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Deciphering interwoven drivers of environment-related migration – A multisite case study from the Ethiopian highlands

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ABSTRACT

Global environmental change is increasing livelihood pressure for many communities, and agricultural households in the Global South are particularly vulnerable. Extant research has debated whether and to what degree this amplifies migration flows while also acknowledging that migration can be an adaptive strategy. However, little is known about which contextual factors are most relevant and how they interact in shaping environment-related migration. We shed light on this issue by conducting an in-depth qualitative, yet multisite and medium-N study of farming households in the northern Ethiopian highlands. We utilized qualitative comparative analysis (QCA) – a novel approach in the research field – to overcome the existing methodological challenges. We found that the migration experience within the household in combination with either the usage of the longer summer rainy season (Kiremt) or non-farm in situ diversification are sufficient causes for migration. Non-farm income activities and favorable environmental conditions during the Kiremt season increases economic household resources and as such migration ability. However, only together with migrant networks, which can reduce the costs and risks of migration and shape migration aspirations, can these drivers explain why households engage in migration. Our findings reveal that capabilities and networks, rather than commonly cited push factors, are far more important drivers of environment-related migration at the household level. Additionally, we illustrate that while migration is an important adaptation strategy, it cannot be adopted equally among households and as a result often reinforces existing inequalities.

1. Introduction

The changes in the natural environment of the Earth are increasingly being recognized as threats to people, especially for those dependent on natural resources. Rapid or slow-onset hazards, such as tropical storms, shifting rainfall patterns and land degradation, can have an impact on migration patterns (Foresight, 2011). These environment-related migrations can take various forms across scales and times and are likely to become even more urgent in the view of the projected climatic changes and the increasing numbers of people affected (IPCC, 2014, 2018).

Scientifically, major progress has been made in providing empirical evidence and in conceptualizing the relationship between the environment and migration (McLeman, 2013; Hunter, Luna and Norton, 2015; Neumann and Hilderink, 2015). In recent years, the community has moved beyond the monocausal understanding of environment-related migration (e.g., Myers, 2002) towards a more complex and multicausal conceptualization (e.g., Bardsley and Hugo, 2010; Castles, de Haas and Miller, 2015; Cattaneo *et al.*, 2019). The vast number of empirical studies describe migration as a risk diversification strategy that is heavily shaped by social, economic, political, demographic and environmental factors (e.g., Morrissey, 2013; Nawrotzki, Riosmena and Hunter, 2013; Warner and Afifi, 2014). These factors can enable or inhibit migration, are often interrelated, and operate at different scales (de Haas, 2010; Foresight, 2011; Call *et al.*, 2017). Consequently, environmental changes influence migration outcomes through a "*complex web of causal links*" (Mastrorillo *et al.*, 2016, p. 155). This complexity – which is inherent to environment-related

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migration – makes it challenging to draw coherent conclusions on the influence of the interactions between environmental and non-environmental factors on migration (Kniveton *et al.*, 2008; Renaud *et al.*, 2011; Fussell, Hunter and Gray, 2014). Despite this complexity, deciphering these causal interlinkages between environmental change and migration is crucial, for example, for the development of strategies to reduce forced migration and to build local resilience, but also to counter an inept securitization of environment-related migration (Methmann and Oels, 2015, p. 51-68).

One main reason for the difficulty of grasping the complex interactions is the methods that are commonly utilized in empirical studies of environment-migration linkages: mostly, either quantitative large-N or qualitative small-N approaches are applied. Qualitative research designs potentially allow for high explanatory power for factor interactions because they are based on sound knowledge of the local context and thus enable the analyses to tackle complex migration narratives (Borderon et al., 2019). However, they tend to be criticized for lacking replicability and generalizability (e.g., Bilsborrow and Henry, 2012). Quantitative approaches, on the other hand, are promising for obtaining results on the magnitude and direction of migration drivers on larger scales. Nevertheless, quantitative approaches have a restrained ability to deduce causalities from complex realities since case-specific knowledge is typically limited.

Several scholars made attempts to overcome these methodological shortcomings, for instance by integrating survey or census data with Bayesian belief networks (e.g., Drees and Liehr, 2015) or agent-based models (e.g., Kniveton, Smith and Wood, 2011; Hassani-Mahmooei and Parris, 2012) to achieve an increased understanding of complex migration linkages. Further, recent participatory techniques such as mobility mapping were employed to overcome the lack of scaling options in ethnographic studies (e.g., Safra de Campos, Bell and Charles-Edwards, 2017) or to capture short-term migration patterns for large areas by using mobile network data (Lu *et al.*, 2016). Another possible, yet so far under-utilized strategy (but see Haeffner, Baggio and Galvin, 2018) to integrate the benefits of qualitative and quantitative approaches is qualitative comparative analysis (QCA), which allows complex causal links to be traced by using a systematic set-theoretic approach. QCA is especially powerful for detecting the influence of combinations of several factors on a certain phenomenon (Schneider and Wagemann, 2012). Further, it has shown to be a promising tool for deciphering interwoven influencing factors, for instance in the field of environmental security (e.g., Ide, 2015; Kirchherr, Charles and Walton, 2016). QCA holds the potential to improve our understanding of the interactions between migration drivers, which remains as a significant knowledge gap in the field of environment-related migration.

Our study addresses this gap. As a case study, we selected the northern highlands of Ethiopia because the region has high exposure and vulnerability to environmental changes and high out-migration rates (CSA, 2007; Hermans-Neumann, Priess and Herold, 2017). We focus on farming households – which are highly vulnerable towards environmental changes – and aim to decipher the circumstances under which these households engage in migration. We employed a qualitative, multisite approach by integrating data from six kebeles (smallest administrative unit in Ethiopia) and utilized QCA – a novel method in the research field – for data analysis. As such, our approach considers the complex interactions of micro- and mesolevel migration drivers without sacrificing in-depth, case-specific knowledge.

This paper is organized as follows: In the next section, the theoretical context and the used terminology are described (section 2). Afterwards, we sketch the evidence of environment-migration linkages in the study region (section 3). We continue with the method section, in which we introduce our study area and present our approach to data collection and the QCA used for the data analysis (section 4). In the following, we present the results of the QCA (section 5). Afterwards, we interpret our findings based on our in-depth case knowledge and discuss the relations to other relevant studies (section 6). We conclude by embedding our findings in ongoing debates in the research field and with suggestions for future research (section 7).

2. Theoretical context

There exists a plurality of migration theories, which can be assigned to the individual, household, community or macro level and as such, using different lenses to understand migration causes (Hagen-Zanker, 2011). Theories, such as push and pull models (Lee, 1966) or neoclassical micro migration theory (Sjaastad, 1962) mainly focus on individual desires and aspirations, with improving one's well-being as the central migration cause. Theories, such as the dual labor market theory (Rodriguez and Piore, 1981), considers macro-level trends (i.e. labor demands) as determinants for migration. In contrast, the New economics of labor migration (NELM) theory and livelihood approaches chooses the household as the level of analysis and views migration as a household strategy to diversify risks and cooperation (Stark and Bloom, 1985; De Haan, 2000; Etzold and Sakdapolrak, 2016). In the context of environment-related migration, household-level approaches are often applied. Migration is identified as a risk diversification strategy for households (e.g., Findley, 2007; Dillon, Mueller and Salau, 2011; Hunter *et al.*, 2014) or climatic stress is considered as a constraint for the household to engage in migration, since its curtailing household resources (e.g., van der Geest, 2011; Gray and Bilsborrow, 2013; Nawrotzki and Bakhtsiyarava, 2017). Based on this, we have chosen a household perspective to understand migration, acknowledging the high potential of individual and community-level research to complement our findings. In view of the interactions between migration drivers at the household level that we aim to shed light on, our research is inspired by a framework proposed by Black et al. (2011). The framework provides a comprehensive conceptualization of the multiple spatial and temporal dimensions of the direct and indirect drivers (including environmental aspects) of migration. The framework enables us to understand migration as the result of multiple interwoven environmental and non-environmental factors at various levels, which makes it very suitable in the context of this study.

In the remainder of the paper, we use the notions of environmental or non-environmental influence factors for migration when referring to direct or indirect migration drivers according to Black et al. (2011). Furthermore, we specify the directional influence of these factors and use the notion of enabling factors, if these influence factors increase the migration ability of a household (e.g., Carling and Schewel, 2018). This may include intervening facilitators for migration, such as social networks or legal frameworks (Black *et al.*, 2011), and personal and household characteristics, such as financial resources (e.g., Zickgraf, 2018).

3. Environment-related migration in the northern Ethiopian highlands

Sub-Saharan Africa is considered a global hotspot of vulnerability to climatic and environmental stress because of its low adaptive capacity and the population's high reliance on rain-fed agriculture (Serdeczny *et al.*, 2017). Within the region, the northern Ethiopian highlands are especially exposed due to the high levels of variability in precipitation and land degradation (Piontek *et al.*, 2014). Moreover, the northern highlands belong to one of the most food insecure regions in Ethiopia and are a current, as well as a potential future, hotspot for out-migration (Little *et al.*, 2006; Hermans-Neumann, Priess and Herold, 2017; Rigaud *et al.*, 2018). Our study therefore focused on a “critical case” according to the definition of Flyvbjerg (2006, p. 230).

