.3.5 Relevant household strategies

Table 3.3.1 Categorisation of household strategies adopted to deal with environmental change.

Strategy type	Examples of specific strategies from the studies
Crop management	Crop diversification, intercropping, monocropping, crop rotation, increase of farm size, use of organic/ chemical fertiliser, drought-tolerant/ early maturing varieties, change timing of land preparation/ planting, crop irrigation, grain storage, sharecropping
Livestock management	Livestock sale, fodder storage, transhumance, herd diversification, drought-tolerant species, culling of sick animals, provision of shade, bull fattening, veterinary care, purchase of hay, home feeding
Soil and water management	Erosion control, terracing, drainage ditches, ridges, micro-catchments, ploughing, stone bunds, mulching, digging of boreholes and wells, construction of small dams, water storage, drinking water treatment

Income diversification	Off-farm employment, local wage labour, petty trading, hunting, charcoal selling, tourism/ wildlife-related income, sell bush products, fishing, pottery
Food provision	Reduce food consumption, change diet, seek food aid, eat wild fruits, work for food, sell assets to buy food, store food, purchase fish, use savings to obtain food, harvest to obtain food, plant food trees
Social networks	Rely on support from relatives/ friends, borrow money from neighbours, send out children, receive remittances, collaboration
Migration	International migration, labour migration, rural-urban migration, temporary relocation to government camps
Humanitarian aid	Rely on/ ask for humanitarian aid provided by the government, NGOs or religious organisations
Information	Consult extension officers, send children to school, join information group, access weather forecast information, early warning systems
Religious activities	Prayers, turn to faith and church groups, go to the mosque, ritual ceremonies
Other activities[20]	Sale of property, insurance scheme, sedentarisation, household splitting, get loan or credit, reduce expenses after drought, measures to prevent inundation of houses, reduction of gifts to the poor
No coping/ adaptation	-

The reported household strategies from each study were aggregated into twelve overarching categories, acknowledging that a clear-cut distinction is difficult due to real-world overlap[21]: crop management, livestock management, soil and water management, income diversification, food provision, social networks, migration, humanitarian aid, religious activities, information, other activities, and no coping/adaptation (Table 3.3.1). Although migration is commonly viewed as a form of income diversification, it is treated a as a separate category here to allow for a closer examination. It needs to be added that some strategies are likely to be

[20] 'Others' also include strategies that were somewhat ambiguous and could not be assigned clearly to any of the other categories, and strategies that entail activities from various categories and could not be disaggregated further.

[21] Each strategy was assigned to one category only in order to avoid double counting.

underreported in the literature under study, either because they are illegal in some countries, such as grazing in protected areas, local beer brewing or cutting wood for charcoal production, or because they are socially stigmatised, e.g. the consumption of wild plants (e.g., Antwi-Agyei et al., 2014; Goldman & Riosmena, 2013; Smucker & Wisner, 2008).

The results reveal that agricultural strategies, including the management of crops, livestock, soil and water, are by far the most commonly adopted in rural Sub-Saharan drylands (Figure 3.3.2). This is most notable in the case of crop management that is reported in more than three quarters of the reviewed studies and soil and water management reported in about two thirds. Here, the number of studies in which a strategy was reported is contrasted with the number of households who adopted a strategy (Figure 3.3.3) in order to account for the differences in sample sizes but also the varying shares of study populations that adopted a certain strategy. The household numbers reveal an even more clear-cut picture as the gap between agricultural and resource management and other strategy types increases notably. In sum, this reflects the predominantly agricultural character of the rural livelihoods as well as the harsh conditions in Sub-Saharan drylands shaped by severe soil erosion and water scarcity. The fact that approx. 17% of the interviewed households claimed to not have adopted any response measure underlines the need to consider locals' perceptions of environmental change (i.e. do they perceive the need to take any action?) and factors constraining coping and adaptation (i.e. are they actually able to adopt response measures?).

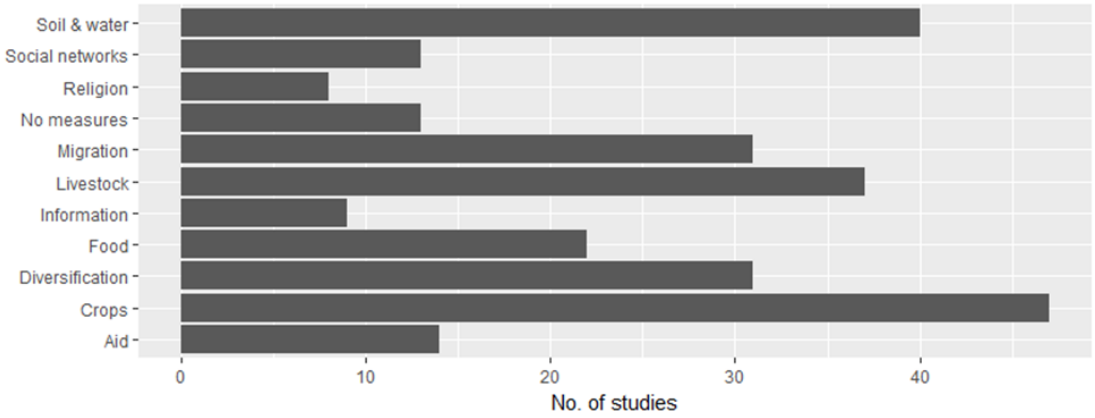

Figure 3.3.2 The number of studies in which each strategy is reported. Published as Fig. 3 in Wiederkehr et al. (2018).

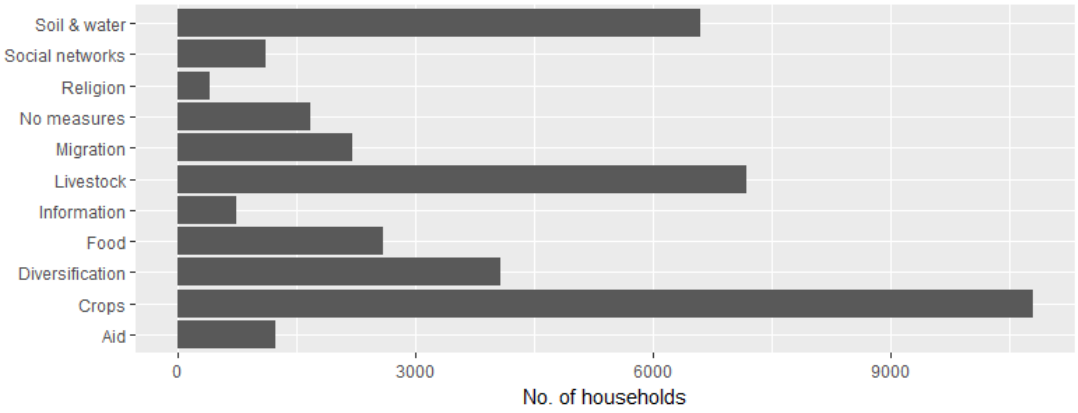

Figure 3.3.3 The total number of households that reported the adoption of a strategy (multiple answers by households per category are possible due to the aggregation of strategies into overarching groups). Published as Fig. 4 in Wiederkehr et al. (2018).

Given the discrepancy between the number of studies and the number of households presented here, a ranking approach was chosen to combine both types of information and estimate the strategy relevance. The results are compared between the three livelihood groups in order to provide a more nuanced picture (Figure 3.3.4). Not surprisingly, strategies related to crop cultivation are dominating for farming households, which corresponds to findings by other researchers such as Juana et al. (2013). Livestock management, in turn, is the most common strategy type in the sample of pastoralist households. Agro-pastoralist households figure somewhere in between the other two groups, reflecting the combination of cultivation and herding that is characteristic for agro-pastoralist livelihoods. Here, it is noteworthy that in the sample of agro-pastoralists migration is reported in more studies than all other strategy types. In the sample of pastoralist households migration is more common than other income diversification strategies. Nevertheless, as illustrated in Figure 3.3.4, in the studies in which migration is reported, it is usually not the strategy that the majority of households adopted.

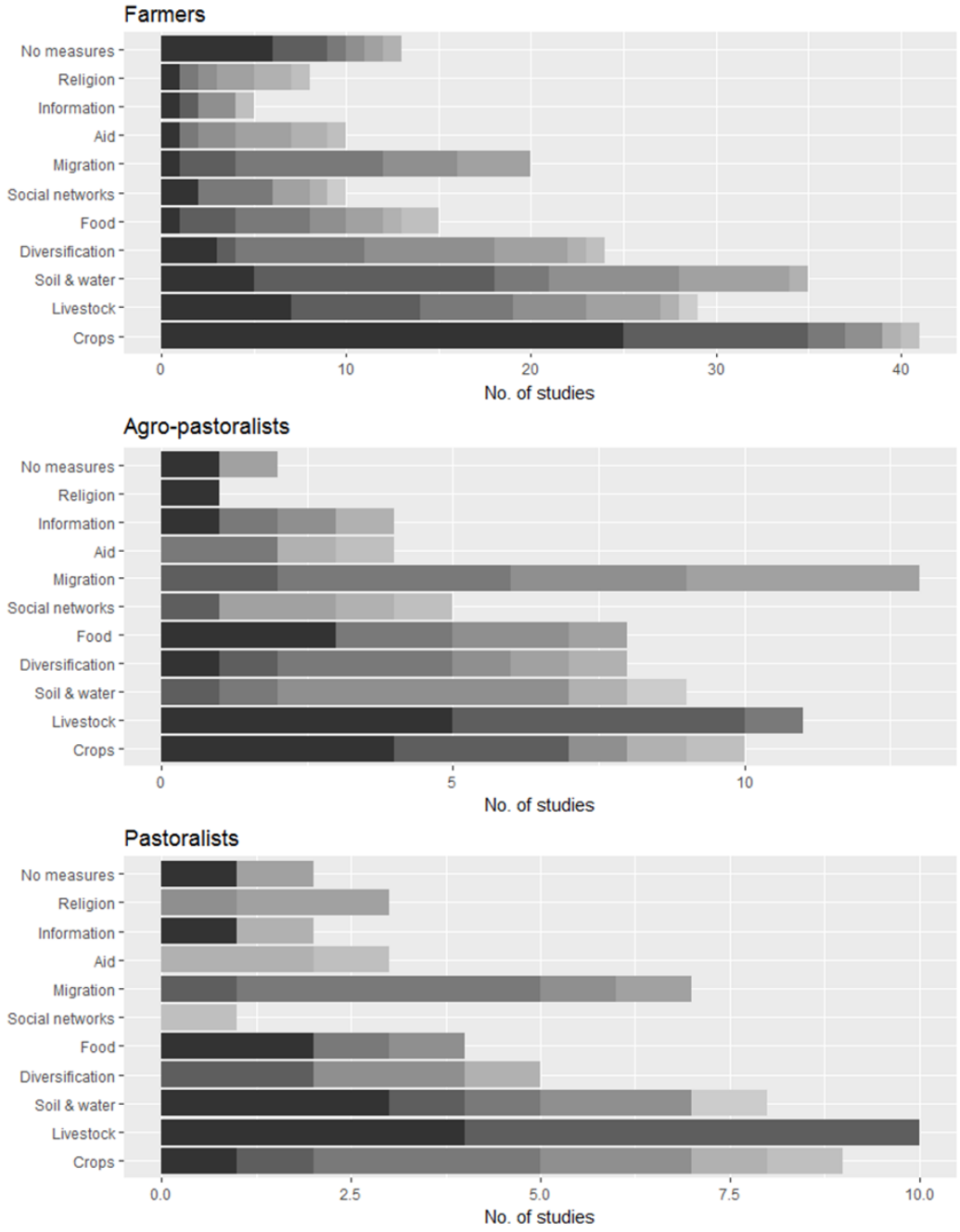

Figure 3.3.4 Estimated relevance of strategies as reported by different livelihood groups (based on the frequency of adoption aggregated per strategy category and assessed in relation to other categories per study; the darker the grayscale, the more common the strategy category in the individual study). Published as Fig. 5 in Wiederkehr et al. (2018).

3.3.6 Migration as strategy to deal with environmental change

Table 3.3.2 Examples of reported migration types and associated household numbers.

Type of migration	Number of households
Temporary	287
Permanent	77
En exode	43
Economic/labour	443
Rural-urban	23
International	21

A diverse range of migration types are reported as response to environmental change in almost half of the reviewed studies. About 23% of the interviewed households claim to have been involved in some type of migration. Thus, together with food-related strategies other forms of income diversification, migration constitutes one of the most relevant strategies after agricultural and resource management. The types of migration include, amongst others, temporary/short-term migration (e.g., Osbahr et al., 2010), permanent migration (Zampaligre et al., 2014), migration *en exode* (McKune & Silva, 2013), economic/labour migration (e.g., Opiyo et al., 2015; Snorek et al., 2014), rural-urban migration (e.g., Dumenu & Obeng, 2016) and international migration (e.g., Mersha & van Laerhoven, 2016) (Table 3.3.2). Information about the duration or migration distance is often not provided, which makes a more detailed comparison infeasible. Temporary migration and economic/labour migration (which are often overlapping) are the most common types in the sample of studies. Moreover, even if migration is not explicitly framed as 'economic', it is often mentioned in association with job search or remittances and, thus, hints at economic purposes. Antwi-Agyei et al. (2014), for instance, conclude that temporal migration is still one of the dominant strategies among vulnerable farming communities in northern Ghana, mostly undertaken by younger people to engage in wage labour in southern Ghana.

An interesting observation from the qualitative analysis is that in several studies out-migration is described as common phenomenon or household strategy in the study area without explicitly considering it as either coping or adaptation strategies (e.g., Dah-gbeto & Villamor, 2016; Eriksen et al., 2005; Silvestri et al., 2012; Tambo, 2016). For instance, in a case of Ethiopian smallholder farmers the vast majority of respondents perceive that migration has 'aggravated' as a result of climate change.

However, the reported frequency of migration as climate change adaptation strategy is almost negligible (Tesfaye & Seifu, 2016). Similarly, Mertz et al. (2009) recognise migration as both a climate change impact and a household adaptation strategy in their cross-country study. But the provided quantitative information only includes migration as a perceived impact of climate-related parameters, whereas more work done by old people in all seasons is named as associated adaptation measure (ibid.).

These examples hint at the fundamental conceptual and methodological challenges of grasping the links between the environment and human migration. As illustrated in the framework presented in the influential Foresight Report (2011), the migration decision by households or individuals involves a complex set of interlinked factors in which environmental change also acts as indirect driver influencing other migration drivers. This indirect, and perhaps less obvious influence partly explains why local people are more likely to associate migration with more apparent socio-economic factors, such as the search of labour, than environmental change—although the latter significantly shapes local framework conditions (see e.g., Morrissey, 2013a). This corresponds to Neumann and Hermans (2015) who show that economic and social motivations account for 80% of the migration drivers reported in 53 studies from the Sahel. In other words, even though migration forms part of household coping or adaptation, it may not always be perceived as such and is, thus, likely to be underreported as strategy in the literature under study.

3.3.7 Strategy dynamics

Despite existing evidence that households usually adopt various coping or adaptation strategies simultaneously (see e.g., Hooli, 2016; Mogotsi et al., 2013; Silvestri et al., 2012; Tesfaye & Seifu, 2016), only four of the reviewed studies explicitly investigate the interconnectedness and dynamic interactions of individual strategies, i.e. how they complement, substitute, reinforce or undermine each other (e.g., Tesfaye & Seifu, 2016). Examples from the analysed literature include Tambo (2016) who used the correlation between different adaptation measures as an indicator and concluded that most of the measures analysed are complementary rather than substitutes. Beyond that, Eriksen et al. (2005) underline the tendency of households to engage in one principal coping strategy complemented by various less favoured activities during drought periods. Interestingly, Ng'ang'a et al. (2016) found that migration is associated with the enhanced adoption of measures for self-protection against weather shocks, especially in cases of high investment costs,

suggesting that remittances flows constitute a key mechanism supporting local agricultural innovation. A more nuanced understanding of these strategy dynamics in general could make a substantial contribution to making adaptation planning more effective.

An even more pressing issue in this context concerns the impact of strategies on the households themselves and the social-ecological system in general. The literature indicates that—despite short-term gains—certain coping or adaptation strategies might not be sustainable in the long run and undermine the viability of local livelihoods (e.g., Yaffa, 2013). This includes activities that erode the natural resource base (Chianu et al., 2004; Opiyo et al., 2015), reduce the adaptive or buffer capacity of local agents (Bola et al., 2014; Goldman & Riosmena, 2013; Haile et al., 2013; Silvestri et al., 2012) and generate negative externalities for other population groups (McKune & Silva, 2013; Osbahr et al., 2010). A well-known example of the latter is the expansion of farmland that reduces pastoral space and therewith limits pastoral adaptation (Snorek et al., 2014). These processes are captured by terms such as 'maladaptation', 'erosive coping' or 'divergent adaptation'. Whereas the benefits of remittances are often emphasised in the literature (e.g., Dumenu & Obeng, 2016), several scholars mention risks and negative effects of emigration on the remaining communities, such as weakened local labour force (Mertz et al 2009), increased divorce rates and loss of solidarity (McKune & Silva, 2013), and the migrants themselves (e.g., Mersha & van Laerhoven, 2016; Yaffa, 2013). A holistic and systemic policy approach that supports both ecologically and socially sustainable adaptation demands prior consideration of potential repercussions.

A remaining question is whether there have been significant changes in coping and adaptation strategies and whether the overall mobility of certain groups has increased or decreased in the course of evolving environmental stressors. Some indications exist in the analysed literature of pastoralist groups becoming more sedentary (e.g., McKune & Silva, 2013; Snorek et al., 2014), whereas some farming and fishing groups are said to become more mobile in search of fertile lands and fish-abundant areas (e.g., Dah-gbeto & Villamor, 2016). Furthermore, it remains questionable to what extent there is a general trend of traditional agricultural livelihoods being increasingly abandoned in favour of more diversified livelihoods and off-farm income-generating activities (e.g., Antwi-Agyei et al., 2014; Eriksen et al., 2005; Rankoana, 2016). Based on surveys conducted in Kenya in 1977 and 1996,

Campbell (1999) concludes that more coping strategies have become available over time. Interestingly, Smucker and Wisner (2008) argue that, within the same country, the range of coping strategies has declined between 1971 and 2001. Either way, more longitudinal studies of this kind are needed to draw meaningful and generalisable conclusions on this issue.

3.3.8 Methodological challenges of the analytical approach

In this chapter, a first attempt has been made to systematically generate and quantify knowledge on household behaviour under environmental change on a macro scale. Obviously, there are certain limitations to this study that shall be addressed briefly. First and foremost, as this study is confined to published English-speaking scientific literature, the risk of publication bias exists. However, even leaving aside grey literature and articles in other languages, the scientific data basis on this research topic is already quite extensive. Besides, the fact that only studies from peer-reviewed journals were included ensures a certain quality standard and formal uniformity of the publications under analysis. Nevertheless, it is important to acknowledge that the uneven country coverage in the reviewed literature puts a clear limitation on the scope of this study's findings[22]. Beyond this, given that this synthesis is literature-based, the results presented here are completely dependent on the information provided in the selected papers and were not verified using external data.

Despite the narrowly defined criteria for the selection of studies, the type of information and richness of detail provided in the studies differ considerably, leading to what is known as the 'lowest common denominator problem'. This proved especially problematic regarding the environmental conditions at the study areas and the socio-economic characteristics of the study populations which are viewed as important determinants of household coping and adaptation behaviour (e.g., Berhanu & Beyene, 2015; Feleke et al., 2016; Gbetibouo et al., 2010; Gebrehiwot & van der Veen, 2013; Juana et al., 2013; Ng'ang'a et al., 2016; Tambo, 2016; Tesfaye & Seifu, 2016; Zampaligré et al., 2014). Limited comparable information on these has reduced the leeway for systematic comparison of the studies and interpretation. In addition, lacking definitions of used terminology, including coping and adaptation,

[22] For a discussion on why climate change research in Africa is biased towards certain countries see Hendrix (2017).

agro-pastoralism, different types of migration and environmental change processes, has been a major challenge, as well as often inexplicit descriptions of how information about the household strategies was elicited (e.g. what was the formulation of the interview questions?).

Synthesising the vast and diverse range of strategies reported in the studies requires aggregating the strategies into strategy groups. When it comes to the frequency of adoption, the aggregation proved problematic because usually no information was provided by the individual studies regarding how many households were adopting two or more of the listed strategies simultaneously (i.e. the overlap of percentages). Consequently, the relative importance of broad strategy groups such as crop, livestock, soil and water management are likely to be overestimated as multiple answers (and therewith higher household numbers) are more likely than in the case of more narrowly defined strategy groups, such as religious practices, humanitarian aid or information.

3.4 Interim Conclusion

This chapter constitutes a first step towards addressing the lack of meta-knowledge on rural household behaviour in the context of environmental change in drylands. Comprehensive quantitative and qualitative data from 63 systematically selected studies covering more than 9700 households and 16 Sub-Saharan African countries were integrated and synthesised to create a bigger trans-regional picture. Within the sample of analysed studies, I identified an information gap regarding certain dryland areas such as in Sudan or Somalia, and pastoralist and female-headed households, which are considered two of the most vulnerable population groups. The results demonstrate that the vast majority of reported environmental change processes are related to slow-onset hazards and the context of climate change and variability. In terms of response strategies, agricultural and resource management are most commonly adopted by rural households, followed by various forms of migration, other income diversification strategies and measures for food provision. About 23% of the households claim to have been involved in some form of migration. Yet, it is hypothesised that migration plays a bigger role in the process of adaptation than the quantitative data synthesised here suggest. This is likely explained by methodological and conceptual challenges of grasping the complex and dynamic environment-migration nexus in which environmental change acts as

both a direct and indirect driver. Other less frequently adopted strategies are related to social networks, religious practices, humanitarian aid and information.

From a synthesis perspective, the following information is considered important to enhance the comparability of local case study results and to draw meaningful and generalisable conclusions:

- Clear definition of used terminology (e.g. adaptation and coping concepts, migration, agro-pastoralism and pastoralism), especially regarding environmental change and stress (to allow for a better distinction between actual change processes and typical site-specific phenomena or natural variability).
- Reliable indication of the case study site (e.g. coordinates of study site and month/year of field data collection) so that complementary external data (e.g. climate or census data) may be integrated if necessary.
- Basic socio-economic characteristics of the study population (age mean/range and sex ratio of the interviewees, ethnic background, economic status of households, e.g. farm size or number of livestock, and number of household members) as these are known to be important factors influencing the coping and adaptation behaviour of households.

The analysed studies consistently indicate that significant obstacles to long-term adaptation by rural households remain and that enhanced support from governments and organisations is needed to overcome these effectively. Furthermore, more nuanced and substantial knowledge of strategy dynamics (i.e. their interlinkages, impacts on people's livelihoods and the socioecological system in general, and potential changes over time) is crucial for increasing households' capacity to deal with environmental change and for reducing the risk of maladaptation, resource degradation and conflict. Such an improved understanding is essential for advancing the development of appropriate adaptation policy instruments and interventions at all levels.

4. Violent Resource Struggles in Areas of Immigration

4.1 Introduction

The relations between migration, natural resource use and conflict have long been a contested issue in the policy and academic community due to sustainability and security concerns. Recently, this nexus has attracted growing attention as global climate change is expected to impact both migration and renewable resource availability, therewith supposedly fuelling resource competition in destination areas (Abel et al., 2019; Barnett & Adger, 2007; IPCC, 2019; Reuveny, 2007; Salehyan, 2008; UN News, 2019, January). As described in Chapter 1.3, this is prominently mirrored in discussions about the crises in Darfur and Syria (e.g., Ash & Obradovich, 2020; De Juan, 2015).

The pathways connecting migration and resource conflict are far from evident (Martin, 2005; Mitchell & Pizzi, 2020). Migration can contribute to tensions in destination areas. However, most migration flows do not lead to conflicts (e.g., Bernauer et al., 2012). Local and immigrant populations can engage in beneficial cooperation over scarce resources (Bukari et al., 2018; Tubi & Feitelson, 2016). Moreover, questioning the claims of environmental scarcity theorists, resource scarcity or degradation alone have been found to provide only a limited explanation for the occurrence of conflict (Salehyan, 2008; Seter et al., 2018). Evidence remains inconclusive and, above all, illustrates the relevance of mediating factors and their interaction for the occurrence of conflict, including social dynamics in host communities, political institutions and the background of migration processes (Abrahams, 2020; Brzoska & Fröhlich, 2016; Burrows & Kinney, 2016; Ide, 2015; Ide et al., 2020; Koubi, 2019).

Local case studies are known to be sufficiently content-rich to reliably reveal mechanisms and processes behind conflicts. Such analyses have provided comprehensive evidence for the onset of resource-related tensions in immigration areas (e.g., Bassett, 1988; Bogale & Korf, 2007; Gray, 2002; Ojha et al., 2018). The ability of such studies to detect generalizable patterns has been questioned (Scheffran et al., 2012b). Large-N, statistical analyses remain largely infeasible due to a lack of detail especially on nuanced local realities (e.g., Seter et al., 2018). I here

therefore employ Qualitative Comparative Analysis (QCA) which is well-suited to detect complex causal patterns based on context-sensitive qualitative data. QCA is capable generating insights for a medium number of cases and is helpful to determine multiple, complex pathways to conflict (Bara, 2014; Ide, 2017).

Here I thus seek to identify combinations of context factors conducive to conflicts over renewable resources in rural immigration areas in the Global South. Importantly, the rather broad understanding of (im)migration[23] adopted here includes both cross-border and internal movement as well as refugees and internally displaced persons (IDPs). Resource conflict is defined here as a violent clash of interests regarding the use of one or more renewable resources between at least two social groups at the local level (violence may be against property and/or humans). I apply QCA to generate systematic knowledge of the complex interaction of factors conducive to resource conflicts in receiving areas and therewith a more nuanced understanding of migration-resource conflict links. Importantly, I aim to unravel the circumstances under which destination areas witness such conflicts rather than establishing a causal relationship between migration and conflict.

4.2 Theoretical background of relevant context factors

Migration-conflict links discussed in academic literature tend to refer to specific types of migration. In particular, forced movement is considered a significant mechanism of conflict diffusion across borders due to the associated impact on ethnic structure, economic competition and the circulation of weapons, actors and ideologies (Salehyan & Gleditsch, 2006). Beyond this, Rüegger (2018) shows that the refugee-conflict link is dependent on the presence of ethno-political tensions in the host country. There is less consensus, however, on whether environment-induced population movement generally enhances the likelihood of conflict or not (e.g., Ghimire et al., 2015; Hendrix & Glaser, 2007; Reuveny, 2007; Sakaguchi et al., 2017). One reason for this, amongst others, is that the pace of environmental change or hazard at the origin matters. Koubi et al. (2018) argue that migrants who experienced

[23] Oriented towards the migration definition of the IOM Glossary on Migration (2011): "The movement of a person or a group of persons, either across an international border, or within a State. It is a population movement, encompassing any kind of movement of people, whatever its length, composition and causes; it includes migration of refugees, displaced persons, economic migrants, and persons moving for other purposes, including family reunification" (IOM, 2011, pp.62)..

long-term climatic events (e.g., droughts) are more likely to have developed grievances that result in increased conflict perceptions at their destination compared to migrants who experienced short-term events. People migrating due to environmental reasons also usually have very limited access to weapons, connections to armed groups, or grievances related to specific (armed) conflicts (Brzoska & Froehlich, 2016).

Among the broad range of context factors conducive to conflicts discussed in the reviewed literature, governance aspects and social dynamics in host communities are at the core. As stated by Brzoska and Froehlich (2016), "it is not necessarily migration patterns or the number of migrants which enhance the probability of conflict escalation, but the inherent power relations in the respective society" (p. 204). These are inter alia reflected in property right regimes which determine resource tenure and access and thereby prioritise certain resource use interests. Participatory and inclusive resource management can help local communities to deal with competing resource use constructively (Martin, 2005; Ratner et al., 2017), suggesting that resource conflict is not inevitable even under demographic pressure and resource scarcity. However, the commercialisation and privatisation of resources and state interventions with conservation or developmental aims can have an escalating effect on renewable resource disputes, e.g. by leading to the marginalisation or exclusion of local users (e.g., Azocar et al., 2005; Homewood et al., 2004; Jewitt, 2008). In addition, it is important to consider how political institutions respond to migrants as this likely affects pre-existing power relations and how social groups perceive the threat of resource competition (Barnett & Adger, 2007; Esses et al., 1998).