Although the northern highlands of Ethiopia are well represented in the literature on environment-related migration, the evidence on migration drivers, their interactions and their directional influences is relatively inconsistent and remains context-specific. Studies that have

explicitly focused on climatic changes, and especially drought-related studies, have generally concluded that climate shocks increase migration propensity, but highlight that other factors including gender, economic household resources and community vulnerability also strongly mediate and even have the potential to inhibit migration (Ezra and Kiros, 2001; Gray and Mueller, 2012a; Mersha and Van Laerhoven, 2016a; Hermans and Garbe, 2019). For example, Hermans and Garbe (2019) found that drought increased short-term migration, whereas it hampered long-distance migration due to the curtailed household resources. Furthermore, Gray and Mueller (2012a) as well as Mersha and van Laerhoven (2016a) revealed that drought increased the labor-related mobility of men, whereas the marriage-related mobility of women declined due to the limited abilities of households to cover wedding expenses. In contrast, Tegegne and Penker (2016), for instance, showed that favorable agro-ecological conditions, sufficient agricultural production and improved access to markets increased short-term migration. The authors emphasized that such mesolevel migration drivers are crucial for understanding environment-related migration in the region. Other scholars who have studied migration drivers without specifically focusing on environmental stressors such as drought have further identified land holding size, lack of in situ non-farm activities, intravillage conflict, the absence of relief aid, livestock ownership, social networks and information flows as strong drivers for migration (Asfaw, Tolossa and Zeleke, 2010; Wondimagegnhu and Zeleke, 2017). To date, no consensus on the complex set of factors shaping migration decisions in the region has emerged.

However, these results suggest that to understand environmental migration in the northern highlands, we must account for household factors at the microlevel in combination with mesolevel factors such as agro-ecological characteristics. However, the available evidence in this regard is inconsistent, not at least because mesolevel migration drivers are thus far underrepresented in the literature (Borderon et al., 2019). In addition, and similar to empirical studies in other regions of the world, the approaches either stick to qualitative migration narratives or do not have sufficient in-depth case-specific knowledge to explain how all the different influencing factors actually interact and how their interactions may enable or hamper migration. For the northern Ethiopian highlands, this is particularly unfortunate, as the region has an enormous relevance for current and potential future environment-related migration processes.

4. Methods

4.1. Study area

We conducted this study in the South Wollo Zone of the Amhara Regional State in the northern Ethiopian highlands (Figure 1), where significant depletion of natural resources and increasing climate variability have been observed, especially shifts in rainy season durations and water shortages due to declining rainfall amounts (Bewket, 2009; Rosell, 2011; Hermans-Neumann, Priess and Herold, 2017).

The rainfall in South Wollo has a bimodal pattern: precipitation falls during the Belg season between January and May and primarily during the Kiremt season between June and September, with annual precipitation sums significantly varying between years (Figure 2). In our study region, the changing rainfall pattern has been mainly illustrated by a tentatively delayed – and increasingly variable – onset of Belg. The onset of Kiremt has been less variable, yet it has been occurring tentatively earlier than it occurred in the past (Figure 2) and has been increasingly characterized by torrential rainfalls (Rosell, 2011). Periodic droughts have become common in South Wollo.

In addition to rainfall failures, severe land degradation due to both climate change and the mismanagement of land is widespread (Nyssen *et al.*, 2004; Morrissey, 2013; Meshesha *et al.*, 2014). Although land rehabilitation efforts have a long history, the northern highlands have been severely affected by topsoil losses, gully formation and declining soil fertility (Meshesha *et al.*, 2014; Adimassu *et al.*, 2017; Mekuriaw *et al.*, 2018).

The livelihoods of the farmers in South Wollo depends mainly on mixed subsistence, rain-fed and low input agriculture; they keep livestock and grow mainly barley, wheat, teff, maize, pulses and sorghum. Overall, the altitude-dependent low temperatures combined with high precipitation intensity – partly in the form of hail, which potentially destroys the harvest – causes the farmers in the higher elevation regions to refrain from cropping during the Kiremt season. Those Belg-dependent farmers are considered the most vulnerable to the indicated changes in rainfall due to its increasing unpredictability (Rosell and Holmer, 2007).

In densely populated South Wollo (148 persons/km^2 in 2007 (CSA, 2007)), the land has been almost completely distributed and is often only accessible via inheritance; hence, farmers suffer severe land scarcity (CSA, 2007; Bezu and Holden, 2014; Ege, 2017). Land scarcity is expected to increase, given the growing population (annual population growth rate in 2018 was 2.6% (World Bank, 2019). In addition, severe land degradation significantly reduces crop yields and forces farmers to farm marginal lands, which also curtails livelihood security (Hurni *et al.*, 2007). The northern highlands are one of the most food insecure regions in the country and have been dependent on relief aid for many years, even in seasons with adequate rainfall and harvests. South Wollo was one of the most affected zones during the famines in the 1970s, 1980s, 1990s, and most recently in 2015/16 (Little *et al.*, 2006; Joint Government and Humanitarian Partners, 2016). Governance structures are weak, and employment opportunities, especially in the rural areas of the highlands, remain rare (Ayenew, 2002; World Bank, 2005; Little *et al.*, 2006).

Consequently, farmers living in the northern highlands are some of the most vulnerable in the country, and the changing rainfall patterns, increasing land degradation and land scarcity further undermine their natural resource-dependent livelihoods. To address these adverse developments, farmers in the northern highlands apply various strategies, such as livestock and crop management, soil and water management, migration and income diversification (e.g., Meze-Hausken, 2000; Gilligan, Hoddinott and Taffesse, 2009; Gebrehiwot and van der Veen, 2013; Adimassu *et al.*, 2017). Migration, as one of these strategies, occurs across various times and scales (Asfaw, Tolossa and Zeleke, 2010; Gray and Mueller, 2012a; Weldegebriel and Prowse, 2017; Hermans and Garbe, 2019).

4.2. Selection of the research sites

This paper is based on a qualitative case study design and used a purposive sampling approach. During a preparatory visit in April/May 2017, the first and last author interviewed officials in 19 kebeles (smallest administrative unit in Ethiopia) belonging to the four woredas (districts) of Legambo, Dese Zuria, Kutaber and Kalu. We did so to systematically increase heterogeneity regarding the composition of livelihoods, the major risks for these livelihoods (including the role and extent of land degradation and rainfall variability), and the main coping and adaptation strategies (including migration).

Based on the information provided, we purposively selected six out of the 19 kebeles for further study with the aim of increasing heterogeneity in the relevant socioeconomic and ecological variables for which we assumed that they would influence migration. These kebeles are distributed along an agro-ecological gradient ranging from Kola (1200-1600 masl), to Weyna Dega (1600-2600 masl) and Dega (2600-3600 masl), according to two different specifications of land degradation (high and low severity) and two different specifications of remoteness (own market and asphalt road). The six sites are further specified based on the rainy seasons used by the farmers (Table 1). While not drawing a random sample, this approach increases our confidence that our results are not driven by the characteristics of specific sites, but are broadly representative of South Wollo.

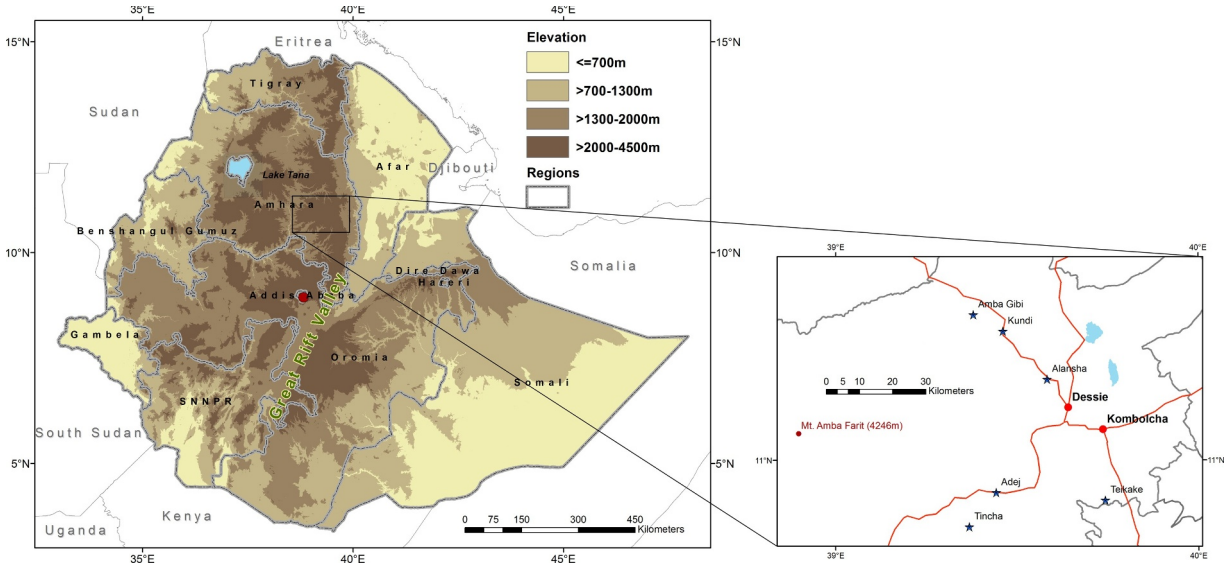

Figure. 1. Left: Location map showing the administrative regions of the country and the research site in South Wollo based on elevation data obtained from the Shuttle Radar Topography Mission (SRTM) at 250-meter resolution (Farr *et al.*, 2007). Right: The map shows the locations of the six studied kebeles, the two major cities of Dessie and Kombolcha and the main roads (red).