Collective narratives or identities, that define social groups, their goals and values, and who is to blame for something and why, can essentially influence collective action towards cooperation or competition (e.g., Kaufman, 2006). They play a particular role in natural resource conflicts as the identity of rural livelihoods is often closely connected to the resource base that groups rely on (e.g., Rademacher-Schulz, 2014; Unruh & Abdul-Jalil, 2014). Sometimes identities are instrumentalised by political actors to mobilise their electorate and by social groups to organise their grievances. In this context, the 'othering' of (or delineation from) other groups can pave the way for the use of violence if the 'other' is depicted in negative terms. Ide (2015), for instance, shows based on 20 cases from the Global South that, in

combination with other factors, negative othering plays a key role for the violent escalation of disputes over scarce renewable resources.

Against this background and in the light of qualitative insights gained from case knowledge, I concentrate on four main aspects and their interaction in this study. First, I focus on resource access in each destination area. I here assume that strict access regulations for important local groups can increase resource competition, especially when local livelihoods are highly resource-dependent or regulations are considered unfair. Yet, I assume that lacking restrictions may also motivate rent-seeking behaviour or enhance competition if there is no established (or well-accepted) resource use regime. Thus, I do not have a clear directional expectation regarding this aspect's influence. Second, I assume that large-scale commercial or industrial resource use activities in the area can contribute to resource scarcity (e.g. arable land shortage), increase competition among local users and therewith the likelihood of resource conflict. Third, I account for the national government's reaction and position regarding immigration. I assume that an adverse government position towards migrants, for instance xenophobic stereotypes reproduced in the political arena, can negatively influence the perception of local groups and therewith contribute to conflict risk. Government policies that explicitly favour migrants may cause jealousy and resentment and, thus, also contribute to conflict risk. Accordingly, no directional expectations regarding the influence of this aspect can be formulated. Lastly, I take into account whether migrants are blamed for environmental degradation by other local groups as I expect this form of negative othering to particularly enhance grievances towards migrants and therewith the likelihood of resource conflict.

4.3 QCA procedure and description of global case sample

4.3.1 Qualitative Comparative Analysis (QCA)

QCA is a set-theoretic method designed for the systematic comparison and causal interpretation of a medium number of cases[24] (Ragin, 1987). QCA is chosen for this study because "there are good reasons to believe that the phenomenon to be

[24] Usually defined as somewhere between 10 and 50 cases (Ragin, 2000). Recently, QCA has also been applied to several large-N samples.

explained is the result of a specific kind of causal complexity" (Schneider & Wagemann, 2012, p.77). That is, because any linkages between migration and resource-related conflict is most likely dependent on a complex set of context factors. The method allows the integration of both qualitative and quantitative data and combines some of the strengths of qualitative case-oriented and quantitative variable-oriented approaches. Although QCA has become a well-established tool in the fields of peace and conflict studies and environmental social sciences (see e.g., Bara, 2014; Basedau & Richter, 2014; Bernath, 2016; Bretthauer, 2015; Ide, 2015; Ide et al., 2020), it has not yet been applied to explore resource conflicts in the context of various migration types.

In QCA causal relations are represented as subset or superset relations. A set of cases (in which the outcome Y is present) is a subset (indicating necessity) of condition X, if, whenever Y is present, X is also present. It is a superset (indicating sufficiency) of condition X, if, whenever X is present, Y is also present. Boolean algebra and logical minimisation based on the Quine-McCluskey algorithm serve to reduce empirical complexity. In the course of this process, sufficient and necessary conditions and combinations of conditions that lead to the outcome of interest are identified. The approach is based on three key assumptions: (1) alternative factors can produce the same outcome (i.e. equifinality), (2) some conditions might only reveal their effect in combination with other conditions (i.e. conjunctural causation), (3) combinations of conditions for the occurrence of an outcome can usually not be simply inverted to explain its non-occurrence (i.e. causal asymmetry) (Schneider & Wagemann, 2012).
In QCA terminology, calibration refers to the "process of using empirical information on cases for assigning set memberships to them" (Schneider & Wagemann, 2012, p.32). Essentially, all empirical cases (here studies covering immigration areas) can be either in (=1) or out (=0) of a certain set of cases (e.g., those which experienced conflict). In this study, I apply a crisp-set QCA, i.e. cases are either members or non-members in a set (ibid.). All possible combinations of conditions are displayed in a so-called truth table; each case under study is assigned to one specific truth table row (i.e. one configuration of conditions). Logical remainders refer to rows without empirical evidence. Given that with each condition the number of possible configurations (and therewith logical remainders) grows exponentially, a high number of conditions with a small sample of cases generates problems of limited diversity (Ragin & Sonnett, 2005) and theoretical interpretation (Schneider & Wagemann, 2012), and may lower the confidence in the results (Ide,

2018a; Marx & Dusa, 2011). This problem is not unique to QCA, however. After calibrating the cases, the combinations of conditions (i.e. truth table rows) which are linked to the outcome under study can be minimised to generate the so-called solution term or formula (Ragin, 2009).

The scholarship on QCA emphasises the essentially iterative nature of this approach ('back-and-forth between ideas and evidence') (Schneider & Wagemann, 2012). The choice of conditions to be analysed and their calibration is oriented towards theoretical assumptions but also informed by the in-depth case knowledge of the researcher. Systematic robustness tests which include trial rounds with adjusted set of cases, conditions and different thresholds serve to further increase confidence in the results.

4.3.2 Case selection

I used online search engines and the snowballing technique to identify suitable case studies in peer-reviewed literature. Each case is based on the description in a 'baseline paper' and, depending on the level of information and availability, was complemented by additional academic papers or 'grey literature' on the study area (see Table 4.3). To be selected, case studies had to describe a context where I would expect to observe conflicts surrounding renewable resources and involving local and immigrant groups. As such, all case studies refer to rural areas in the Global South characterised by the arrival of migrants in the past and mostly resource-dependent livelihood systems prone to environmental change. Moreover, the presence or absence of resource conflict in the study area had to be explicit in the baseline paper. Yet, it needs to be stressed that the prevalent conflict bias in the scientific literature made it challenging to identify comparable cases characterised by immigration and the absence of conflict (see also Adams et al., 2018; Bright & Gledhill, 2018). The drivers of migration are often intertwined and hard to reveal for the individual cases, which is why I refrained from focussing exclusively on one specific type of or motive for migration. In total, I selected 11 conflict and 9 non-conflict cases (all post-1945) and, thus, consider different periods of time, a range of cultural and political contexts and several renewable resources (see Figure 4.3, Tables 4.3.1, 4.3.2 and A4.1). Environmental degradation trends are indicated in the literature on all cases except for one and, thus, are considered a common feature of my sample and not included as a condition in my analysis.

Table 4.3.1 Background information and references of selected conflict cases.

Study area location	Time period	Type of migration	Timing of migration	Migration background[25]	Resource degradation trends	Baseline source	Add. sources
Nadowli-Kaleo District, Upper West Region, Ghana	conflict since mid-1970s, in 2016 still ongoing	cross-border	since 1960s/70s, refugees in 1987	droughts, environm. push & pull, conflicts in Ivory Coast	land degradation, increasing pasture scarcity, deforestation	Weesie, 2019	Tonah, 2003
Katiali, Korhogo Region[26], Ivory Coast	conflict since 1970s (peaks in 1974, 1980/81, 1986)	cross-border	since 1950s, esp. 1960s and early 1970s	droughts	environm. degradation	Bassett, 1988	Tonah, 2003
Tui Province, Hauts-Bassins Region, Burkina Faso	conflict mainly in 1980s & 1990s	internal	since 1930s, esp. 1970s & 1980s	droughts, population pressure, econ. push & pull	land degradation	Gray, 2002	Gray, 1999
Narok County, Kenya	conflict in 1990s, settled in 2002	internal	since early 20th century	demogr. pressure, environm. push & pull	NA	Adano et al., 2012	Fratkin, 1994; Kronenburg García, 2017

[25] Whilst acknowledging the complex and interlinked nature of migration drivers, I used a simple categorisation here to aggregate the wealth of available information: economic (e.g., job opportunities, poverty, land availability), social (e.g., networks, marriage), environmental (e.g., resource quality/availability, rainfall regime); push = at migrants' area of origin, pull = study area (i.e. destination).

[26] these are borders of the 1980s – today: Katiali, M'Bengué Department, Poro Region, Savanes District, Ivory Coast

Study area location	Time period	Type of migration	Timing of migration	Migration background[25]	Resource degradation trends	Baseline source	Add. sources
Kibondo & Kigoma Districts, Tanzania	conflicts in 1990s	cross-border	mainly 1993-1998	refugees from DRC, Rwanda & Burundi	deforestation, water resource depletion, soil erosion, loss of wild animal habitat	Whitaker, 2002b	Berry, 2008; Whitaker, 2002a
Usangu Plains, Mbarali District, Tanzania	conflict mainly 1970s-1990s, ongoing in mid-2000s	NA	since late 1950s, mainly 1970s/80s	econ. pull	water scarcity in rivers	Kajembe et al., 2003	
Indio-Maíz Reserve, Rio San Juan Department, Nicaragua	conflict since 1990s (peak in 1998)	internal	since 1990s	econ. pull, resettlement, returning refugees & IDPs	deforestation, poor soil quality	Nygren, 2004	
Yaxhá, Petén Department, Guatemala	conflict since 1991	internal	since 1960s, return of IDPs after 1986	econ. push & pull, environm. push, returning refugees & IDPs	deforestation, land degradation, water scarcity, loss of biodiversity	Clark, 2000	Elías et al., 1997; Shriar, 2001; Ybarra, 2009

Study area location	Time period	Type of migration	Timing of migration	Migration background[25]	Resource degradation trends	Baseline source	Add. sources
Galápagos Islands, Ecuador	conflict since 1990s (peaks in 1995 & 2000)	internal	since 1980s/90s	environm. push, econ. & social pull	overfishing	Bremner & Perez, 2002	Hearn, 2008
Nawalparasi District, Terai Region, Nepal	conflict since late 1990s, in 2016 still ongoing	internal	since 1950s/60s	gov. resettlement (political & environm. motives)	deforestation, degradation of soils and water sources	Ojha et al., 2018	Lama, 2017; Paudel et al., 2018; Satyal Pravat & Humphreys, 2013; Sharma et al., 2014; Sinha, 2011
Chomthong & Mae Chaem Districts, Chiang Mai Province, Thailand	conflict since 1980-84, particularly in 1980s & 1990s	cross-border	at least since 1930s	opium cultivation (political refugees?[27])	pressure on land, forest, water resources, deforestation, water scarcity & pollution	Hares, 2009	Laungaramsri, 2000

[27] Laungaramsri (2000) mentions that the Hmong were perceived as fleeing from war and harassment from neighbouring countries, even though their immigration dates back to the early 20th century.

Table 4.3.2 Background information and references of selected non-conflict cases.

Study area location	Time period	Type of migration	Timing of migration	Migration background[28]	Resource degradation trends	Baseline source	Add. sources
Sissili Province, Centre-Ouest Region, Burkina Faso	fieldwork in 2008	mostly internal	since 1970s, esp. in 1980s	droughts, environm. & econ. push, unrest in Ivory Coast	declining forest & woodlands	Ouedraogo et al., 2009	Howorth & O'Keefe, 1999
Nkoranza South District, Brong Ahafo Region, Ghana	fieldwork in 2014	internal	since 1960s, esp. in 1980s	econ. & environm. pull	NA	Sward, 2017	Awumbila et al., 2015; van der Geest, 2011
Wenchi Municipal District, Brong Ahafo Region, Ghana	fieldwork in 2014	internal	since 1960s	econ. & environm. pull	soil degradation	Sward 2017	Awumbila et al., 2015; van der Geest, 2011

[28] Whilst acknowledging the complex and interlinked nature of migration drivers, I used a simple categorisation here to aggregate the wealth of available information: economic (e.g., job opportunities, poverty, land availability), social (e.g., networks, marriage), environmental (e.g., resource quality/availability, rainfall regime); push = at migrants' area of origin, pull = study area (i.e. destination).