4.3. Collection of qualitative data

Between November 2017 and February 2018, the first author conducted in-depth fieldwork by spending eight to nine days in each kebele. The data collection was conducted in Amharic (the local language) with the aid of a local assistant who received training prior to the fieldwork. The identification of appropriate respondents was supported by local extension workers and, similar to the selection of the six research sites followed, a purposive sampling approach. To assure the ability to recall the last decade, respondents had to be at least 30 years old.

We started our data collection with three mixed-sex focus group sessions (each with five to seven participants) in each kebele; the first was held with kebele officials (e.g., kebele administrations head, local extension workers, and religious leaders), the second with heads of migrant households or their spouses, and the third with heads of non-migrant households or their spouses. In each focus group session, we

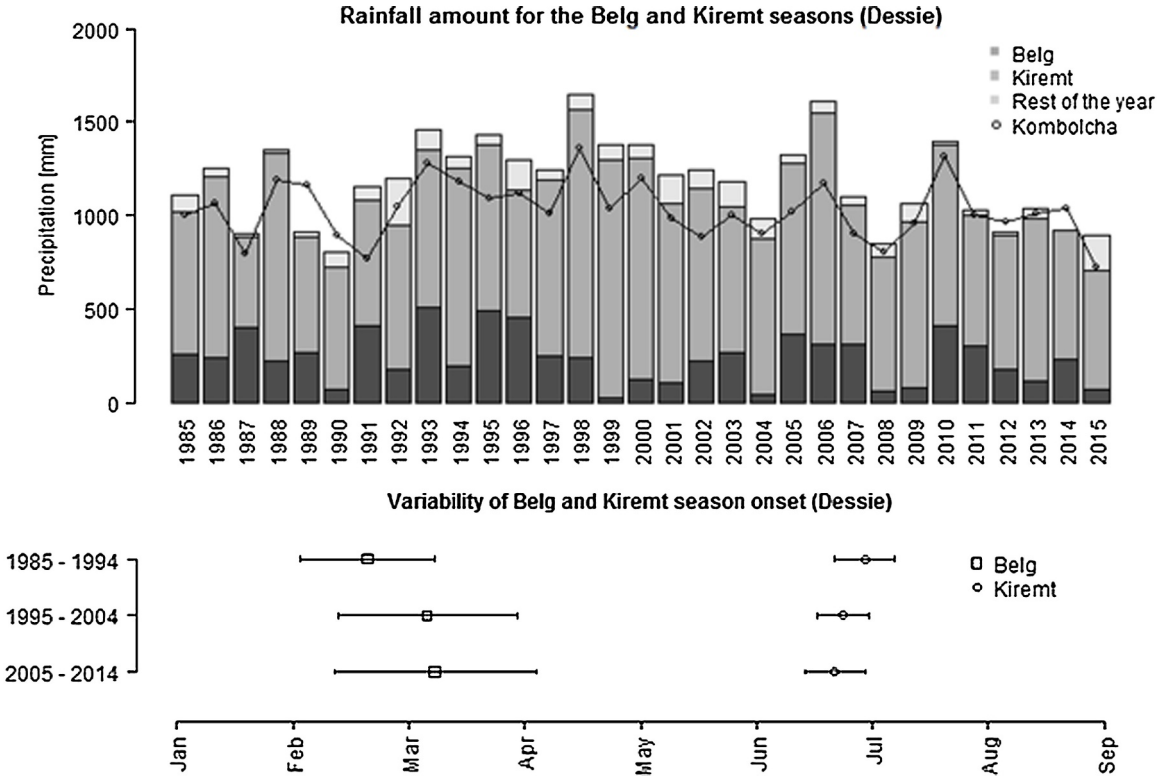

Figure. 2. Upper panel: Annual precipitation for the Belg and Kiremt seasons between 1985 and 2015 for Dessie (2470 masl) and the total annual precipitation for Kombolcha (1842 masl) between 1985 and 2015. Lower panel: Mean onset and variability of onset (expressed in standard deviation) of Belg and Kiremt season for the decades 1985-1994, 1995-2004, and 2005-2014 in Dessie. Daily precipitation data were aggregated across three subsequent days. If more than 15 mm fell within 3 subsequent days, the onset of Belg or Kiremt was identified. Data were provided by the Meteorological Agency in South Wollo.

Table 1
Details of the six studied kebeles as described by the local officials. Agro-ecological zones are defined according to Hurni (1998). We defined land degradation as the reduced capacity of the soil and land to provide goods and services for human well-being mainly driven by soil erosion, i.e. gully erosion or the loss of topsoil and nutrients. The level of land degradation was determined by the local officials.

Kebele	Agro-ecological zone	Belg	Kiremt	Own market	Asphalt road	Land degradation
Adej	Dega	x				High
Alansha	Dega	x	x		x	Low
Amba Gibi	Weyna Dega		x			High
Tincha	Weyna Dega			x		Low
Kundi	Kola		x	x	x	High
Teikake	Kola	x	x			Low

adopted methods used for community participation, such as wealth ranking, historical timelines, daily activity calendars, livelihood risk assessments, strategy ranking and mobility maps (modified after Kumar, 2002; Kienberger, 2009; Rademacher-Schulz *et al.*, 2012). The focus groups were crucial for obtaining an overview of the specifics of local livelihoods and to build trust among the communities.

Complementing the focus groups, we conducted six to eight semi-structured household interviews per kebele. Hereby, we covered migrating and non-migrating households equally. The households were selected with the aim to maximize heterogeneity regarding household wealth, and thus, represented at least one household from the low, middle and upper wealth spectrum of the kebele in each migration category (migrating/non-migrating household). During the household interviews, first, we gathered features of the economic and social composition of the household, including the main activities, land and crop management and personal characteristics of the household members. Second, questions addressed the perceived changes in land degradation and rainfall, how such changes had affected the respondent's daily lives, and household strategies for addressing those environmental changes. Third, details of migration experiences such as time span, destination, reason for leaving and returning and financial or material transfers for all current and former household members were gathered. In addition, we conducted follow-up interviews with returnees who were members of the already interviewed migrant households to gather in-depth knowledge of the socioeconomic, personal, political and environmental factors driving out-migration. An overview of the socio-economic household characteristics can be found in appendix A.

Finally, the information from the focus groups and interviews were contextualized through expert talks, i.e., key informants from non-governmental organizations and local government operating in the region. Overall, the qualitative approach and the intensive collaboration with a well-established local NGO enabled a trustworthy relationship with the communities and thus deepened the insights into the local lives and challenges of the people. In total, we conducted 18 focus groups (three in each kebele), 42 household interviews (seven to eight in each kebele), 20 interviews with returnees (among the 20 migrating households) and five expert talks. In the remainder of the analysis, we used the 42 households as the unit of analysis.

4.4. Qualitative comparative analysis

To decipher the interwoven drivers of environment-related migration, we applied qualitative comparative analysis (QCA). This is a set-theoretic approach that aims to detect causal relationships within data (Schneider and Wagemann, 2012). The causal relationships between the potential influence factors and each phenomenon can be described as being either necessary[1], sufficient[2] or non-existent. In particular, QCA identifies whether (combinations of) various causal conditions (~ independent variables) are necessary and/or sufficient for an outcome of interest (~ dependent variable), which in our case was out-migration. If a relationship between these influence factors and migration was detected, we used the notion of causal factors or causal relationships.

QCA is a powerful tool for depicting complex causal patterns characterized by conjunctural causation (conditions only have an impact if other conditions are present or absent) and equifinality (several different combinations of conditions can result in the same outcome) (Ragin, 1987; Schneider and Wagemann, 2012). Research has long highlighted that migration decisions can be explained by plentiful – and equally valid – pathways of intertwined direct and indirect migration drivers (equifinality). Migration decisions, including northern Ethiopia (e.g., Hermans and Garbe, 2019), typically can only be explained by the interaction of several factors (conjunctural causation) (de Haas, 2010; Foresight, 2011). Consequently, QCA was especially appropriate in the context of this study. Furthermore, QCA allows the integration of qualitative and quantitative data in the context of medium- and large-N research designs. Hence, it combines the advantages of large-N statistical analyses (generalizability beyond a few cases and high replicability) and in-depth case studies (deep knowledge of the respective context and the data used) (Hughes and Nix, 1989).

To integrate different kinds of data and run the QCA algorithm that identifies necessary and sufficient (combinations of) conditions, we needed to employ a calibration procedure. In other words, we translated our (largely qualitative) empirical information from the interviews into numerical formats. As our outcome was binary (migration/non-migration), we employed the crisp-set, binary version of QCA (Schneider and Wagemann, 2012). Hence, we defined whether each household was a member in the set of cases where a certain condition was present (1) or not (0). In line with good practices in QCA (Schneider and Wagemann, 2012; Schneider and Rohlfing, 2013), we developed causal conditions and calibration thresholds in an iterative process of consulting the relevant literature (as outlined in the description of the conditions in the following section 4.5) as well as utilizing our in-depth case knowledge. Section 3, section 4.5 and the online appendix provide further information on this. Following established standards, we limited our analysis to a maximum of five conditions to reduce the number of logical remainders (combinations without empirical evidence) and to avoid the problem of "too many variables, too few cases", which reduce confidence in the results (Marx and Dusa, 2011; Ide et al., 2018).