Study area location	Time period	Type of migration	Timing of migration	Migration background[28]	Resource degradation trends	Baseline source	Add. sources
Masindi District, Bunyoro, Uganda	fieldwork in 2007 & 2008	cross-border and internal	labour immigr. since 1950s, refugee influx since 1960s (peak 1994-97), migration towards forest since 1998	econ. & social push, refugees (IDPs, DRC, Sudan)	deforestation	Zommers & Macdonald, 2012	Mwavu & Witkowski, 2008
Kibale National Park, Toro Kingdom, Uganda	fieldwork in 2009	internal	resettlement in 1950s, several waves 1950s-1990s	gov. resettlement (demogr. & land pressure), econ. & environm. pull	declining soil fertility, forest conversion	Hartter et al., 2015	Hartter & Goldman, 2011
Metema, Amhara Region, Ethiopia	focus on 1990s-2010	internal	immigr. mainly since 1980s (coinciding with major resettlements)	gov. resettlement (drought, famine, partly forced), econ. & environm. pull	deforestation, land degradation, water logging	Lemenih et al., 2014	Belay, 2004
Yerer & Daketa Valleys, Somali Region, Ethiopia	focus on 1985-2005	internal	immigration in 1980s/90s	droughts, environm. pull	pressure on grazing land	Bogale & Korf, 2007	

Study area location	Time period	Type of migration	Timing of migration	Migration background[28]	Resource degradation trends	Baseline source	Add. sources
Minahasa District, North Sulawesi, Indonesia	fieldwork in 1999 & 2001	internal	since 1950s, refugees in 1990s	econ. and social pull, IDPs	(perceived) declining fish catches	Cassels et al., 2005	Kramer et al., 2002
Uxin Ju, Inner Mongolia Autonomous Region, China	coopera-tion esp. since 1980s	cross-border/ internal (shifting borders)	since 1800s, recent waves 1950s/60s, 1996	drought, social unrest, econ. and environm. push & pull, political factors	pasture degradation, declining groundwater level	Jiang, 2004	

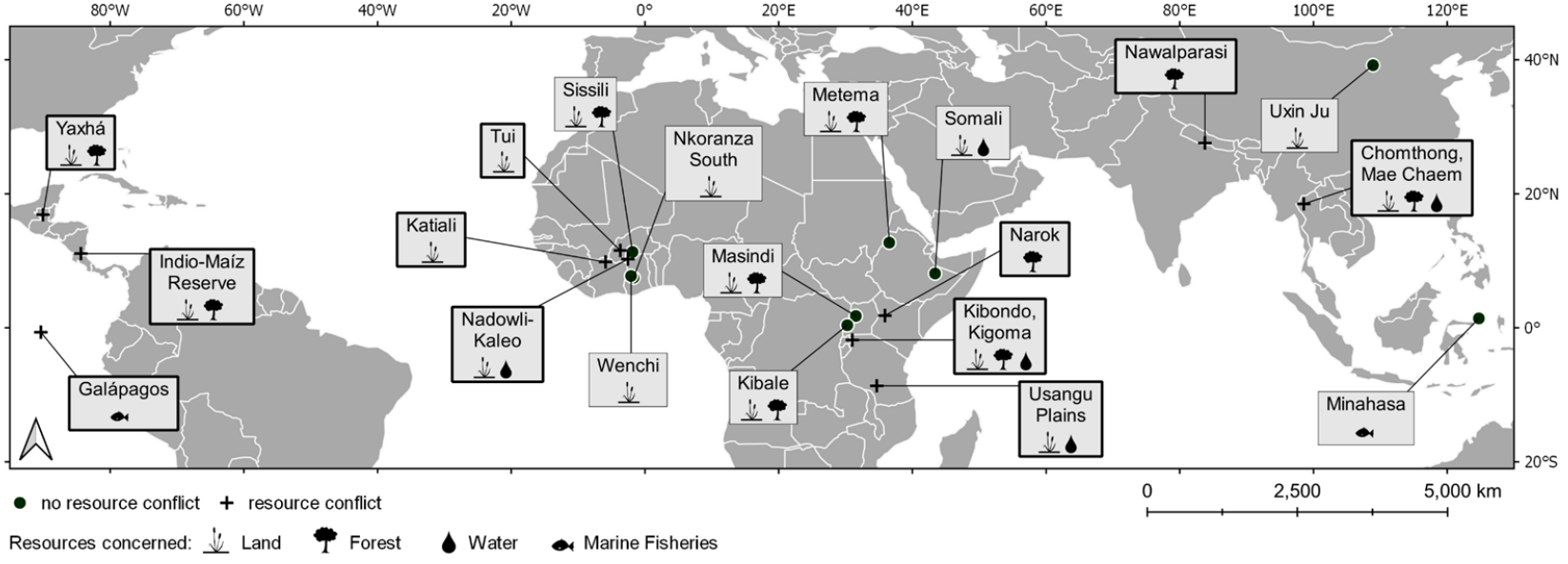

Figure 4.3 Sample of cases under study and type of renewable resource(s) concerned. Conflict cases are highlighted in bold.

4.3.3 Data collection and calibration

The conditions integrated in my main analysis are literature-based, meaning that I draw from the wealth of information provided in the baseline papers and complementary sources. I and a research assistant independently assessed the qualitative data at hand in order to capture all relevant information and minimise the risk of misinterpretation. Additionally, the case study authors and regional experts were contacted to cross-validate the text-based coded information, therewith also filling remaining information gaps and reducing uncertainties. In line with good practices in QCA (Marx & Dusa, 2011) and to avoid issues related to models with too many variables (Achen, 2005), I initially used four conditions for the main analysis which are described in the following. Seven additional conditions (including those based on external quantitative data) are used during robustness tests (see Chapter 6.4).

- *Resource use restrictions (restrict):* A case is calibrated as member of the set (i.e. 1) if significant formal resource use restrictions exist for important local groups in the study area (e.g., due to a protected area and regulated buffer zone). If formal restrictions for these groups are only marginal (e.g., under customary land tenure or a de facto open access situation due to lacking enforcement), a case is calibrated as being out of the set (i.e. 0).
- *Type of resource use (use):* If commercial or industrial resource use activities take place in the study area and significantly restrict resource access or use by local inhabitants (e.g., large-scale agriculture, industrial fisheries or logging), then a case is considered a member of the set (i.e. 1). If resource use is predominantly subsistence-based and/or small-scale, a case is considered out of the set (i.e. 0).
- *Government attitude towards migrant group (govern):* A case is considered member of the set (i.e. 1) if the attitude of the destination area's national government was adverse or suspicious with respect to immigration and/or action was taken to reduce immigration or to discriminate against migrants (e.g., in terms of land allocation). If the national government's position was largely liberal, welcoming or even encouraging (e.g., sponsored resettlement or financial incentives), a case is considered out of the set (i.e. 0).
- *Blaming of the migrant group (blame):* A case is considered member of the set (i.e. 1) if the migrant group is blamed for unsustainable resource use and causing

resource degradation by important local groups in the study area[29]. If this is not the case, a case is calibrated as out of the set (i.e. 0).

4.4 QCA results on contexts conducive to violent resource conflicts

In line with Ragin (2009), my first step is to test whether there is any necessary condition for the occurrence of resource conflict. It is good practice in QCA to acknowledge only those conditions as necessary that have a consistency value of at least 0.9, indicating a high degree to which the respective condition contributes to the outcome across all cases (Schneider & Wagemann, 2012). None of the four conditions presented above (nor the seven conditions used for the robustness tests) passes this threshold. Of the conditions used in the main analysis, blaming of the migrant group has the highest consistency value (0.73). Hence, I reveal no conditions that are necessary for the occurrence of resource conflict.

Table 4.4 Parsimonious solution for the resource conflict outcome.

Causal pathway	*blame * ~use*	*~govern * restrict * use*
Consistency	1	1
Raw coverage[30]	0.36	0.36
Unique coverage[31]	0.36	0.36
Cases covered	*Katiali; Tui; Nadowli-Kaleo; Kibondo, Kigoma*	*Indio-Maíz Reserve; Yaxhá; Usangu Plains; Galápagos*
Cases not covered	*Chomthong, Mae Chaem; Nawalparasi; Narok*	
Solution formula	*blame * ~use + ~govern * restrict * use → conflict*	
Solution consistency[32]	1	
Solution coverage[33]	0.73	

* = and; + = or; ~ = absence of; → = sufficient for

[29] The emphasis here is on the perception of local groups, independent of whether resource use in the area is actually sustainable or not.

[30] Raw coverage: Expresses the degree to which the outcome is covered by a specific causal pathway.

[31] Unique coverage: Expresses the degree to which a specific causal pathway uniquely explains the outcome.

[32] Solution consistency: Indicates the degree to which the empirical information supports the claim that sufficiency exists.

[33] Solution coverage: Indicates the degree to which the outcome under study is explained by the solution term.

The truth table which forms the basis of my QCA is shown in the Appendix (Table A4.2). In this study, only truth table rows with a consistency threshold of 1 (i.e. configurations of conditions that are present exclusively in conflict cases) are included in the logical minimisation process. The parsimonious solution (displayed in Table 4.4) has the highest consistency value possible (indicating a high degree to which the empirical data correspond to the postulated subset relation). It can explain 73% of my sample, i.e. eight out of eleven resource conflict cases (see solution coverage), and is absent in all nine cases without resource conflicts.

Following the argument of Duşa (2019), I also compute the intermediate solution. This extends the first solution term to *blame * ~use + (~restrict + govern)*. This extension does not prove robust in further tests and is hence not discussed here. A set of 20 systematic robustness tests (documented in detail in the Appendix) show that the parsimonious solution term is in a subset or superset relation with all of the robustness test solutions and can, thus, be considered consistent and robust.

The QCA findings reveal two equally relevant pathways. Firstly, the combination of blaming of the migrant group and predominantly small-scale or subsistence-based resource use (*blame * ~use*) explain the occurrence of resource conflict (in immigration areas) in four of the eleven cases. Interestingly, in all these cases, migrant-host relations were described as initially amicable or even mutually beneficial. However, over time these relations degenerated into tensions and competition in the context of a growing population and perceived resource degradation for which migrant groups became the major scapegoat (*blame*). In addition, these cases are characterised by a high resource dependence of local livelihoods (*~use*). Two of the West African cases (*Nadowli-Kaleo* and *Katiali*) describe typical farmer-herder conflicts, in which the blaming of migrants is superimposed by xenophobic stereotypes towards the migrant Fulani. The fact that in *Katiali* crop damage remained uncompensated most of the times and hugely impacted farmers' yearly income illustrates how such accusations can become particularly contentious under high resource dependence. Furthermore, envy (of the migrants' rich livestock herds, higher yields, or financial state support due to national livestock policy) seems to have been an important motivating factor for the blaming of migrants in the cases of *Nadowli-Kaleo*, *Tui* and *Katiali*.

The second pathway identifies the simultaneous presence of a supportive (or indifferent[34]) government attitude towards the migrant group, significant formal resource use restrictions, and commercial or industrial resource use activities (*~govern * restrict * use*) as a quasi-sufficient condition for resource conflicts. In the cases of the *Indio-Maíz Reserve*, *Yaxhá* and *Usangu Plains* national government policy favoured (at least parts of the) migrant groups. This was evident in regards to resource access and distribution (*~govern*), and thereby enhanced local tensions. In the two cases from Central America the return of civil war refugees and IDPs coincided with an increasing number of colonists. Against this background, the governments promised large landholdings to demobilised military personnel contributing to conflicting land claims. At the same time, subsistence users felt disadvantaged by conservation policies (*restrict*) and faced competition by, for instance, wealthy cattle owners, tourism, industrial logging and petroleum extraction (*use*). Similarly, in the *Usangu Plains* case (Tanzania) the promotion of paddy cultivation and an irrigation scheme by the government incentivised immigration by farmers (*~govern*), farmland expansion and agricultural intensification (*use*). Moreover, the establishment of a game reserve had displaced pastoralists from their dry season feed resources (*restrict*). This jointly contributed to shrinking livestock areas, reduced water access, and, ultimately, local farmer-herder conflicts.

4.5 Discussion of QCA results and associated limitations

4.5.1 Unexplained cases

Three of the conflict cases (*Chomthong, Mae Chem; Nawalparasi; Narok*) are not explained by the two causal pathways and deserve detailed discussion. A major difference between the cases of *Chomthong, Mae Chem* (Thailand) and *Masindi* (Uganda), which shares the same configuration of conditions as the Thai case but did not witness resource conflict, is the level of social capital. This aspect has not been considered in this QCA. Whereas social relations are shaped by ethnic discrimination and marginalisation in *Chomthong, Mae Chaem*, exemplifying a high level of negative othering, the study population of *Masindi* is characterised by

[34] In the *Galápagos* case the government position concerning migration cannot be considered supporting, but at that time rather indifferent. It was only in 1998 that restrictions on migration from the mainland to the islands were introduced due to environmental concerns.

peaceful co-existence and a high level of acquaintance – despite its cultural diversity and forest loss attributed to migrants. This confirms claims by Curran and Agardy (2002), Ratner et al. (2013), Tubi and Feitelson (2016) and Bukari et al. (2018) regarding the importance of social relations for resource-sharing and conflict outcomes. Another possible explanation might be that the upland minorities in the Thai case (regarded as migrants) appear to be much more resource-dependent than at least parts of the migrant group in *Masindi* where forced migrants more often engage in wage labour. This was not accounted for in the conditions as in both cases large-scale resource use activities take place in the area, as well.

The *Nawalparasi* case (Nepal) resembles the two cases from Central America (*Indio-Maíz Reserve* and *Yaxhá*) in the sense that strategic political motives played a role for settling certain groups in the study region and allocating resource access. In a context of high livelihood dependence on renewable resources, the establishment of community forestry that favoured proximate users (i.e. migrants) whereas distant users were excluded and felt deprived of their traditional use rights, which in effect triggered intense conflict in *Nawalparasi*. This is a major difference to the *Kibale* case (Uganda), which – although sharing the same configuration of conditions as *Nawalparasi* – is characterised by a relatively high acceptance of the National Park in the study area[35] and did not experience conflict.

Narok, the third unexplained case (Kenya), is the only sub-ethnic conflict (between two Maasai groups) in my sample. Tensions between these two groups originate, according to the literature, from before the colonial period. Moreover, in *Narok* clan struggles have been merging with local political power struggles, which were not taken into account in my conditions on national government attitude, ethnic exclusion or political institutions.

4.5.2 Reflection of key results

Different facets of negative othering are described in eight of the eleven conflict cases and confirm my assumptions on its escalating effect on resource-related tensions, in particular in contexts of high resource dependence (*~use*). This manifested itself most notably in the form of ethnic tensions and xenophobia, especially when there had

[35] This is related to the fact that the forest reserve, which had preceded the national park, had already existed before and current residents are mostly migrants or descendants of migrants without ancestral land claims; they were also not victims of expulsion from the park when it was established.

been few previous relations between ethnic groups (*Narok; Nawalparasi; Mae Chem, Chomthong; Tui; Katiali; Nadowli-Kaleo*). In three of these cases, tensions are closely linked to distinct resource use practices by migrant and host communities (*Mae Chem, Chomthong; Nadowli-Kaleo; Tui*). These observations correspond to Obioha (2008) who found that most of the examined violent land conflicts in North-eastern Nigeria against the background of population drift are inter-ethnic, especially between herdsmen and sedentary farmers. The above described case of *Mae Chem, Chomthong* (Thailand) further illustrates the powerful impact of negative othering at different scales when ethnic stereotypes that associate migrants inter alia with destructive environmental behaviour (in this case framed as the 'hill tribe problem') are reinforced at the national political level (*govern*).