4.5. Theoretical assumptions and calibration

For our outcome of interest, a household[3] was categorized as migrating (positive case) if one of the household members left the kebele for at least one month within the last five years, excluding migration for purely marital or educational purposes. This definition was based on

[1] The condition is a subset of the outcome. When the condition is present, the outcome is present.

[2] The outcome is a subset of the condition. Whenever the outcome is present, the condition is present. The outcome cannot be achieved without the condition.

[3] A household includes all absent or present members who depend substantially on the same food and income.

information gathered during the household and migrant interviews, given that the shortest migration duration reported was one month, and that migration for exclusively educational or marital purposes was present in two households only[4] (all others had rather mixed motives).

In this section, we present the causal conditions and their directional expectations, which were used to calibrate the original interview data as absent or present for the 42 cases.

i **Belg-dependent only** *(belgonly)*: Households that were fully dependent on Belg rain are considered to be more vulnerable to rainfall variability than others, as Belg rainfall amounts are smaller than those in Kiremt, and Belg seasons have become shorter and increasingly variable within the study area (see Figure 2; Rosell, 2011). Households that exclusively used Belg rainfall for farming were calibrated as part of this set. Among these households, we expected limited abilities to engage in migration (Gray and Mueller, 2012a) since rainfall changes threaten the economic basis of farming livelihoods, especially in areas with limited irrigation infrastructure. However, this tendency could be countered by the strategy of migrating to overcome increasing risks, such as season failures or food shortages (Hermans and Garbe, 2019).

ii **Perceived land size was too small** *(landscarc)*: The household perceived its cultivated land as too small to fulfill the food needs of the household. This condition combined land productivity and land size in relation to the number of household members who depended on the same land resources and does not differentiate between own land and sharecropped land. Hence, all households that described their cultivated land as "too small" or "not enough" during the interviews were members of this set. Land scarcity is a well-known driver of out-migration in the Ethiopian highlands (Gray and Mueller, 2012a; Morrissey, 2013) and it was one of the major reasons to migrate as mentioned in our semistructured interviews with household heads and returning migrants.

iii **Migration experience** *(migratexper)*: The influence of kinship ties on migration decisions has long been recognized among scholars (e.g., Brown and Tilly, 1967; Choldin, 1973; Asfaw, Tolossa and Zeleke, 2010). Our respondents often mentioned migrated siblings (or other household members) as a strong incentive for leaving. We therefore assumed that existing migrants increased the likelihood that members of the same household would also decide to migrate. A household was part of this set if at least two subsequent migration events (for migrating households) occurred or if the most recent migration event had taken place before 2013[5] (for non-migrating households).

iv **Non-farm (in situ) diversification** *(non-farm)*: In regions where people depend strongly on natural resources, they become potentially vulnerable to environmental change and stressors. Many of our interview partners responded that agricultural activities had become increasingly insecure (in particular due to increasing rainfall uncertainty and land degradation), and they had therefore been seeking jobs outside agriculture. We expected that increasing environmental stress and insufficient options for livelihood activities outside agriculture (as is the case for South Wollo) would increase the motivation to migrate to places where these options exist to diversify livelihoods and increase the household income (e.g., Stark and Bloom, 1985; Asfaw, Tolossa and Zeleke, 2010). Consequently, for households having access to non-farm in situ activities, the need to migrate would decrease. We calibrated households as part of this set if they were involved in at least one of the following activities; daily labor, cultivating eucalyptus trees, or running a small enterprise (which, compared to agriculture activities, play a minor role for the household income).

v **Kebele has own market and/or asphalt road connection** *(marketroad)*: Having a market close by and/or access to distant markets through paved roads facilitates small business activities and livelihood diversification. Households in remote localities were not part of this set, and we expected that household members in these locations would tend to be more motivated to migrate and to diversify their livelihoods elsewhere to reduce the risks associated with increasing environmental stress (e.g., Kniveton *et al.*, 2008; Tegegne and Penker, 2016).

The complete dataset that resulted from the calibration process together with a truth table can be found in appendices B and C. Once the data were calibrated, we used the fsQCA 2.5 software (Ragin, Kriss A. Drass and Davey, 2014) to test which of the five conditions were necessary or sufficient for explaining the occurrence of migration. If not otherwise stated, we reported the parsimonious solution as it is considered most robust (for more details see Baumgartner and Thiem, 2017).

Testing the robustness of the QCA results was crucial for confirming the validity of the results (Skaaning, 2011). To do so, we followed the schema developed by Ide et al. (2020), which compromises a large number of different tests generally considered adequate in the QCA literature. Specifically, we checked whether the solution was robust to (1) changing consistency thresholds, (2) different inclusion thresholds for the number of cases populating a given truth table row, (3) adding or dropping causal conditions, (4) changing calibration decisions and (5) excluding a group of cases, i.e., potential outliers (see table E.2 in appendix E for further information). Robustness was indicated if the resulting solution terms reproduced the main solution or showed a sub- or superset relationship.

5. Results

First, we detected the potential necessary conditions for migration. Following the established standards, we used the common consistency threshold of 0.9 for assuring necessity. This implies that the respective condition needs to be present in at least 90% of the migration cases (Schneider and Wagemann, 2012). The consistencies were measured for the absences and presences of all five conditions and only the absence of *belgonly* passed the respective threshold since 18 out of 20 migrating households (90%) used Kiremt for farming. For the 14 subsequent robustness tests, the absence of *belgonly* exceeded the 0.9 threshold in six tests and remained well above 0.8 in the remaining eight tests (see Table E.2 in appendix E). We therefore conclude that the availability of another rainy season for cropping besides the Belg season (hence, the Kiremt season) was a quasi-necessary condition for the migration of household members.

The QCA yielded two sufficient causal pathways for migration (see Table 2); first, the combination of migration experience and the absence of full Belg dependency explained migration for 15 out of the 20 migrating households. The second pathway, which had almost equally strong empirical evidence, showed that the combination of migration experience and the availability of non-farm in situ diversification explained migration for 14 out of the 20 migrating households. The main solution term covered 17 out of the 20 migrating households (85%), implying that overall, it explained 39 out of the 42 cases under study. This coverage indicates a high empirical relevance of our results.

The robustness tests demonstrated the robustness of the main solution terms (*migratexper * (~belgonly + non-farm) → migration*), which were exactly reproduced by 10 out of 15 tests (see Table E.2 in appendix E). For the remaining five tests, the solutions showed a sub- or superset relationship to the main solution, meaning that either the

[4] The two households with exclusively marital or educational migration motives blur the main solution term when calibrated as a migrating household as shown in robustness test #13 (appendix E).

[5] Given that a non-migrating household was defined as a household in which no member had migrated within the last 5 years (before the data collection in 2017).

Table 2
Parsimonious solution term for sufficiency[a,b,c,d]

Solution term	*migratexper* * (~*belgonly* + *non-farm*) → *migration*	
Solution coverage	0.85 (17 out of 20 cases)	
Solution consistency	1.00	
Causal pathway	*migratexper* * ~*belgonly*	*migratexper* * *non-farm*
Raw coverage	0.75 (15 out of 20 cases)	0.70 (14 out of 20 cases)
Unique coverage	0.15 (3 out of 20 cases)	0.10 (2 out of 20 cases)
Cases covered	15 out of 20	14 out of 20

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

[a] Solution coverage: Expresses the degree to which the outcome is explained by the solution term. It is the share of cases that are explained by the solution term.

[b] Solution consistency: Expresses the degree to which empirical evidence supports the claim that a set-theoretic relationship [sufficiency] exists. A solution consistency of 1.00 implies that there were no contradictory truth table rows included in the logical minimization process.

[c] Raw coverage: Expresses the degree to which the outcome is covered by a certain causal pathway. It is the share of cases that are explained by a certain causal pathway.

[d] Unique coverage: Expresses the degree to which a single causal pathway solely explains the outcome. It is the share of cases that are explained by certain causal pathway solely.

robustness test solutions were contained in the main solution term (main solution was a superset of the test solution) or the main solution was contained in the test solutions (main solution was a subset of the test solution). No robustness test provided any results that contradict the main solution. In addition, for all performed tests, the causal pathway containing the main solution had the highest raw coverage, with at least 0.69. All tests performed, including the detailed explanations and respective parameters, can be found in appendix E.

6. Discussion

Land degradation and precipitation variability in the northern Ethiopian highlands curtail the livelihoods of the populations dependent on agriculture and can also be important drivers of migration (e.g., Morrissey, 2013). Previous studies in the region have identified that migration is mainly a strategy for diversifying household income sources and reducing the risks of environmental stressors; however, this is very much context dependent (Gray and Mueller, 2012a; Morrissey, 2013; Wondimagegnhu and Zeleke, 2017; Hermans and Garbe, 2019). Indeed, the young rural populations in particular articulated strong aspirations in our interviews to live and work elsewhere, given the increasingly harsh environmental conditions for agriculture, the growing scarcity of land, and the few job opportunities in the rural areas. Nonetheless, the circumstances under which some households actually decide to migrate remain unclear. We identified three intertwined contextual factors within the migrating households: the use of Kiremt rainfall (*~belgonly)*, non-farm in situ income activities (*non-farm)* and migration experience (*migratexper)*. All three conditions are so-called INUS conditions for migration, implying that they are by themselves insufficient to cause migration but in combination become sufficient conditions under which households adopt migration (for more details see Schneider and Wagemann, 2012).