Despite this, the cases of *Sissili* (Burkina Faso) and *Uxin Ju* (China) demonstrate that different resource use practices of migrants and hosts with distinct ethnicities can also be a source of mutual learning and benefit if not paralleled by negative othering. Moreover, the peaceful case of *Masindi* (Uganda) suggests that social capital can compensate for potential grievances resulting from resource degradation associated with immigration. It also needs to be highlighted here that, despite careful interpretation and cross-validation, I cannot completely rule out the risk of reverse causalities regarding negative othering in a few cases, i.e. that negative othering did not chronologically precede the conflict but went hand in hand with it. Although a considerable body of literature on ethnic relations and conflicts exists, the dynamics of blame attribution in the context of migration, resource use and conflict – which evolved as a common theme in my sample – are generally not well explored yet.

Besides negative othering, it is worth emphasising that in all but one of the conflict cases government action played a fundamental role influencing migrant-host relations and contributing to tensions at the local level: resettling groups and granting resource access due to political motives (*Nawalparasi; Indio-Maíz Reserve; Yaxhá*), providing incentives for migrants due to economic motives (*Usangu Plains; Katiali*), discouraging settlement or even disadvantaging migrant groups (*Nadowli-Kaelo; Mae Chem, Chomthong; Kibondo, Kigoma;* later also *Gálapagos*), reforming land tenure (*Tui; Usangu Plains*). This confirms my initial assumption that both an adverse and a supporting government position (*~govern* and *govern*) have the potential to accelerate conflict and, more importantly, illustrates the diverse ways in which politics – sometimes acting in the background – are also reflected in my conditions

on resource use and access (*use* and *restrict*). This is in line with Seter et al. (2018) who claim that at the onset of a resource-related dispute state policies altering resource control, use or access are decisive. Similar patterns can be found in studies concerning resource management and conflicts in other geographical contexts (e.g., Benjaminsen et al., 2009; Benjaminsen & Ba, 2009). Political and economic interests that induce central governments to support migration are also addressed by Fearon and Laitin (2011) with a focus on post-1945 "sons-of-the-soil" conflicts[36]. In sum, these key findings refute deterministic narratives of migration-conflict links and corroborate the relevance of social and political context factors as suggested by the political ecology community.

4.5.3 Methodological challenges of the meta-study

I observed a substantial sampling and publication bias in the academic literature on the topic (with a focus on countries that experience conflict, are convenient to access, etc.) (see also Adams et al., 2018; Seter et al., 2018). Consequently, cases from East and West Africa figure most prominent, whereas other regions are less well represented. Furthermore, identifying an adequate counterpart for the conflict cases proved to be a major challenge for this study. Non-conflict cases were carefully selected but still not perfect as the absence of conflict was mostly not the research focus of the respective paper. It was particularly difficult to identify cases of environmental cooperation in immigration areas.

The conditions regarding the quality of political institutions, ethnic exclusion, educational attainment and child mortality are common variables in QCA studies on conflict outcomes and based on well-established external data sets. However, in contrast to my expectations, they played a minor role in combination with my conditions in this analysis (see robustness tests). One reason could be that – considering the localised nature of the conflicts under study – these data are too aggregate (spatially and temporally) to reflect the complex situation on the ground in terms of power structures, ethnic tensions and socio-economic inequalities. This

[36] This term refers to conflicts between members of a minority ethnic group concentrated in certain region, that consider themselves indigenous and the area to be their ancestral (or at least long-standing) home, and relatively recent migrants from a distinct ethnic group and other parts of the same country. According to Fearon & Laitin (2011), this applies to nearly a third of post-1945 ethnic civil wars.

is most evident for the condition of ethnic exclusion as more than half of the conflict cases had an ethnic dimension[37].

Lastly, the aggregation of data for a cross-case comparison at the global level inherently comes with certain trade-offs in terms of nuance. I am aware that the highly complex situation in each of the cases under study cannot be depicted in its entirety in a binary calibration. Despite this, by contacting authors and experts for cross-validation and by testing the robustness of my calibration decisions I did my best to tailor my interpretation of the cases to their respective contexts, and received a higher degree of comparative insights and generalisability (compared to small-N studies) in exchange.

4.6 Interim Conclusion

In light of heated political and academic debate and inconclusive evidence supporting the nexus between migration, resource use and conflict, this chapter investigated why certain immigration areas in the Global South experience resource conflicts while there is peaceful co-existence or even environmental cooperation between migrant and local groups in others. I identified two sets of context factors conducive to resource conflicts in destination areas: (1) high reliance on natural resources and negative othering of migrants regarding resource use, and (2) government policies supporting parts of the migrant group coupled with limited resource use possibilities due to conservation efforts or industrial activities.

This is the first systematic cross-case comparison that assesses the occurrence of resource conflicts in the broader context of immigration in different parts of the world and periods of time whilst considering factor interactions at various scales. My findings essentially challenge deterministic and one-sided narratives of migration, resource scarcity and conflict, and highlight the complex and multi-scalar contexts driving resource competition in receiving areas. By underlining the importance of power structures in terms of resource access and distribution as well as the key role of politics in shaping these, I endorse the tenor of the political ecology scholarship. Although migration can contribute to resource struggles in rural

[37] Despite this, ethnic tensions could not be added as a text-based condition though due to a potential endogeneity problem. This aspect was expected to be covered, at least partly, by the 'ethnic exclusion' condition used in the robustness tests (see Appendix).

destination areas, government interests and actions are critical for mitigating or accelerating these. Moreover, negative othering of migrants, often reflecting grievances related to the distribution of benefits or low social capital between migrants and hosts, or, again, hinting at strategic political motives, turned out to be a common theme in the conflict cases assessed. I conclude that in future research on the topic – above all when intended to guide policy-making – careful attention must be paid to how government actions impact local power relations in rural areas, and to how negative othering of migrants can be counteracted. Beyond this, a more profound understanding of favourable contexts for environmental cooperation between migrant and local groups is clearly required to support constructive political action.

5. General Discussion and Outlook

5.1 Key findings and contributions of the thesis

Different spatial and temporal scales of environmental change, migration and conflict processes as well as the multiscale interaction of influencing factors constitute a major challenge for research and policy-making alike (see also Eklund et al., 2016). In this dissertation, I considered various levels of analysis (individual, household, regional), geographical regions and time periods in order to contribute to a larger picture on these interrelated topics based on available data.

In **Chapter 2**, I suggested a new conceptual framework that, for the first time, connects nature's contributions to people (NCP) with migration need, ability and aspiration. This serves to disentangle the complex links between the environment and migration decisions in an illustrative way, therewith deepening our understanding of why different types of mobility and immobility evolve under environmental change. Besides that, the added value of this framework lies in the explicit consideration of important (yet often ignored) cultural and subjective aspects, such as place attachment and the perception of personal capacities or risks. The qualitative literature-based analysis mostly revealed links between declining or lacking material and regulating NCP and increasing migration need, above all reflected in impacts on agricultural income, water and food provision, and health issues. Therefore, I hypothesised that decreasing material and regulating NCP reduce the scope for individual migration decisions, i.e. enhance the risk of both involuntary mobility and immobility. The links between NCP and migration aspirations are less clear-cut due to the varying directional influences on risk perception, self-efficacy and place attachment and scarce evidence in the literature. Accordingly, I identified migration aspirations as key priority for future research as this knowledge is decisive for devising policy measures that empower vulnerable population groups and support self-determined adaptation and migration decisions. By elucidating the range of non-environmental mediating factors, such as landownership, available infrastructure and gender norms, I also emphasised the crucial role of underlying inequalities in shaping people's migration need, ability and aspiration in contexts of environmental change.

In **Chapter 3**, I described the first systematic synthesis of household adaptation and coping behaviour in arid and semi-arid lands south of the Sahara with a focus on the relative significance of migration. This meta-study combines the wealth of qualitative and quantitative information covering 16 countries and more than 9,700 rural households, including farmer and herder populations. Based on these data, I illustrated the diverse range of strategies employed by households to react to different types of environmental change. The findings reveal that agricultural strategies, such as changes in cultivation practices, are clearly the most common in the region under study, meaning that most of the households adapt in-situ rather than migrating elsewhere. Different types of migration were reported by about 23% of households. This clearly shows that – in contrast to common simplistic assumptions in public discourse – migration is not the first strategy rural dwellers turn to when facing environmental stress. Besides, approximately 17% of households claimed to not have adopted any response strategy, which demonstrates that fundamental adaptation barriers remain. In addition, the risk perception of locals, which is a prerequisite for adaptation behaviour, may differ from externally measured data. A fundamental question that remained open in this chapter regards the long-term impact of adaptation strategies and especially migration on the respective actors and the social-ecological system in general.

In **Chapter 4**, I presented the first comparative cross-case analysis on this topic that considers various types of migration backgrounds, including internal displacement, government resettlement and environment-related movement, as well as factor interactions at different scales. The rich information base of this chapter consists of purposefully selected academic and grey literature, external quantitative data and feedback from regional experts. The QCA results revealed two distinct pathways conducive to resource conflict involving migrant groups in receiving areas. Firstly, a high dependence of livelihoods on natural resources coupled with the negative othering of migrants regarding resource use, exemplified amongst others by two cases of farmer-herder conflicts from West Africa. Secondly, government policies benefiting parts of the migrant group combined with restricted resource use possibilities as well as conservation or industrial activities in the area, illustrated for instance in the two Central American cases. These findings, above all, underline the relevance of social and political mediating factors for the violent escalation of resource-related frictions. Drawing from the rich contextual qualitative insights, I uncovered the crucial role of governments in shaping migrant-host dynamics at the

local level, therewith fuelling a climate of either resource competition or cooperation. Moreover, I discussed manifestations of negative othering associated with resource use, which often mirror inter-ethnic tensions and prejudices due to differences in resource use practices between communities.

Put together, the results of this dissertation essentially refute deterministic and alarmist assumptions of environmental change inevitably causing migration and of immigration necessarily culminating in resource conflicts at destinations. Instead, they show how these processes are decisively shaped by underlying structural inequalities and power relations that make people vulnerable in the first place and stir up grievances between stakeholders. Whether a person migrates or not depends on a range of environmental and non-environmental factors at various scales, including other available adaptation options that may involve in-situ measures. As demonstrated in Chapter 2 and 3, migration is not necessarily the preferred strategy to deal with environmental change nor accessible to everyone. In Sub-Saharan drylands in-situ strategies related to agricultural and soil and water management are far more common among rural households than different types of migration. Environmental change, in Chapter 2 depicted as decreasing or lacking NCP, can impact migration need, ability and aspiration in multiple ways. Hereby, people's perception of their environment and associated risks as well as their own capacities play a key role, which makes migration aspirations particularly difficult to grasp. Socio-cultural factors, including those related to local environments as captured in the notion of place attachment, are often decisive when people wish to stay put despite deteriorating living conditions. Beyond that, immigration and resource competition involving violent conflict are not an automatism in themselves, even in areas characterised by highly resource-dependent livelihoods and a degrading resource base as examined in Chapter 4. Whether migrant receiving areas experience resource conflicts or not depends on questions of resource access and distribution, which are in part negotiated at the national level, and local perceptions thereof. This is strongly influenced by government interests and actions and the level of social capital between migrant and host populations.

5.2 Limitations and opportunities of literature-based synthesis

A major advantage of meta-studies based on case study literature is the possibility to draw from the wealth of detailed local-level and context-specific information (see

also Steinberg, 2015). Nonetheless, as argued by others before (e.g., Card, 2012; Davis, et al. 2014; Magliocca et al., 2018) and exemplified in this dissertation, this kind of research endeavour involves certain hurdles and limitations. First and foremost, the scope of literature-based synthesis is dependent on the extent, level and quality of information provided by other researchers. In addition, if only scientific peer-reviewed literature is used this comes with a certain level of publication bias. This may result in the focus on certain countries or regions (e.g., East and West Africa in Chapter 2 and 4) and the overrepresentation of certain population groups (e.g., in Chapter 3 sedentary farmers and male household heads) (see also Adams et al., 2018; Hendrix, 2017; Piguet et al., 2018). Secondly, even if narrowly defined eligibility criteria are applied to select case studies, the aggregation and comparison of literature-based data remains a challenge. In this dissertation, this was especially due to inconsistent data reporting, diverging levels of detail, lacking definitions of concepts and methods used and lacking clarity of causal linkages between context factors. In the field of environment-related migration it is also the diversity of definitions and methods that complicates the integration of research findings (see also Borderon et al., 2019).

Besides communicating research limitations transparently, I dealt with the above listed challenges in various ways. In Chapter 2, I formulated a set of recommendations for case studies to facilitate the transfer of local case knowledge to other scales and enhance the comparability of empirical data. Similar suggestions have been made in other disciplines, for example by Gerstner et al. (2017). In Chapter 4, I addressed uncertainties and filled remaining data gaps by adding grey literature and contacting numerous authors and regional experts to request feedback; this worked well but is time-intensive. Moreover, I complemented the literature-based data with additional external data sources for the comparative analysis. Eventually, these quantitative external data play a subordinate role in the final main analysis in Chapter 4, but figure in the robustness tests which are an integral part of QCA. Possible explanations for this are that the selected data are too aggregate in terms of temporal and geographical scale to account for local-level dynamics and that other factors were more decisive for the occurrence of conflicts (see Chapter 4.5). Combining different data sources seems promising as a way to compensate for the limitations of literature-based synthesis when the respective external data are available with an adequate resolution and can thus be connected well with the individual cases from the literature. This could facilitate, for instance, the cross-case

comparison of migration behaviour or resource-related tensions considering different climatic and socio-economic contexts across regions.

The potential of literature-based synthesis for transferring knowledge across scales in this research field certainly goes beyond the scope of what has been explored in this dissertation. A further area of application could be the support of simulation model development, in particular agent-based models (ABM). ABMs are regarded as useful to analyse environment-migration linkages and potential future trajectories at different spatial scales (Kniveton et al., 2011; Neumann & Hilderink, 2015; Thober et al., 2018). According to Magliocca et al. (2015b), meta-studies are best suited to assist the conceptualisation and experimentation stages in the model development process. Information that literature-based meta-studies could provide for ABMs on environment-related migration include for instance migrant attributes or indicators of migration need, ability and aspiration as determinants of agent behaviour. The potential benefit of such synergies could be enhanced if meta-studies are specifically devised for the support of model development (ibid.).

5.3 Geographical focus

In terms of geographical focus, in this dissertation priority is given to rural areas in the Global South, in particular countries south of the Sahara. In these areas large parts of the population heavily rely on natural resource-based activities, especially rainfed agriculture, which implies a high sensitivity to changes in temperature and precipitation (Serdeczny et al., 2017). Accordingly, agriculture is considered a major channel of environmental impact on livelihoods and migration outcomes in rural areas of the Global South (Cattaneo & Peri, 2016; Falco et al., 2019; Nawrotzki & Bakhtsiyarava, 2017). Additional structural factors, such as lacking infrastructure or endemic poverty in many African countries, hamper adaptation processes and contribute to a high social-ecological vulnerability (Boko et al., 2007). Therefore, these areas are expected to be particularly illustrative of environment-migration linkages and prone to resource competition under increasing demographic pressure. This is inter alia reflected in the Groundswell Report (Rigaud et al., 2018), which projects more internal climate migrants in Sub-Saharan Africa by 2050 than in South Asia and Latin America together. Besides, Bangladesh, one of the two focal regions of Chapter 2, is one of the countries with the highest number of disaster-related internal displacements worldwide in 2019 (IDMC, 2020).

Nonetheless, increased research efforts focussing on other parts of the world are obviously needed to address challenges associated with environmental change and migration. This concerns regions such as Central Asia, Northern Africa or South America which also face severe environmental risks (e.g., Cruz et al., 2007; Magrin et al., 2007) but have thus far received much less attention in this research field in terms of case studies (Piguet et al., 2018). Furthermore, this also generally applies to urban areas, especially in middle-income countries, which are frequent destinations of rural migrants and expanding quickly (e.g., Adger et al., 2015, 2020; Barrios et al., 2006; Foresight, 2011). Many of these are considered highly fragile and major yet often neglected sites of global environmental change impacts in the upcoming decades (Black et al., 2011a; Parnell & Walawege, 2011; Serdeczny et al., 2017).

5.4 Prospects for future research

Subjective and non-material aspects, including risk perception and place attachment, evolved as a key theme in this dissertation as they are decisive for how people respond to environmental changes, including whether and how they migrate or not. Nevertheless, these aspects are still comparatively understudied. Socio-cultural and psychological factors, that may motivate or hinder human action, have traditionally received much less attention than economic, technological or biophysical factors in the literature on adaptation and migration (e.g., Adams & Adger, 2013; Ayeb-Karlsson et al., 2019; Shackleton et al., 2015). As stated in Chapter 2 and 3, local perceptions of environmental change and associated risks may differ from measured climate data for various reasons (Deressa et al., 2011; Kosmowski et al., 2016; Mertz et al., 2009). Consequently, various scholars argue that this kind of information is indispensable as a complement to conventional climate and demographic data, which are typically used in studies on environment-related migration (e.g., de Longueville et al., 2020; Dessai et al., 2004; Parsons & Nielsen, 2020). The same applies to people's perceptions of their individual scope of action, i.e. their perceived capacity to adapt in-situ and to migrate (Grothmann & Patt, 2005; Jones & Tanner, 2017). Moreover, as outlined in Chapter 2, place attachment and related concepts are considered crucial in the context of risk perception, adaptation and migration (e.g., Adams, 2016; Quinn et al., 2018). Yet, it is not clear how place attachment is affected by environmental change and how this, in turn, potentially alters migration patterns (Dandy et al., 2019).

Despite recent advances in research on migration aspirations and immobility (e.g., Adger et al., 2021; Aslany et al., 2021; de Haas, 2021; Mallick et al., 2020; van Praag, 2021), more knowledge on socio-cultural and psychological factors is needed to enhance our understanding of environment-related mobility and immobility processes (Mallick & Schanze, 2020). Here, the conceptual framework proposed in Chapter 2 could make an important contribution. In particular, the context-specific perspective of NCP, which explicitly accounts for knowledge systems other than economic or natural science (see Díaz et al., 2018), could guide future empirical work to target the research gaps on non-material NCP and environmental influences on migration aspirations mediated by cultural identities.

In this dissertation, the important role of context factors at different scales in mediating environment-migration links came up repeatedly. When taking a closer look, most of these factors reflect pre-existing inequalities that are the root causes of people's vulnerability and generate varying degrees of migration need and ability. A prime example at the meso- and micro-level, also addressed in Chapter 2, is gender. A range of studies show how social norms can increase the marginalisation of women and have an immobilising effect at the same time in situations of environmental stress (e.g., Ayeb-Karlsson, 2020; Evertsen & van der Geest, 2020; Mersha & van Laerhoven, 2016). In line with this, I suggest that future empirical research in this field should also move beyond the household level, which has traditionally been the analytical focus of case studies, as mirrored in the literature sample assessed in Chapter 2 and 3. A fine-grained perspective on inequalities and resulting vulnerabilities, which is needed to understand environment-migration dynamics, requires an intersectional approach accounting for intra-household variations in addition to relevant household-level data (see also Sakdapolrak et al., 2016; Tebboth et al., 2019).

Furthermore, such a perspective could contribute to answering the key question of under which conditions migration becomes a sustainable adaptation strategy. What likely makes the difference here and determines the impact of migration on households is the level of agency in the migration decision (Tebboth et al., 2019; McLeman et al., 2021). A low level of agency, in Chapter 2 associated with high migration need and low migration ability, implies fewer possibilities to choose a favourable migration destination and get well established there. As a result, people may be compelled to move to areas, which face their own risks, such as sea-level rise

or water insecurity (Foresight, 2011; Parnell & Walawege, 2011). These risks potentially reinforce migrants' vulnerability, including poverty traps, and, again, the threat of both involuntary mobility and immobility (e.g., Ayeb-Karlsson et al., 2020; Jacobson et al., 2019). This is corroborated by de Sherbinin et al. (2012) who indicate positive net-migration in hazard-prone areas. Furthermore, this is reflected in a recent case study by Adger et al. (2020), which describes how environmental hazards evolve as an increasing source of insecurity for Bangladeshi migrant populations in cities over time.

I propose that a constructive debate on migration as adaptation requires more generic knowledge on the impacts of different mobility types on the social-ecological systems in sending, transit and receiving areas. Due to an emphasis on sending areas in research on environment-migration links, the latter two have often been neglected (see also Gemenne & Blocher, 2017). A system-wide and translocal perspective, as suggested by e.g. Sakdapolrak et al. (2016), could be a more holistic approach and help address this gap. In addition, research should focus on how policies can be devised to generally increase the agency of marginalised population groups affected by environmental change to enable self-determined migration decisions and maximise the beneficial potential of mobility – in short, on how to effectively promote 'mobility justice'[38] (Sheller, 2018).

As illustrated in Chapter 4, natural resource conflicts are among the myriad of challenges potentially awaiting migrants at rural destinations and likely to be particularly detrimental when escalating into violence as in the conflict cases assessed. Brzoska and Fröhlich (2016) assume three types of receiving regions to be particularly prone to conflict in connection with immigration processes: regions with extreme resource scarcity (i.e. absolute resource scarcity relative to population density and available external assistance), regions with pre-existing high levels of conflict over interests or identity, and regions with exclusive identities (i.e. host communities unwilling to accept others). The third type resonates with the findings of Chapter 4 that revealed how the negative othering of migrants contributes to local conflicts over renewable resources, especially when local livelihoods are highly

[38] Mobility justice can be understood as a multiscale "overarching concept for thinking about how power and inequality inform the governance and control of movement, shaping the patterns of unequal mobility and immobility in the circulation of people, resources, and information" (Sheller, 2018, pp.30). It implies the view that people displaced by climate change should be entitled to relocate to other countries, especially in those that bear the greatest responsibility for climate change.

resource-dependent. Literature discussing the perception of migrants as 'exceptional resource degraders'[39] (e.g., Codjoe & Bilsborrow, 2011; Kibreab, 1997) and the complex role of ethno-religious identities and claims to indigeneity in conflicts (e.g., Bara, 2014; Côté & Mitchell, 2017; Fearon & Laitin, 2011; Tonah, 2003) exists in different research strands. Despite this, unravelling the dynamics of blame attribution associated with identities and resource use practices in destination areas requires further investigation.

Importantly, conflict and environmental degradation can become mutually reinforcing factors, which again restrict the scope for action by increasing migration need while reducing people's migration ability. As a result, the risk of forced mobility and immobility grows as well as the likelihood of vulnerable population groups moving within or to conflict-prone regions due to a lack of choice (see also Bank et al., 2017; Raleigh, 2011). This is exemplified by a case of pastoralists at the Horn of Africa who during the 2000 drought were hindered from moving to water sources by ongoing regional conflict, which exacerbated the drought impacts (Simpkin, 2005). Besides, evidence corroborates the relevance of instability, conflict and violence as drivers of migration and asylum applications (e.g., Abel et al., 2019; Conte & Migali, 2019; Mallick, 2019; Seven, 2020). For instance, a case study from rural Benin reveals that one-third of all interviewed migrants cited conflicts with landowners among the motives for moving once more (Doevenspeck, 2011).

Following from the above, I argue that in situations of low levels of agency there is the risk of a vicious migration-conflict cycle, which is likely to be intensified by global environmental change. Consequently, enhanced knowledge is needed on the conditions that foster peaceful co-existence and environmental cooperation in migrant hosting areas in different world regions – an issue that has received little attention thus far. A better understanding of interacting variables, including social capital between migrants and hosts, which influence how resource conflicts are perceived and acted upon locally, would help develop well-targeted and preventive policy measures (Martin, 2005). A translocal approach, as mentioned above, could be of great use here by combining insights from both out- and in-migration areas. In line with claims by Côté and Mitchell (2017), Mitchell and Pizzi (2020), and Turner

[39] A number of scholars suggested that migrants are 'exceptional resource degraders', e.g. because they lack familiarity with the local environment or the incentive to preserve resources for future generations and, thus, may use unsustainable resource practices. However, this thesis is highly controversial and has been rejected by others for various reasons (see e.g., Codjoe & Bilsborrow, 2011).

(2004), amongst others, I advocate close attention to the influence of governments in this context, which decisively shape resource access of local stakeholder groups. QCA, which proved a valuable tool for comparative analysis here, could make an essential contribution in future synthesis studies on these aspects at the meso- or macro-scale. However, in light of the conflict bias in academic literature as mentioned before, this will be possible only if the existing evidence base is extended by local case studies focussing on peaceful and cooperative outcomes rather than conflict (see also Tubi & Feitelson, 2016). A recent study by Bukari et al. (2018) that explores everyday peaceful cooperation between Fulani herders and farmers in Ghana provides a useful starting point in this regard.

5.5 Final Conclusions

This dissertation has contributed to a generic understanding of the environment-migration nexus by transferring available knowledge, above all from detailed case study literature, to the regional and global scale. I specifically focussed on environmental influences on individuals' migration decision, the role of migration as adaptation strategy and the contexts that are conducive to resource conflict in destination areas. My findings illustrate how mediating factors, especially related to structural inequalities and power relations, play a critical role in all of these sub-topics and dynamically (inter)act at various scales. This reflects the complexity of this research field and explains why assumptions of linear causal relations between environmental change, migration and resource conflict are inaccurate.

Decisive political efforts at all levels are clearly needed to reduce migration needs and simultaneously increase migration abilities of marginalised population groups to empower them to take self-determined migration decisions and maximise the adaptive potential of migration. This implies, for instance, further assistance of in-situ adaptation for those desiring to stay, but also amplifying legal migration corridors to facilitate voluntary, safe and dignified movement in the face of environmental change (see also Cattaneo et al., 2019). Furthermore, regional policy-makers should aim to facilitate peaceful co-existence and resource-sharing in rural areas receiving migrants while being careful not to play different groups off against each other. As rightly stated by Boas et al. (2019) in respect of climate-induced migration, "[w]hether or not such mobility becomes a political or humanitarian problem depends on the policy choices by home, host and transit states and involved

organizations, not on the mobility itself" (p.902). In this regard, the UN Global Compact for Safe, Orderly and Regular Migration (agreed upon in 2018 but not yet legally binding) gives reason for hope as it could be a major advancement in the legal protection of international migrants reacting to climatic hazards – if implemented resolutely by the signatory states (see also McLeman, 2019). In any case, it is up to us, the research community, to actively contribute to more differentiated migration narratives in the public imagination and a political environment, especially in Europe and North America, which embraces migration as an opportunity and legitimate claim, not a threat.

6. Appendices

Appendix of Chapter 2

Table A2. Definitions and operationalisations of framework elements.

Framework element	Definition/ operationalization
Material NCP	"substances, objects, or other material elements from nature that directly sustain people's physical existence and material assets" (Díaz et al., 2018, p.271) - Energy - Food and feed - Material, companionship and labour - Medicinal, biochemical and genetic resources - Maintenance of options
Regulating NCP	"functional and structural aspects of organisms and ecosystems that modify environmental conditions experienced by people and/or regulate the generation of material and non-material contributions" (Díaz et al., 2018, p.271) - Habitat creation and maintenance - Pollination and dispersal of seeds and other propagules - Regulation of air quality - Regulation of climate - Regulation of ocean acidification - Regulation of freshwater quantity, location and timing - Regulation of freshwater and coastal water quality - Formation, protection and decontamination of soils and sediments - Regulation of hazards and extreme events - Regulation of detrimental organisms and biological processes - Maintenance of options
Non-material NCP	"nature's effects on subjective and psychological aspects underpinning people's quality of life, both individually and collectively" (Díaz et al., 2018, p.271) - Learning and inspiration

	- Physical and psychological experiences - Supporting identities - Maintenance of options
Migration need	Resulting from a person's vulnerability (composed of risk exposure, sensitivity and adaptive capacity (Adger, 2006))
Migration ability	A person's capacity to leave based on individual characteristics and resources
Migration aspirations	A person's motivation to leave based on risk perception, self-efficacy and place attachment
Indicators	Specific factors that allow conclusions on migration need, ability or aspiration and can be directly linked with NCP, e.g. health status, agricultural income, food and drinking water availability
Moderators	Specific factors that mediate the relationship between NCP and migration need, ability and aspiration but are not directly linked to NCP, e.g. gender roles, humanitarian aid, social networks

Appendix of Chapter 3

Table A3. Characterisation of the reviewed studies.