The use of Kiremt rain (*~belgonly*) was identified, in addition to being an INUS condition, as the only quasi-necessary condition. From this, we infer that the more favorable environmental conditions in the regions where the Kiremt season is used increase the likelihood of migration. This might be because the Kiremt rain, compared to the Belg rain, is often more favorable for agriculture given its higher and less variable rainfall amounts (see Figure 2). In addition, advantageous temperatures during the Kiremt season facilitate crop growth and the implementation of soil and water conservation measures such as tree and grass planting (expert interview, Hurni et al., 2007). Consequently, the Kiremt farmers have a higher agricultural diversity[6] and yield compared to the Belg-dependent farmers. We argue that Kiremt households can derive more stable incomes from their agricultural activities, allowing them to be more likely to accumulate at least small amounts of savings or assets. As a result, their economic resources and their adaptive capacities increases, and thus, their ability to migrate. This is in line with findings from Hermans and Garbe (2019), who revealed that households using the Kiremt rains have significantly more coping strategies available for responding to drought conditions compared to Belg farmers. These findings highlight the importance of mesolevel, agro-ecological features for shaping migration, which have thus far been studied less than household or individual influence factors (but see Tegegne and Penker, 2016).

In contrast to our expectations, the QCA identified the presence of a non-farm in situ activity as another INUS condition for migration. Furthermore, the second causal pathway revealed that *non-farm* substituted the use of Kiremt (and vice versa) as it could equally cause migration (if *migratexper* was simultaneously present) given the low unique coverage of both pathways. Within our interviewed households, activities such as daily labor (e.g., construction work), small businesses (e.g., tailoring work, running a cafeteria) or the cultivation of eucalyptus trees were reported as supplementary income sources. We infer, that similar to *~belgonly, non-farm* enables the accumulation of income and assets and thus increases the adaptive capacities of the households to deal with (environmental) stressors and thus allow additional flexibility for actions, including migration. However, one may argue that the described causal effect can also be reversed, i.e., migration made it possible to carry out a non-farm activity. This may apply to activities that require seed capital (e.g., small businesses) but apply less to activities such as daily labor or the cultivation of eucalyptus trees (where usually no or very little financial investment is required). Furthermore, the results of the robustness test, in which we excluded small business activities and used only the cultivation of eucalyptus trees, showed no significant change to the main solution term, suggesting that our interpretation of the effect direction is more likely (see appendix E, test #6).

Collectively, the two identified INUS conditions, *~belgonly* and *non-farm*, highlight the relevance of favorable environmental conditions and in situ livelihood diversification since both can increase the economic resources of a household, which could be used for migration. This implies that migration as adaptation is constrained for those lacking the respective resources – which are predominately the most vulnerable ones – such as the Belg-dependent farmers, or for farmers that have limited access to non-farm activities for reasons such as the remoteness of the kebele or gender or age. The importance of economic resources for environment-related migration has long been recognized, but mainly in the context of long-term and international (costly) migration (e.g., Gray and Mueller, 2012). At our research sites, various migration types in terms of distance and duration occurred, and our identified causal pathways encompassed all of them, implying that the economic resources can enable several types of migration and are not limited as facilitators for long-term or -distance migration. It is still possible, however, that follow-up studies reveal important differences between short- and long-distance/-term migrations not covered by our study.

In addition to the conditions discussed above, our results highlight the central role of migrant networks for migration. *Migratexper* is the only causal condition that is part of both sufficiency pathways, hence

[6] Belg farmers focus on a few crops and vegetables types, which are primarily barley, potatoes and cabbage, whereas Kiremt farmers can cultivate wheat, maize, sorghum, pulses, teff and several vegetables.

indicating its high importance. This aligns with research that has long been emphasizing the importance of social networks for better understanding migration processes (e.g., Brown and Tilly, 1967; Choldin, 1973; Massey, 1990). Often, scholars have argued that migrant networks reduce the risks and costs of migration (e.g., McLeman and Smit, 2006; Doevenspeck, 2011). Indeed, when asked about the reasons for choosing a specific destination, our respondents often reported that other family members or close friends already live there and supported them in finding jobs and housing. In addition, several focus group discussions revealed that young people see their migrated siblings or friends with better clothes and mobile phones, and therefore, their own desire to migrate is strengthened. Interestingly, the latter statements exposed another strand of how migrant networks can influence migration: migration depends strongly on the perceptions and the stories that the returnees convey. We thus conclude that migrant networks not only shape the abilities to migrate but also the migration aspirations (cf. Carling and Schewel, 2018).

Contrasting earlier studies in the region (e.g., Gray and Mueller, 2012a; Morrissey, 2013), we identified neither land scarcity nor the lack of job opportunities as migration drivers. While both aspects were mentioned during the interviews with the returnees as motivations to migrate, they were, interestingly, not detected as causal conditions in our analysis. However, the identified main solution highlights the inevitable interconnection between the economic resources of households and the migration networks. Thus, we can infer that migration, from a household's perspective, depends more on the enabling factors than on, e.g., the push factors and is shaped by the presence, perception and experience of other migrants. This is further supported given that the perceived impact of rainfall variability and education level within the household played only a minor role in the robustness tests (see appendix E).

Despite the rich information and the interesting implications that we derived from our analysis, one should also be aware of its limitations. One of them is that QCA as a method is geared towards explaining outcomes, and is indeed unable to estimate substantive effects or thresholds other than by identifying the prominence in the solution formula. Another one is that we have been unable to gain satisfactory insights into the current state of and recent changes in land degradation and its impact on the livelihoods of the farmers. We believe that the vast majority of our interviewees had biased answers with regard to land degradation because there was little coherence in their responses to yield change, soil erosion and the success of the many soil and water conservation measures in South Wollo. One possible reason for these biases could be the general mistrust of the local authorities by the farmers and their dependence on the support of the local authorities (Rahmato, 2009). Another reason for inconsistent responses, which is also relevant for rainfall variability, may have been a mismatch between the measured and perceived environmental changes (e.g., Murtinho *et al.*, 2013; Reyes-García *et al.*, 2016). This may be because of aspects of vulnerability or cultural backgrounds influence local perceptions (for Ethiopian studies, see Meze-Hausken, 2004; Rettberg, 2010; Adimassu, Kessler and Stroosnijder, 2014). But while perceptions might differ from measured changes, it is the former in which farmers base their decision and behavior (Hansen, Marx and Weber, 2004; Thomas *et al.*, 2007; Silvestri *et al.*, 2012). Furthermore, our proposed main solution – although the solution coverage was quite high – left three cases of migrating households unexplained (ID 3, 4 and 26). These three cases had in common that the migrants within the household were solely female, whereas in all other households, only men or both men and women migrated. Studies from the northern highlands showed that there are gender-specific barriers for climate adaptation, including migration, associated with differences in roles, responsibilities and access to resources (Gray and Mueller, 2012a; Mersha and Van Laerhoven, 2016b). Although our study did not explicitly aim to analyze the influence of gender on migration, the three unexplained cases suggest that migration evolves differently for women than for men. Finally, our analysis did not capture migration for less than one month. Although such short-term migrations were not reported during the household or migrant interviews, they still might occur. They are however more difficult to recall, especially for other household members, compared to longer migration and as such could have escaped our analysis.

7. Conclusion

Our study sought to disentangle the drivers of environment-related migration at the household level by studying a region particularly vulnerable to environmental change: the northern highlands of Ethiopia. We combined the comprehensive data collected during extensive field research via QCA, a novel method in the research field that is well suited to the unraveling complex causal patterns that are inherent to environment-related migration.

In contrast to other studies, we identified neither land scarcity nor the lack of non-farm activities as drivers of migration. Overall, the two causal pathways suggest that migrant networks in interaction with economic resources – either gained through favorable environmental conditions or non-farm in situ income diversification – are drivers of migration at the household level. This is so because they can reduce the costs and risks of migration, but also because they influence migration aspirations. Moreover, our results demonstrate that only the interaction of migration networks and either mesolevel environmental factors or household economic factors can sufficiently explain why migration occurred in the migrating households (and why it did not occur in the non-migrating households). From this, we conclude that migration at the household level is strongly mediated by the ability of a household to migrate (and is not dominated by push factors such as land scarcity or lack of non-farm activities). This contradicts push factor-centered and largely determinist narratives about environmental change and migration (cf. Boas *et al.*, 2019).

Furthermore, our findings offer important conclusions about the most vulnerable households in the areas where only Belg rain can be used for farming. In these areas, households would need to engage in non-farm in situ diversification activities to be able to migrate. In other words, the absence of an alternative in situ livelihood diversification option and the unfavorable environmental conditions undermine the pivotal resources necessary for migration. This indicates that limited livelihood options and unfavorable environmental conditions can force people to stay put. The Foresight report (Foresight, 2011) highlighted the issue of “trapped populations” and stressed that people who are unable to leave are mostly those with the fewest capital assets and staying put contributes to their impoverishment and increases vulnerability.