Reference	Focus of the study	Conceptual framework	Empirical data collection
Padonou et al., 2014	Perceived causes and consequences of bowalization and coping strategies	-	Semi-structured household interviews (random sampling)
Oyerinde et al., 2015	Adaptation mechanisms to CC, consistency of perceived and observed hydro-climatic trends	-	Household survey (random sampling)
Dah-gbeto & Villamor, 2016	Gender-specific coping/ adaptation strategies and perceptions of CV	Anticipatory learning	Household survey (stratified random sampling) and experimental gaming exercise
Motsholapheko et al., 2011	Household access to capital, impacts of extreme flooding on livelihoods, coping and long-term adaptive strategies	Sustainable livelihood framework, socio-ecological	Household survey (random sampling), key informant/ expert interviews, FGD
Motsholapheko et al., 2012	Impacts of desiccation on livelihoods, adaptation strategies, influence of institutional changes on households' adaptive capacity	Sustainable livelihood framework, socio-ecological	Household survey (random sampling), key informant interviews, FGD
Barbier et al., 2009	Farmers' vulnerability to CV and adaptation strategies	Vulnerability	Household survey (random sampling), FGD
Zampaligré et al., 2014	Perceptions of CCV and coping and adaptation strategies	-	Semi-structured household interviews, FGD (random sampling), incl. other

Reference	Focus of the study	Conceptual framework	Empirical data collection
			PRA tools, key informant interviews, climate data
Okpara et al., 2016	Lake drying and livelihood dynamics (incl. response strategies)	Livelihoods and household well-being	Household survey and semi-structured household interviews (combination of different sampling types), FGD, expert interviews
Gebrehiwot & van der Veen, 2013	Perceptions of CC, adaptation strategies, determinants of strategy choice, adaptation barriers	-	Household survey (multi-stage and random sampling), climate data
Haile et al., 2013	Flood impacts, flood coping and adaptation strategies and their effectiveness for avoiding loss and damage	-	Household survey (random sampling), key informant interviews, focus groups
Ariti et al., 2015	Perceived and observed LULC changes, their drivers and impacts, adaptation strategies, factors affecting adaptation	-	Semi-structured household interviews, expert interviews, field observation, remote sensing data
Berhanu & Beyene, 2015	CC adaptation strategies, their determinants and implied economic impacts	-	Household survey (random sampling), key informant interviews, FGD, participant observation
Feleke et al., 2016	CC adaptation strategies, determinants of strategy choice	-	Semi-structured household interviews (purposive and random sampling), expert interviews, FGD
Mersha & van Laerhoven, 2016	Gender-specific CC and drought adaptation strategies and barriers	Sustainable livelihood approach	Semi-structured household interviews (snowball sampling), FGD, expert

Reference	Focus of the study	Conceptual framework	Empirical data collection
			interviews, participant observation, informal discussions, non-structured interviews
Ng'ang'a et al., 2016	CC adaptation strategies, links between migration and adoption of other strategies	-	Household survey (random sampling), FGD
Tesfaye & Seifu, 2016	Perceived CC and its effects and adaptation strategies, factors influencing strategy choice	-	Semi-structured household interviews (multi-stage sampling)
Yaffa, 2013	Drought impacts and coping strategies, effectiveness of strategies for avoiding loss and damage	-	Household survey (random sampling), FGD, expert interviews
Antwi-Agyei et al., 2014	CV adaptation strategies	-	Household survey (stratified random sampling), key informant interviews, FGD, other participatory tools
Dumenu & Obeng, 2016	Social vulnerability to CC, CC impacts, adaptation strategies	Social vulnerability to CC	Household survey (stratified random sampling), semi-structured household interviews, FGD
Limantol et al., 2016	Perceived and observed CCV, adaptation strategies	-	Household survey, climate data
Tambo, 2016	Climate resilience, CCV adaptation strategies, determinants of strategy choice	Climate resilience	Household survey (stratified random sampling)

Reference	Focus of the study	Conceptual framework	Empirical data collection
Smucker & Wisner, 2008	Drought coping strategies and livelihood change (longitudinal study)	-	Household survey (random stratified sampling), expert interviews, FGD, participant observations, participatory workshops
Silvestri et al., 2012	Perceptions of CC, CC adaptation strategies, adaptation barriers	-	Semi-structured household interviews
Opiyo et al., 2015	Drought characteristics, drought adaptation and coping strategies, constraints to adaptations	-	Semi-structured household interviews (systematic and purposive sampling), key informant interviews, FGD, informal interviews, rainfall data
Sanogo et al., 2017	Perceptions of CC, its drivers and impacts on ES delivery of parklands, factors explaining perception, CC adaptation/coping strategies	-	Household survey (stratified random sampling)
Hooli, 2016	Flood coping strategies, role of IK in resilience building	Socio-ecological resilience, indigenous knowledge (IK)	Household survey (random sampling), expert interviews, FGD
McKune & Silva, 2013	Interactions between and consequences of environmental and economic stressors, coping strategies	Double exposure framework	Household survey (random sampling), expert interviews, FGD, participant observation
Snorek et al., 2014	Adaptation strategies, divergent adaptation of different resource users	Divergent adaptation	Semi-structured household interviews (random sampling), expert interviews, FGD, PRA tools

Reference	Focus of the study	Conceptual framework	Empirical data collection
Chianu et al., 2004	Farmers' agricultural performance and resource pressures, coping strategies, evaluation of strategies	-	Household survey (two-stage random sampling)
Tambo & Abdoulaye, 2013	Perceptions of CC and adaptation strategies	-	Household survey, FGD
Yila & Resurreccion, 2014	Drought adaptation strategies, factors influencing farmers' vulnerability and adaptive capacity	Gender-differentiated vulnerability, drought vulnerability	Household survey (purposive and random sampling), key informant interviews, FGD
Mertz et al., 2009	Perceptions of CC, coping and adaptation strategies	-	Semi-structured household interviews (random sampling), key informant interviews, FGD
Gbetibouo et al., 2010	Perceptions of CCV, adaptation strategies, adaptation barriers	-	Household survey
Osbahr et al., 2010	CCV coping and adaptation strategies, evaluation of strategies	Response space	Semi-structured household interviews, FGD
Rankoana, 2016	Perceptions of CC, adaptation strategies	-	Household survey (purposive sampling)
Pauline et al., 2017	Biophysical context, impacts on farmers, coping and adaptation strategies, barriers and enablers of adaptation	-	Household survey (random sampling), expert interviews, FGD
Bola et al., 2014	Perceptions and impacts of droughts and floods, coping strategies	-	Household survey, key informant interviews, FGD, rainfall data

Reference	Focus of the study	Conceptual framework	Empirical data collection
Jiri et al., 2017	CCV adaptation strategies, evaluation of strategies for increasing resilience and adaptive capacity	Vulnerability to resilience model	Household survey (random sampling), key informant interviews, FGD
Mertz et al., 2012	Perceptions of CCV and impacts on natural resources, adaptation strategies	-	Household survey, FGD

FGD (focus group discussions); PRA (participatory rural appraisal); CC (climate change); CV (climate variability); CCV (climate change and variability); LULC (land use and land cover); IK (indigenous knowledge

6.3 Supplementary methods

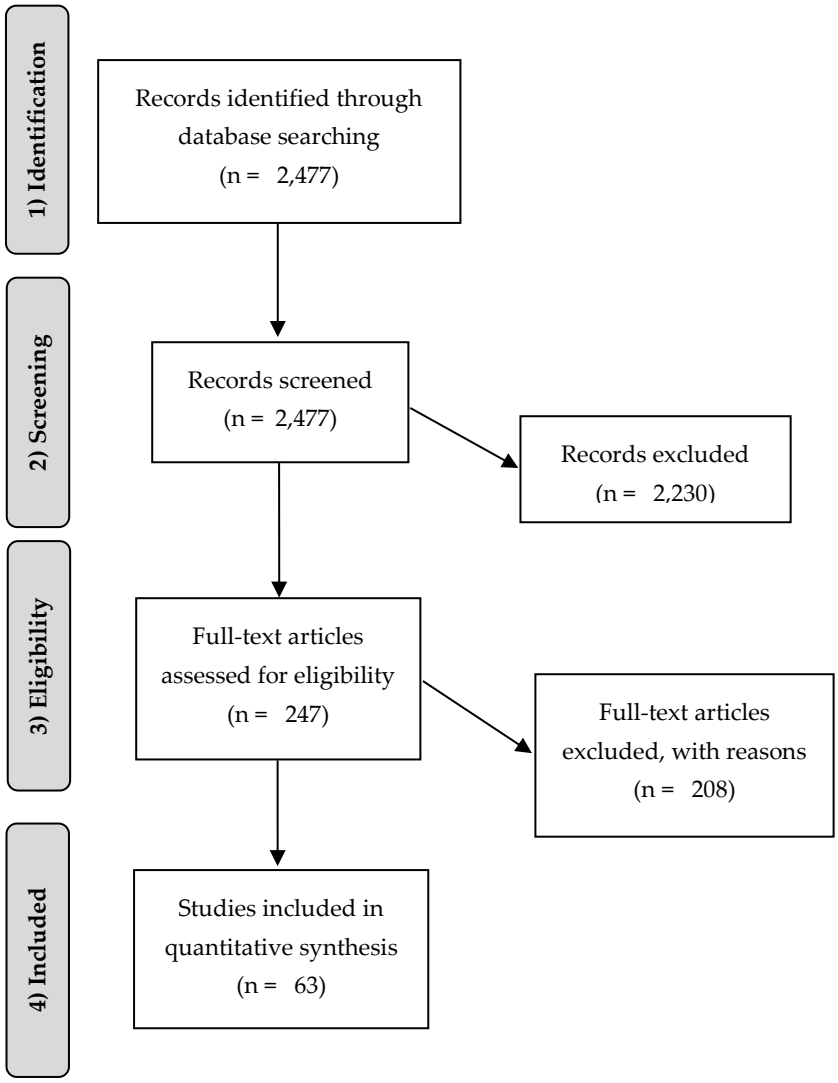

Figure A3. Systematic literature search procedure (PRISMA Statement, adapted from: Moher et al., 2009).

1) The search term used in Web of Science to identify topic-related papers included all country and population names of SSA, the terms 'adapt' and 'cope', and a range of environmental change processes and associated weather events known to be relevant in SSA drylands (see complete search term below). The use of wildcards in the search term provided for the inclusion of all possible endings. Additionally, Web of Science categories were used to exclude irrelevant papers from unrelated disciplines.
2) Publication titles, keywords and abstracts were screened to filter potentially relevant papers. For a study to be considered relevant it has to be published in English and contain primary household-level data from local case studies located in predominantly rural and arid or semi-arid lands in SSA were considered. The study population has to be characterised by subsistence livelihoods or small-scale agriculture. Information has to be provided on various coping or adaptation strategies that are being or have been adopted by households, including quantitative information on the adoption rate. Some type of environmental change process has to be specified in the paper (literal interpretation of text-based information). 2,230 records were excluded at this stage because they did not meet one or several of these eligibility criteria (see also 'Data and Methods' section).
3) At this stage, the remaining selection of publications was assessed in more detail (i.e. full text) for eligibility. 208 records were excluded as they did not meet one or several of the eligibility criteria.
4) Studies were included in the quantitative synthesis and analysed in depth if they met all of the eligibility criteria.

Database search term:

((((((((((TS=((Sub-Sahara OR "Sub-Saharan Africa*" OR Angola* OR Benin* OR Botswana* OR Motswana OR Batswana OR Burkina* OR Burundi* OR Cameroon* OR "Cape Verd*" OR "Cabo Verd*" OR "Central African Republic" OR Chad* OR Comor* OR Congo* OR "Cote dIvoire" OR "Ivory Coast" OR Ivorian* OR "Democratic Republic of the Congo" OR Djibouti OR "Equatorial Guinea*" OR Equatoguinean* OR Eritrea* OR Ethiopia* OR Gabon* OR Gambia* OR Ghana* OR Guinea* OR Guinea-Bissau* OR Kenya* OR Lesotho OR Mesotho OR Basotho OR Mauritania* OR Mauriti* OR Liberia* OR Madagascar OR Malagasy OR Malawi* OR

Mali* OR Mozambi* OR Namibia* OR Niger* OR Nigeria* OR Rwanda* OR Sao Tome* and Principe OR Senegal* OR Seychell* OR "Sierra Leone*" OR Somali* OR "South Africa*" OR Sudan* OR Swazi* OR Tanzania* OR Togo* OR Uganda* OR Zambia* OR Zimbabwe*) AND ("environment* chang*" OR "climat* chang*" OR "ecological chang*" OR "land degrad*" OR "soil degrad*" OR "soil erosion" OR "resource* degrad*" OR "environment* degrad*" OR "rainfall variab*" OR "climat* variab*" OR "precipitation chang*" OR "temperature* chang*" OR "drought*" OR "desertification" OR "flood*" OR "environmental stress*") AND (adapt* OR cop*) NOT (*biotic OR cell* OR molecul* OR photovoltaic OR photosynthe* OR pathogen* OR AMF OR genotype* OR "plant invasion*" OR "reef coral*" OR "coral reef*" OR bioapatite OR cichlid* OR "bird migration" OR "carbon sequestration" OR hydrogeochemical OR Pliocene OR "marine ecosystem*" OR "tree recruitment" OR levallois OR "fynbos biome*" OR "Afromontane taxa" OR "invasive alien tree*" OR Paleolithic OR Pleistocene OR "urban metabolism" OR lepidoptera))))))))))))) *AND* **LANGUAGE:** (English) *AND* **DOCUMENT TYPES:** (Article)
Refined by: [excluding] **WEB OF SCIENCE CATEGORIES:**
(ENGINEERING CHEMICAL
OR GENETICS HEREDITY
OR PHARMACOLOGY PHARMACY
OR MEDICINE GENERAL INTERNAL
OR ORNITHOLOGY
OR ENDOCRINOLOGY METABOLISM
OR BIOTECHNOLOGY APPLIED MICROBIOLOGY
OR TOXICOLOGY
OR PSYCHOLOGY CLINICAL
OR NEUROSCIENCES
OR PARASITOLOGY
OR CHEMISTRY APPLIED
OR CHEMISTRY ANALYTICAL
OR MARINE FRESHWATER BIOLOGY
OR ENTOMOLOGY
OR BIOCHEMICAL RESEARCH METHODS
OR LIMNOLOGY
OR BIOCHEMISTRY MOLECULAR BIOLOGY
OR TROPICAL MEDICINE
OR PSYCHIATRY
OR PHYSIOLOGY
OR NUCLEAR SCIENCE TECHNOLOGY
OR EVOLUTIONARY BIOLOGY
OR OCEANOGRAPHY

OR MICROBIOLOGY
OR INFECTIOUS DISEASES
OR CELL BIOLOGY
OR PALEONTOLOGY)
Timespan: All years. **Indexes:** SCI-EXPANDED, SSCI

Types of information extracted from the reviewed studies:

- Empirical data collection methods (grouped into: structured household survey/ semi-structured household interviews/ focus groups discussions/ expert or key informant interviews/ participant observations/ others)
- Sample size and sampling method
- Study area, coordinates and aridity of the study area (arid/semi-arid/dry sub-humid)
- Annual rainfall and temperature means/ranges
- Ethnic background, age mean and sex ratio of respondents
- Main livelihood activities of the study population (grouped into: farmers/ agro-pastoralists/ pastoralists)
- Environmental change processes reported (grouped into: increasing stress related to temperature/ rainfall amount/ rainfall variability/ droughts/ floods/ wind/ land degradation/ degradation of water bodies)
- Conceptual framework and framing of the household response strategies (coping/adaptation)
- Coping and adaptation strategies (grouped into: crop management/ livestock management/ soil and water management/ income diversification/ food provision/ social networks/ migration/ humanitarian aid/ information/ religious activities/ other activities/ no coping/adaptation)
- Other drivers and barriers reported

Appendix of Chapter 4

Table A4.1 Additional information on conflict cases.