However, we have to avoid overemphasizing migration as a decision solely dependent on the lack or presence of economic household resources, and we have to be careful in concluding that the absence of these resources necessarily means that people are trapped. Our analysis revealed that the perception and experience of other migrants shaped migration decisions as well, and the motives for persistence illustrated that there were several reasons for non-migration, such as strong ties to the place of residence and social dependencies. Thus, a separate analysis of non-migration accounting for factors related to risk and migration perceptions, place attachment and place identity may generate further insights regarding (non-) migration (for more details Adams, 2016; Adams and Kay, 2019). Nevertheless, from our findings we conclude that migration is an important adaptation strategy in the northern highlands, which, however, cannot be adopted equally among households since it is more contingent on factors shaping migration abilities than on push factors for migration. Thus, we want to stress that more attention should be paid to migration-enabling mechanisms to better understand how to strengthen rural livelihoods and their abilities to choose migration (in the case that they want to) and reduce the risk of trapping people in vulnerable environments.

Our multisite approach also enabled us to move beyond household-centered influence factors and to consider mesolevel factors like agro-ecology. Thus, we generated new insights into the influence of the rainy season (and the related agro-ecological features) on the adaptive capacities of households and thus on migration. These findings stress the need to put more effort into incorporating mesolevel migration drivers in future studies to avoid missing important interactions between migration drivers and to enhance our understanding of migration processes.

Finally, we want to encourage scholars in the field of environment-related migration to utilize QCA or other novel methods more frequently to overcome methodological challenges and to fill the still-existing knowledge gaps. The often used qualitative and quantitative approaches for analyzing environment-related migration are limited either in moving beyond extensive case descriptions or in dealing with the multicausal and complex nature of migration processes (Kniveton *et al.*, 2008; Piguet, 2010; Neumann and Hilderink, 2015). In our study, using QCA allowed us to compare and abstract our in-depth findings from the households to unravel the various ways in which households engage in migration. However, given the binary type of QCA we employed, some of the details were lost in the analysis. The return to our rich interview data, however, provided the content we needed to actually understand how the complex interactions of the three identified conditions enabled households to participate in migration. Thus, in combining QCA with in-depth interviews, multiple pathways for migration and the relevance of social and economic (non-) environmental factor interlinkages for the ability of people to migrate were demonstrated. As such, our study has illustrated how the gap between qualitative and quantitative research can be bridged to address complex causalities that are necessary for a better understanding of migration processes.

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CRediT authorship contribution statement

Juliane Groth: Writing - original draft, Conceptualization, Methodology, Investigation, Formal analysis. **Tobias Ide:** Writing - review & editing, Methodology, Formal analysis. **Patrick Sakdapolrak:** Supervision, Conceptualization. **Endeshaw Kassa:** Conceptualization, Investigation. **Kathleen Hermans:** Writing - review & editing, Conceptualization, Methodology, Supervision, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Supplementary materials

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References

Adams, H., 2016. 'Why populations persist: mobility, place attachment and climate change. Population and Environment 37 (4), 429–448. https://doi.org/10.1007/s11111-015-0246-3.

Adams, H., Kay, S., 2019. 'Migration as a human affair: Integrating individual stress thresholds into quantitative models of climate migration. Environmental Science & Policy 93, 129–138. https://doi.org/10.1016/j.envsci.2018.10.015.

Adimassu, Z., et al., 2017. 'Impacts of Soil and Water Conservation Practices on Crop Yield, Run-off, Soil Loss and Nutrient Loss in Ethiopia: Review and Synthesis. Environmental Management 59 (1), 87–101. https://doi.org/10.1007/s00267-016-0776-1.

Adimassu, Z., Kessler, A., Stroosnijder, L., 2014. 'Farmers' strategies to perceived trends of rainfall and crop productivity in the Central Rift Valley of Ethiopia. Environmental Development 11, 123–140. https://doi.org/10.1016/j.envdev.2014.04.004.

Asfaw, W., Tolossa, D., Zeleke, G., 2010. 'Causes and impacts of seasonal migration on rural livelihoods: Case studies from Amhara Region in Ethiopia. Norsk Geografisk Tidsskrift - Norwegian Journal of Geography 64 (1), 58–70. https://doi.org/10.1080/00291950903557696.

Ayenew, M., 2002. 'Decentralization in Ethiopia: Two Case Studies on Deveolution of Power and Responsibilities to Local Authorities. The Challenge of Democracy from Below. ppsala/Addis Ababa: Nordiska Afrikainstitutet/Forum for Social Studies 130–148.

Bardsley, D.K., Hugo, G.J., 2010. 'Migration and climate change: examining thresholds of change to guide effective adaptation decision-making. Population and Environment 32 (2–3), 238–262. https://doi.org/10.1007/s11111-010-0126-9.

Baumgartner, M., Thiem, A., 2017. Often Trusted but Never (Properly) Tested: Evaluating Qualitative Comparative Analysis. Sociological Methods & Research, 004912411770148. https://doi.org/10.1177/0049124117701487.

Bewket, W. (2009) 'Rainfall variability and crop production in Ethiopia Case study in the Amhara region', in Ege, S. et al. (eds) Proceedings of the 16th International Conference of Ethiopian Studies. Trondheim. doi: http://portal.svt.ntnu.no/sites/ices16/Proceedings/Volume%203/Woldeamlak%20Bewket%20-%20Rainfall%20variability%20and%20crop%20production.pdf.

Bezu, S., Holden, S., 2014. 'Are Rural Youth in Ethiopia Abandoning Agriculture? 64. Elsevier Ltd, pp. 259–272. https://doi.org/10.1016/j.worlddev.2014.06.013.

Bilsborrow, R.E., Henry, S.J.F., 2012. 'The use of survey data to study migration–environment relationships in developing countries: alternative approaches to data collection. Population and Environment 34 (1), 113–141. https://doi.org/10.1007/s11111-012-0177-1.

Black, R., et al., 2011. 'The effect of environmental change on human migration. Global Environmental Change 21, S3–S11. https://doi.org/10.1016/j.gloenvcha.2011.10.001.

Boas, I., et al., 2019. 'Climate migration myths. Nature Climate Change 9 (12), 901–903. https://doi.org/10.1038/s41558-019-0633-3.

Borderon, M., Sakdapolrak, P., Muttarak, R., Kebede, E., Pagogna, R., Sporer, E., 2019. 'Migration influenced by environmental change in Africa: A systematic review of empirical evidence. Demographic Research 41 (August), 491–544. https://doi.org/10.4054/demres.2019.41.18.

Brown, C.H., Tilly, C., 1967. 'On Uprooting, Kinship, and the Auspices of Migration. International Journal of Comparative Sociology. https://doi.org/10.1163/156854267X00114.

Call, M.A., et al., 2017. 'Disruption, not displacement: Environmental variability and temporary migration in Bangladesh. Global Environmental Change 46. Elsevier Ltd, pp. 157–165. https://doi.org/10.1016/j.gloenvcha.2017.08.008.

Carling, J., Schewel, K., 2018. 'Revisiting aspiration and ability in international migration. Journal of Ethnic and Migration Studies 44 (6), 945–963. https://doi.org/10.1080/1369183X.2017.1384146.

Castles, S., de Haas, H., Miller, M.J., 2015. 'The Age of Migration: International Population Movements in the Modern World. Ethnic and Racial Studies 38 (13), 2355. https://doi.org/10.1080/01419870.2015.1050048.

Cattaneo, C., et al., 2019. 'Human Migration in the Era of Climate Change. Review of Environmental Economics and Policy 13 (2), 189–206. https://doi.org/10.1093/reep/rez008.

Choldin, H.M., 1973. 'Kinship Networks in the Migration Process. International Migration Review 7 (2), 163. https://doi.org/10.2307/3002426.

CSA (2007) 'Population and Housing Census', Central Statistical Agency. Addis Ababa, Ethiopia.

Dillon, A., Mueller, V., Salau, S., 2011. 'Migratory responses to agricultural risk in northern Nigeria. American Journal of Agricultural Economics. https://doi.org/10.1093/ajae/aar033.

Doevenspeck, M., 2011. 'The Thin Line Between Choice and Flight: Environment and Migration in Rural Benin. International Migration 49, e50–e68. https://doi.org/10.1111/j.1468-2435.2010.00632.x.

Drees, L., Liehr, S., 2015. 'Using Bayesian belief networks to analyse social-ecological conditions for migration in the Sahel. Global Environmental Change 35. Elsevier Ltd, pp. 323–339. https://doi.org/10.1016/j.gloenvcha.2015.09.003.