Case	Conflict parties	Use interests at conflict	Conflict outcome
Nawalparasi	immigrants (proximate users) vs. natives (distant users)	conservation, development and commercial interests, subsistence needs (incl. traditional use rights)	conflict sometimes turned into violent fights
Mae Chem, Chomthong	immigrants vs. officials and natives	conservation, agri-businesses, subsistence needs	acts of violence, incl. road blockades and destruction of Buddhist infrastructure, arrest
Indio-Maíz	immigrant farmers vs. conservationists and authorities	conservation and development, agriculture (incl. wealthy cattle owners and smallholders)	violent land invasions, squatting inside the reserve, series of arsons and assassinations mentioned
Yaxhá	immigrant farmers vs. conservationists and authorities	commercial activities (incl. tourism, logging, petroleum extraction, agricultural colonisation), conservation, subsistence needs	threats of land takeovers, military sweeps, organised resistance and kidnappings; *campesinos* i.a. burned a forest guard station, held military and CONAP leaders hostage, kidnapped scientists and torched a scientific station
Galápagos	(immigrant and native) fishermen vs. conservationists and authorities	commercial/ small-scale fisheries, conservation/tourism	national park offices raided/ ransacked on several occasions, Galapagos tortoises taken hostage, violent protests

Case	Conflict parties	Use interests at conflict	Conflict outcome
Nadowli-Kaleo	immigrant herders vs. local farmers	subsistence needs	crop damage, mutual aggression, rape and robbery mentioned, theft and wounding of cows, farmers "aggressively guarding their arms"
Katiali	immigrant herders vs. local farmers	subsistence needs (and gov. interest in meat production)	large-scale violence against humans (> 80 pastoralists killed and many wounded during armed attack by farmers), armed resistance by farmers, cattle theft and slaughter, crop damage, camp burning, openly hostile acts of assault, arson, murder
Tui	immigrant farmers vs. local farmers	subsistence needs	land squatting in one village, evictions, sorcery, great potential for violence
Narok	Loita Maasai vs. Purko Maasai	subsistence needs (incl. traditional use rights), commercial agriculture (and potential gains from conservation, tourism)	eruption of conflict and violent confrontation mentioned, violent protests, on one occasion several people were shot prematurely by the police
Kibondo, Kigoma	refugees vs. locals (and gov. + NGO officials)	conservation and subsistence needs	small-scale violent conflicts (most conflicts non-violent though), harassment of refugees by government officials, increase in crime rates
Usangu Plains	farmers vs. herders (both incl. immigrants)	commercial and subsistence agriculture, subsistence needs, conservation	crop damage, only one case of violence (farmers beaten by herders when denying access to farmland)

Table A4.2 Truth table.

govern	blame	restrict	use	Cases
0	0	0	1	*Minahasa; Nkoranzza South; Wenchi*
0	1	1	1	*Indio-Maíz Reserve; Yaxhá; Usangu Plains*
0	1	0	0	*Katiali; Tui*
0	0	1	0	*Nawalparasi; Kibale*
1	0	0	1	*Narok; Uxin Ju*
1	1	1	1	*Chomthong, Mae Chem; Masindi*
0	0	0	0	*Sissili*
1	0	0	0	*Somali*
1	1	0	0	*Nadowli-Kaleo*
1	1	1	0	*Kibondo, Kigoma*
0	1	0	1	*Metema*
0	0	1	1	*Galápagos*
1	0	1	0	Not covered
0	1	1	0	Not covered
1	1	0	1	Not covered
1	0	1	1	Not covered

6.4 Robustness tests

We run a set of 20 robustness tests (see Table A4.3) for the sufficiency analysis following the key types of tests suggested by the QCA scholarship (Cooper & Glaesser, 2016; Schneider & Wagemann, 2012; Skaaning, 2011): (1) using alternative frequency thresholds, (2) using alternative sets of cases, (3) using alternative causal conditions, (4) using alternative decisions for calibration. In the following, these are described in more detail. Using alternative consistency thresholds, another common type of test, is not deemed reasonable here as the consistency threshold can neither be raised nor lowered to 0.8 (which is the minimum threshold suggested by Schneider and Wagemann (2010).

(1) We apply a different threshold for frequency, therewith excluding all truth table rows which are not covered by at least two empirical cases.

(2) We run separate analyses for our sample excluding all cases from Latin America, and Asia, the two cases concerning marine resources, the cases explicitly framed as environmental cooperation, the only case that exclusively focuses on refugee movement and the case for which we received partly contradictory feedback from two regional experts.

(3) We run eight analyses, in each of them adding one alternative causal condition that is also considered plausible and potentially relevant based on the literature on immigration, resource use and conflicts. Given that QCA does not allow for missing data, the choice of external sources was partly determined by the availability of data on all relevant countries and time spans (thus excluding popular data sets such as ACLED, Polity IV or certain climate data). We also had a preference for regional data over country-level data given the localised nature of the resource conflicts under study. In order to avoid reverse causalities, data from years prior to the conflict (or the fieldwork) are taken (if not available, the closest data available were selected). Regarding the data on political institutions and ethnic exclusion: For conflict cases we focused on 5-year period before conflict onset (see Bara, 2014, flexible 'incubation periods'), for non-conflict cases a broader timespan was considered (20-year period as in Bretthauer, 2014).

- Educational attainment (*educ*) and child mortality (*u5mort*): Both are used as common indicators of human development (see e.g. also Ide et al. 2020); these conditions are based on the information from the Demographic and Health Surveys (DHS) made available by US AID; whenever possible we used regional data to account for interregional differences, otherwise data on 'rural areas'; *u5mort* refers to the under-five mortality rate (probability of dying between birth to exact age 5 (5q0), expressed per 1,000 live births (the 0.5 threshold is set at 100); *educ* is operationalised as the share of the total population with no education (the 0.5 threshold is crossed at 40%)[40]
- Quality of political institutions (*instit*): This condition is based on the Freedom House Index, the index is based on an average ranking of political rights and civil liberties at the national level (scale from 1 (free) to 7 (not free); cases with an index of above 4 are assigned membership (1), cases ranked below 4 are considered out of the set, 0.5 threshold at 4 (in line with Bretthauer, 2014)
- Ethnic exclusion (*ethn*): This condition is based on PRIO/GRID, based on EPR data set (also used e.g. by Bretthauer (2014) and Bara (2014); we

[40] The calibration of cases is usually informed by empirical evidence and theoretical knowledge; however, natural gaps in the data may also be used when empirical or theoretical guidance for setting relevant thresholds is lacking (see e.g. Basedau & Richter, 2014; Ide et al., 2020).

selected nine grid cells in total (the grid cell where the study area is located plus the surrounding grid cells to account of uncertainties and potential spill-over effects at local scale); the 0.5 threshold is crossed if at least one group is excluded per cell (low threshold as even just a single or small excluded ethnic group can make a difference in terms of conflict potential)

- Resource tenure (*tenure*): If resource tenure is insecure for important local groups and/or tenure laws are unclear/ambiguous, a case is considered member of this set (1). If resource tenure laws are relatively clear and tenure insecurity is not a major issue in the study area, a case is calibrated as out of the set (0).
- Refugee movement (*refuge*): If refugees/IDPs or returning refugees/IDPs are a major part of the migrant group, a case is calibrated as member of the set (1). If refugees/IDPs or returning refugees/IDPs are not a major part of the migrant group, a case is calibrated as out of the set (0).
- Environmental migration driver (*environ*): Membership is assigned if a slow- or fast-onset environmental stressor (e.g., drought, land degradation) at the area of origin is indicated as major factor contributing to outmigration (1). If this does not apply, a case is considered out of this set (0).
- Conflict history (*hist*): This condition is based on data made available by the Uppsala Conflict Data Program (UCDP). A case is calibrated as 1, if the study area was directly affected by an armed conflict during the five years prior to conflict onset (or the fieldwork for the non-conflict cases). If this does not apply, a case is calibrated as 0.

(4) In a final set of tests we used different calibration decisions for those cases in which the calibration of one or several conditions was not clear-cut and hence difficult:

- *Uxin Ju* (we received divergent feedback for some of the text-based conditions from the author and a regional expert we contacted)
- *Minahasa* (as indicated by one of the experts, there is a Marine Park near the study area, however it is difficult to judge to what extent the study population is affected by the restrictions; we thus tested both options for *restrict* for this case)

- *Yaxhá* (migrants have been blamed by development and conservation organisations working in the area for deforestation problem and their use of swidden cultivation; however, we cannot be sure whether this view applies to important local groups and tested both options for *blame* this case)
- *Kibondo, Kigoma* (the government position on migration shifted dramatically from an internationally recognised open-door policy towards refugees to restrictive policies after 1994, we thus tested both options for *govern* for this case)
- Weak enforcement (two experts mentioned that, despite formal restrictions in *Mae Chem, Chomthong* and *Yaxhá*, enforcement tends to be rather weak; we thus tested both options for *restrict* for these cases)

The robustness test results are displayed in Table A4.3 below. All of these alternative solutions have a consistency value of 1 and, except for row 2, cover more than 60% of the cases respectively. The main solution formula (*blame*~use + ~govern*restrict*use → conflict*) is in a perfect subset or superset relationship with all 20 solutions and therewith confirmed. It should be noted though that the tests displayed in rows 9-16 cannot be viewed as interpretable results by their own due to methodological issues (low case-to-condition ratio); they merely serve as robustness tests here.

Table A4.3. Documentation of robustness test results.

#	Type	Test	Solution formula	Consistency	Coverage
1	-	Main analysis	*blame*~use + ~govern*restrict*use → conflict*	1	0.73
2	1	Frequency cut-off 2	*~govern*blame*(~use + restrict) → conflict*	1	0.46
3	2	Without Latin American cases	*blame*~use + ~govern*restrict*(use + blame) → conflict*	1	0.63
4	2	Without Asian cases	*blame*~use + ~govern*restrict*use + govern*use*(~restrict + ~blame) → conflict*	1	1
5	2	Without fisheries cases	*blame*~use + ~govern*restrict*(use + blame) → conflict*	1	0.7
6	2	Without cooperation cases	*blame*~use + ~govern*restrict*use + govern*(~restrict + ~blame) → conflict*	1	0.82
7	2	Without refugee case	*blame*~use + ~govern*restrict*use → conflict*	1	0.7
8	2	Without *Uxin Ju* case	*blame*~use + ~govern*restrict*use + govern*use*(~restrict + ~blame) → conflict*	1	0.82
9	3	*+ educ*	*blame*~use + ~blame*restrict*use + restrict*educ + ~govern*restrict*use → conflict*	1	0.82
10	3	*+ u5mort*	*blame*~use + restrict*~u5mort + ~govern*restrict*use → conflict*	1	0.82
11	3	*+ instit*	*blame*~use + restrict*~instit + ~govern*restrict*use → conflict*	1	0.82
12	3	*+ ethn*	*blame*~use + govern*~ethn + ~govern*restrict*use → conflict*	1	0.82
13	3	*+ tenure*	*blame*~use + govern*use*~tenure + ~govern*restrict*use → conflict*	1	0.82
14	3	*+ refuge*	*blame*~use + ~govern*restrict*use → conflict*	1	0.73
15	3	*+ environ*	*blame*~use + ~govern*restrict*(use + ~environ) → conflict*	1	0.82
16	3	*+ hist*	*blame*~use + ~govern*restrict*use → conflict*	1	0.73
17	4	Diff. calibration (*Uxin Ju*)	*blame*~use + ~govern*restrict*use + govern*use*(~restrict + ~blame) → conflict*	1	0.82
18	4	Diff. calibration (*Minahasa*)	*blame*(~use + ~govern*restrict) → conflict*	1	0.64

19	4	Diff. calibration (*Yaxhá*)	*blame*~use + ~govern*restrict*use → conflict*	1	0.73
20	4	Diff. calibration (*Kibondo, Kigoma*)	*blame*~use + ~govern*restrict*use → conflict*	1	0.73
21	4	Diff. calibration (weak enforcement)	*blame*~use + ~govern*restrict*use + govern*blame*~restrict → conflict*	1	0.73

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I declare under penalty of perjury that this thesis is my own work entirely and has been written without any help from other people. I used only the sources mentioned and included all the citations correctly both in word or content.

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