Ege, S., 2017. 'Land Use Policy Land tenure insecurity in post-certification Amhara. Land Use Policy 64. Elsevier Ltd, Ethiopia, pp. 56–63. https://doi.org/10.1016/j.

landusepol.2017.02.015.
Etzold, B., Sakdapolrak, P., 2016. 'Socio-spatialities of vulnerability : towards a polymorphic perspective in vulnerability research. Die Erde. https://doi.org/10.12854/erde-147-15.
Ezra, M., Kiros, G.E., 2001. 'Rural out-migration in the drought prone areas of Ethiopia: A multilevel analysis. International Migration Review 35 (3), 749–771.
Farr, T.G., et al., 2007. 'The shuttle radar topography mission. Reviews of Geophysics. https://doi.org/10.1029/2005RG000183.
Findley, S.E., 2007. 'An Interactive Contextual Model of Migration in Ilocos Norte, the Philippines. Demography. https://doi.org/10.2307/2061628.
Flyvbjerg, B., 2006. Five misunderstandings about case-study research. Qualitative Inquiry. https://doi.org/10.1177/1077800405284363.
Foresight, 2011. Migration und Global Environmental Change: Future Challenges and Opportunities. The Government Office for Science, London.
Fussell, E., Hunter, L.M., Gray, C.L., 2014. 'Measuring the environmental dimensions of human migration: The demographer's toolkit'. Global Environmental Change 28, 182–191. https://doi.org/10.1016/j.gloenvcha.2014.07.001.
Gebrehiwot, T., van der Veen, A., 2013. 'Farm Level Adaptation to Climate Change: The Case of Farmer's in the Ethiopian Highlands. Environmental Management 52 (1), 29–44. https://doi.org/10.1007/s00267-013-0039-3.
Gilligan, D.O., Hoddinott, J., Taffesse, A.S., 2009. 'The Impact of Ethiopia's Productive Safety Net Programme and its Linkages. Journal of Development Studies 45 (10), 1684–1706. https://doi.org/10.1080/00220380902935907.
Gray, C., Bilsborrow, R., 2013. 'Environmental Influences on Human Migration in Rural Ecuador. Demography 50 (4), 1217–1241. https://doi.org/10.1007/s13524-012-0192-y.
Gray, C., Mueller, V., 2012a. 'Drought and Population Mobility in Rural Ethiopia. World Development 40 (1), 134–145. https://doi.org/10.1016/j.worlddev.2011.05.023.
De Haan, L.J., 2000. 'Globalization, localization and sustainable livelihood. Sociologia Ruralis. https://doi.org/10.1111/1467-9523.00152.
de Haas, H., 2010. 'The Internal Dynamics of Migration Processes: A Theoretical Inquiry. Journal of Ethnic and Migration Studies 36 (10), 1587–1617. https://doi.org/10.1080/1369183X.2010.489361.
Gray, C., Mueller, V., 2012. 'Natural disasters and population mobility in Bangladesh. PROCEEDINGS OF THE NATIONAL ACADEMY OF SCIENCES OF THE UNITED STATES OF AMERICA 109 (16), 6000–6005. https://doi.org/10.1073/pnas.1115944109.
Haeffner, M., Baggio, J.A., Galvin, K., 2018. 'Investigating environmental migration and other rural drought adaptation strategies in Baja California Sur, Mexico'. Regional Environmental Change 18 (5), 1495–1507. https://doi.org/10.1007/s10113-018-1281-2.
Hagen-Zanker, J., 2011. Why Do People Migrate? A Review of the Theoretical Literature. SSRN Electronic Journal. https://doi.org/10.2139/ssrn.1105657.
Hansen, J., Marx, S., Weber, E.U., 2004. The role of climate perceptions, expectations, and forecasts in farmer decision making: The Argentine Pampas and South Florida. International Research Institute for Climate Predictions Technical Report.
Hassani-Mahmooei, B., Parris, B.W., 2012. 'Climate change and internal migration patterns in Bangladesh: an agent-based model. Environment and Development Economics 17 (6), 763–780. https://doi.org/10.1017/S1355770X12000290.
Hermans-Neumann, K., Priess, J., Herold, M., 2017. 'Human migration, climate variability, and land degradation: hotspots of socio-ecological pressure in Ethiopia. Regional Environmental Change 17 (5), 1479–1492. https://doi.org/10.1007/s10113-017-1108-6.
Hermans, K., Garbe, L., 2019. 'Droughts, livelihoods, and human migration in northern Ethiopia. Regional Environmental Change 19 (4), 1101–1111. https://doi.org/10.1007/s10113-019-01473-z.
Hughes, D.A., Nix, W.D., 1989. Strain hardening and substructural evolution in NiCo solid solutions at large strains. Materials Science and Engineering 122 (2), 153–172. https://doi.org/10.1016/0921-5093(89)90627-8. A.
Hunter, L.M., et al., 2014. 'Rural Outmigration, Natural Capital, and Livelihoods in South Africa. Population, Space and Place 20 (5), 402–420. https://doi.org/10.1002/psp.1776.
Hunter, L.M., Luna, J.K., Norton, R.M., 2015. 'Environmental Dimensions of Migration. Annual Review of Sociology 41 (1), 377–397. https://doi.org/10.1146/annurev-soc-073014-112223.
Hurni, H., 1998. Agroecologial belts of Ethiopia: Explanatory notes on three maps at a scale of. 1:1,000,000. Research Report, Soil conservaton research program.
Hurni, H., et al., 2007. 'Landscape Transformation and Sustainable Development in Ethiopia. Background information for a study tour through Ethiopia 321 4-20 September 2006', (September 2006).
Ide, T., 2015. 'Why do conflicts over scarce renewable resources turn violent? A qualitative comparative analysis. Global Environmental Change 33, 61–70. https://doi.org/10.1016/j.gloenvcha.2015.04.008.
Ide, T., 2018. 'On the appropriate use of QCA in environmental management research: A comment on Hossu et al. Ambio 47 (7), 831–832. https://doi.org/10.1007/s13280-018-1092-1.
Ide, T., Brzoska, M., Donges, J., Schleussner, C-F., 2020. Multi-method evidence for when and how climate-related disasters contribute to armed conflict risk. Global Environmental Change 62. https://doi.org/10.1016/j.gloenvcha.2020.102063.
IPCC, 2014. Climate Change 2014: Impacts, Adaptation, and Vulnerability. Frequently Asked Questions, and Cross-Chapter Boxes. In: Field, C.B (Ed.), A Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. World Meteorological Organization, Geneva, Switzerland Edited by.
IPCC, 2018. Global warming of 1.5°C. In: Masson, V (Ed.), An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levles and related global greenhouse gas emission pathways, in the context of strenghtening the global response to the threat of climate change. Report of the Intergovernmental Panel on Climate Change Edited by Delmotte et al. Available at. https://www.ipcc.ch/sr15/.
Joint Government and Humanitarian Partners (2016) Humanitarian Requirements Document. Available at: https://reliefweb.int/sites/reliefweb.int/files/resources/ethiopia_hrd_2016.pdf.
Kienberger, S. (2009) Toolbox & Manual: Mapping the vulnerability of communities – Example from Bu´zi,Mozambique. Available at: http://projects.stefankienberger.at/vulmoz/wp-content/uploads/2008/08/Toolbox_CommunityVulnerabilityMapping_V1.pdf.
Kirchherr, J., Charles, K.J., Walton, M.J., 2016. 'Multi-causal pathways of public opposition to dam projects in Asia: A fuzzy set qualitative comparative analysis (fsQCA). Global Environmental Change 41, 33–45. https://doi.org/10.1016/j.gloenvcha.2016.08.001.
Kniveton, D., et al., 2008. Climate Change and Migration: Improving Methodologies to Estimate Flows. IOM Migration Research Series, Geneva IOM.
Kniveton, D., Smith, C., Wood, S., 2011. 'Agent-based model simulations of future changes in migration flows for Burkina Faso. Global Environmental Change. https://doi.org/10.1016/j.gloenvcha.2011.09.006.
Kumar, S., 2002. Methods for Community Participation: A Complete Guide for Practitioners. Psychology and Developing Socities.
Lee, E.S., 1966. 'A theory of migration. Demography. https://doi.org/10.2307/2060063.
Little, P.D., et al., 2006. '"Moving in place": Drought and poverty dynamics in South Wollo. Journal of Development Studies 42 (2), 200–225. https://doi.org/10.1080/00220380500405287.
Lu, X., et al., 2016. 'Unveiling hidden migration and mobility patterns in climate stressed regions: A longitudinal study of six million anonymous mobile phone users in Bangladesh. Global Environmental Change 38, 1–7. https://doi.org/10.1016/j.gloenvcha.2016.02.002.
Marx, A., Dusa, A., 2011. 'Crisp-Set Qualitative Comparative Analysis (csQCA), Contradictions and Consistency Benchmarks for Model Specification. Methodological Innovations Online 6 (2), 103–148. https://doi.org/10.4256/mio.2010.0037.
Massey, D.S., 1990. 'Social structure, household strategies, and the cumulative causation of migration. Population index 56 (1), 3–26. https://doi.org/10.1126/science.237.4816.733.
Mastrorillo, M., et al., 2016. 'The influence of climate variability on internal migration flows in South Africa. Global Environmental Change 39. Elsevier Ltd, pp. 155–169. https://doi.org/10.1016/j.gloenvcha.2016.04.014.
McLeman, R., 2013. 'Developments in modelling of climate change-related migration. Climatic Change 117 (3), 599–611. https://doi.org/10.1007/s10584-012-0578-2.
McLeman, R., Smit, B., 2006. 'Migration as an Adaptation to Climate Change. Climatic Change 76 (1–2), 31–53. https://doi.org/10.1007/s10584-005-9000-7.
Mekuriaw, A., et al., 2018. 'Factors influencing the adoption of physical soil and water conservation practices in the Ethiopian highlands. International Soil and Water Conservation Research 6. Elsevier, pp. 23–30. https://doi.org/10.1016/j.iswcr.2017.12.006.
Mersha, A.A., Van Laerhoven, F., 2016a. 'A gender approach to understanding the differentiated impact of barriers to adaptation: responses to climate change in rural Ethiopia. Regional Environmental Change 16 (6), 1701–1713. https://doi.org/10.1007/s10113-015-0921-z.
Mersha, A.A., Van Laerhoven, F., 2016b. 'A gender approach to understanding the differentiated impact of barriers to adaptation: responses to climate change in rural Ethiopia. Regional Environmental Change 16 (6), 1701–1713. https://doi.org/10.1007/s10113-015-0921-z.
Meshesha, D.T., et al., 2014. 'Land-use change and its socio-environmental impact in Eastern Ethiopia's highland'. Regional Environmental Change 14 (2), 757–768. https://doi.org/10.1007/s10113-013-0535-2.
Methmann, C., Oels, A., 2015. 'From "fearing" to "empowering" climate refugees: Governing climate-induced migration in the name of resilience. Security Dialogue. https://doi.org/10.1177/0967010614552548.
Meze-Hausken, E., 2000. 'Migration caused by climate change: how vulnerable are people in dryland areas? Mitigation and Adaptation Strategies for Global Change' 5, 379–406.
Meze-Hausken, E., 2004. 'Contrasting climate variability and meteorological drought with perceived drought and climate change in northern Ethiopia. Climate Research 27, 19–31. https://doi.org/10.3354/cr027019.
Morrissey, J.W., 2013. 'Understanding the relationship between environmental change and migration: The development of an effects framework based on the case of northern Ethiopia. Global Environmental Change 23 (6), 1501–1510. https://doi.org/10.1016/j.gloenvcha.2013.07.021.
Murtinho, F., et al., 2013. 'Water Scarcity in the Andes: A Comparison of Local Perceptions and Observed Climate, Land Use and Socioeconomic Changes. Human Ecology 41 (5), 667–681. https://doi.org/10.1007/s10745-013-9590-z.
Myers, N., 2002. 'Environmental refugees: a growing phenomenon of the 21st century. Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences 357 (1420), 609–613. https://doi.org/10.1098/rstb.2001.0953.
Nawrotzki, R.J., Bakhtsiyarava, M., 2017. 'International Climate Migration: Evidence for the Climate Inhibitor Mechanism and the Agricultural Pathway. Population, Space and Place 23 (4), e2033. https://doi.org/10.1002/psp.2033.
Nawrotzki, R.J., Riosmena, F., Hunter, L.M., 2013. 'Do Rainfall Deficits Predict U.S.-Bound Migration from Rural Mexico? Evidence from the Mexican Census. Population Research and Policy Review 32 (1), 129–158. https://doi.org/10.1007/s11113-012-9251-8.
Neumann, K., Hilderink, H., 2015. 'Opportunities and Challenges for Investigating the Environment-Migration Nexus. Human Ecology 43 (2), 309–322. https://doi.org/10.1007/s10745-015-9733-5.
Nyssen, J., et al., 2004. 'Human impact on the environment in the Ethiopian and Eritrean

highlands—a state of the art. Earth-Science Reviews 64. Elsevier, pp. 273–320. https://doi.org/10.1016/S0012-8252(03)00078-3.
Piguet, E., 2010. 'Linking climate change, environmental degradation, and migration: a methodological overview 1. Wiley Interdisciplinary Reviews: Climate Change, pp. 517–524. https://doi.org/10.1002/wcc.54.
Piontek, F., et al., 2014. 'Multisectoral climate impact hotspots in a warming world. Proceedings of the National Academy of Sciences 111 (9), 3233–3238. https://doi.org/10.1073/pnas.1222471110.
Rademacher-Schulz, C., et al., 2012. Rainfall variability, food security and human mobility. An approach for generating empirical evidence. Bonn.
Ragin, C.C., 1987. The Comparative Method: moving Beyond Qualitative and Quantitative Strategies. University of California Presshttps://doi.org/10.1017/CBO9781107415324.004.
Ragin, C.C., Drass, Kriss A., Davey, S., 2014. Fuzzy-Set/Qualitative Comparative Analysis 2.5. Department of Sociology, University of Arizona, Tucson, Arizona Available at. http://www.socsci.uci.edu/~cragin/fsQCA/software.shtml.
Rahmato, D. (2009) The Peasant And The State: Studies In Agrarian Change In Ethiopia 1950s - 2000s.
Renaud, F. G. et al. (2011) 'A Decision Framework for Environmentally Induced Migration', 49. doi: 10.1111/j.1468-2435.2010.00678.x.
Rettberg, S., 2010. 'Contested narratives of pastoral vulnerability and risk in Ethiopia's Afar region'. Pastoralism. https://doi.org/10.3362/2041-7136.2010.014.
Reyes-García, V., et al., 2016. 'Local indicators of climate change: the potential contribution of local knowledge to climate research. Climate Change 7. Wiley Interdisciplinary Reviews, pp. 109–124. https://doi.org/10.1002/wcc.374.
Rigaud, K., et al., 2018. Groundswell: Preparing for Internal Climate Migration. The World Bank, Washington, DC. https://doi.org/10.7916/D8Z33FNS.
Rodriguez, N.P., Piore, M.J., 1981. 'Birds of Passage: Migrant Labor and Industrial Societies. Contemporary Sociology. https://doi.org/10.2307/2066952.
Rosell, S., 2011. 'Regional perspective on rainfall change and variability in the central highlands of Ethiopia, 1978-2007. Applied Geography 31. Elsevier Ltd, pp. 329–338. https://doi.org/10.1016/j.apgeog.2010.07.005.
Rosell, S., Holmer, B., 2007. 'Rainfall change and its implications for Belg harvest in South Wollo, Ethiopia. Geografiska Annaler, Series A: Physical Geography 89, 287–299. https://doi.org/10.1111/j.1468-0459.2007.00327.x. A(4.
Safra de Campos, R., Bell, M., Charles-Edwards, E., 2017. 'Collecting and Analysing Data on Climate-related Local Mobility: the MISTIC Toolkit. Population, Space and Place 23 (6), e2037. https://doi.org/10.1002/psp.2037.
Schneider, C.Q., Rohlfing, I., 2013. 'Combining QCA and Process Tracing in Set-Theoretic Multi-Method Research. Sociological Methods & Research 42 (4), 559–597. https://doi.org/10.1177/0049124113481341.
Schneider, C.Q., Wagemann, C., 2012. Set-Theoretic Methods for the Social Sciences. Cambridge University Press, Cambridge. https://doi.org/10.1017/CBO9781139004244.
Serdeczny, O., et al., 2017. 'Climate change impacts in Sub-Saharan Africa: from physical changes to their social repercussions. Regional Environmental Change 17 (6), 1585–1600. https://doi.org/10.1007/s10113-015-0910-2.
Silvestri, S., et al., 2012. 'Climate change perception and adaptation of agro-pastoral communities in Kenya. Regional Environmental Change. https://doi.org/10.1007/s10113-012-0293-6.
Sjaastad, L.A., 1962. 'The Costs and Returns of Human Migration. Journal of Political Economy. https://doi.org/10.1086/258726.
Skaaning, S.-E., 2011. 'Assessing the Robustness of Crisp-set and Fuzzy-set QCA Results. Sociological Methods & Research 40 (2), 391–408. https://doi.org/10.1177/0049124111404818.
Stark, O., Bloom, D.E., 1985. 'The new economics of labor migration. American Economic Review.
Tegegne, A.D., Penker, M., 2016. 'Determinants of rural out-migration in Ethiopia: Who stays and who goes? Demographic Research 35, 1011–1043.
Thomas, D.S.G., et al., 2007. 'Adaptation to climate change and variability: Farmer responses to intra-seasonal precipitation trends in South Africa. Climatic Change. https://doi.org/10.1007/s10584-006-9205-4.
van der Geest, K., 2011. 'North-South Migration in Ghana: What Role for the Environment? International Migration 49, e69–e94. https://doi.org/10.1111/j.1468-2435.2010.00645.x.
Warner, K., Afifi, T., 2014. 'Where the rain falls: Evidence from 8 countries on how vulnerable households use migration to manage the risk of rainfall variability and food insecurity. Climate and Development, 6 (1), 1–17. https://doi.org/10.1080/17565529.2013.835707.
Weldegebriel, Z.B., Prowse, M., 2017. 'Climate variability and livelihood diversification in northern Ethiopia: a case study of Lasta and Beyeda districts. The Geographical Journal 183 (1), 84–96. https://doi.org/10.1111/geoj.12178.
Wondimagegnhu, B. A. and Zeleke, M. E. (2017) 'Determinants of Rural Out-Migration in Habru District of Northeast Ethiopia'.
World Bank (2005) Ethiopia - Well-being and poverty in Ethiopia: the role of agriculture and agency. Washington, DC.
World Bank (2019) Population growth (annual %) - Ethiopia. Available at: https://data.worldbank.org/indicator/SP.POP.GROW?end=2018&locations=ET&start=2018&view=bar (Accessed: 4 November 2019).
Zickgraf, C., 2018. 'Immobility. In: McLeman, R., Gemenne, F. (Eds.), Routledge Handbook of Environmental Displacement and Migration. Routledge, New York, pp. 71–84.