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

Juliane Groth[a,*], Tobias Ide[b], Patrick Sakdapolrak[c], Endeshaw Kassa[d], Kathleen Hermans[a,e]

[a] UFZ - Helmholtz Centre for Environmental Research, Department Computational Landscape Ecology, Permoserstrasse 15, 04318 Leipzig, Germany

[b] University of Melbourne, School of Geography, 221 Bouverie Street, Carlton 3053, Australia

[c] University of Vienna, Department of Geography and Regional Research, Universitatsstrasse 7/5, 1010 Vienna, Austria

[d] Ethiopian Evangelical Church Mekane Yesus Development and Social Service Commission (EECMY DASSC), P.O.BOX 1021, Dessie, Ethiopia

[e] Laboratory of Geo-Information Science and Remote Sensing, Wageningen University, 6708 PB Wageningen, The Netherlands

* Corresponding Author. UFZ - Helmholtz Centre for Environmental Research, Department Computational Landscape Ecology, Permoserstrasse 15, 04318 Leipzig, Germany. Telephone: +49 341 235 – 1948

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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.

Keywords: environment-related migration, qualitative comparative analysis (QCA), Africa, climate change, adaptation

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 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

103 study region (section 3). We continue with the method section, in which we introduce our study area
104 and present our approach to data collection and the QCA used for the data analysis (section 4). In the
105 following, we present the results of the QCA (section 5). Afterwards, we interpret our findings based
106 on our in-depth case knowledge and discuss the relations to other relevant studies (section 6). We
107 conclude by embedding our findings in ongoing debates in the research field and with suggestions for
108 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 Flyvberg (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, 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).

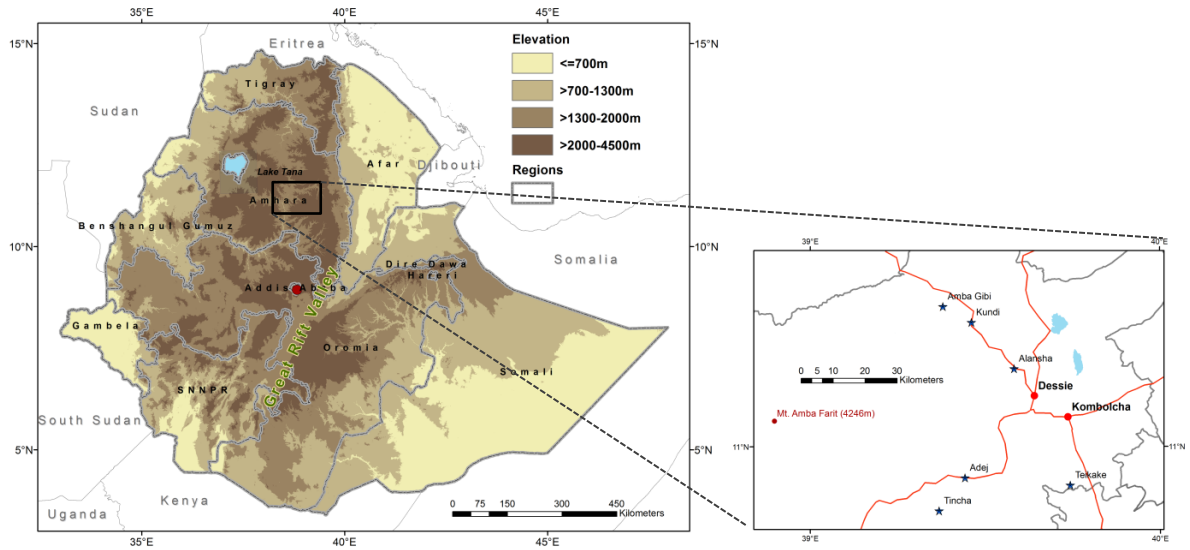

Figure 1: Left: Location map showing the administrative regions of the country and the research site in South Wollo based on elevation data obtained from the Shuttle Radar Topography Mission (SRTM) at 250-meter resolution (Farr *et al.*, 2007). Right: The map shows the locations of the six studied kebeles,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

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.

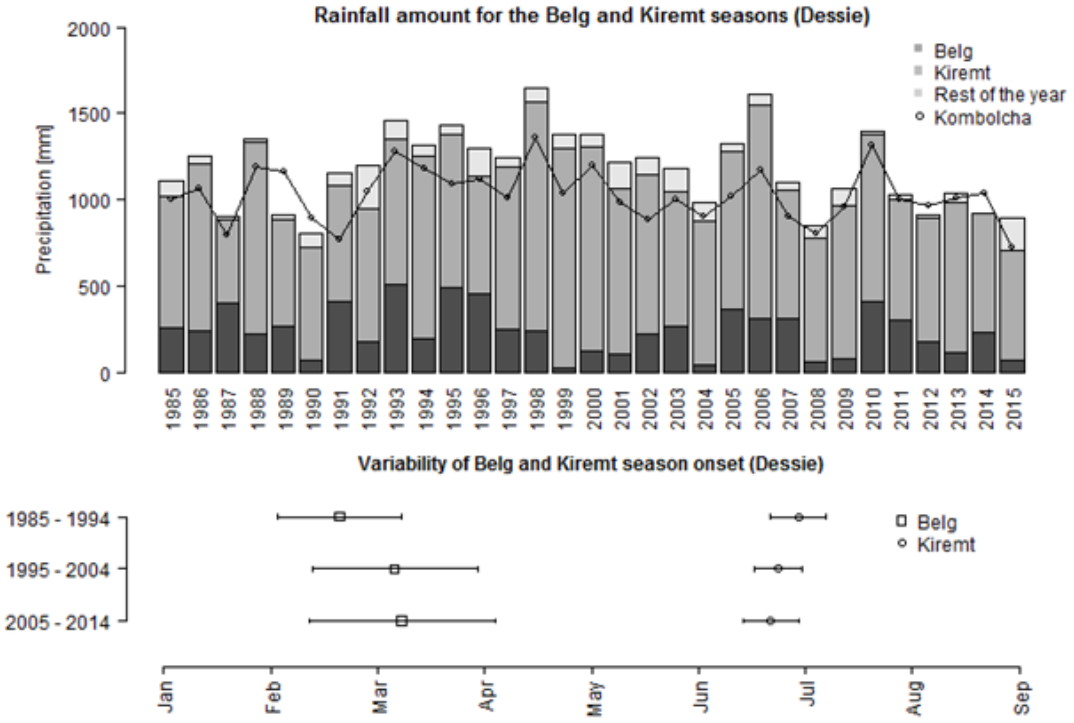

Figure 2: Upper panel: Annual precipitation for the Belg and Kiremt seasons between 1985 and 2015 for Dessie (2470 masl) and the total annual precipitation for Kombolcha (1842 masl) between 1985 and 2015. Lower panel: Mean onset and variability of onset (expressed in standard deviation) of Belg and Kiremt 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.

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 (Meze-Hausken, 2000; Gilligan, Hoddinott and Taffesse, 2009; Gebrehiwot and van der Veen, 2013; e.g., 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 authors 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.

Kebele	Agro-ecological zone[1]	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	x		Low
Kundi	Kola		x	x	x	High
Teikake	Kola	x	x			Low

Table 1: **Details of the six studied kebeles as described by the local officials. 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.**

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,

[1] (Hurni, 1998)

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 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.

298 **4.4. Qualitative comparative analysis**

299 To decipher the interwoven drivers of environment-related migration, we applied qualitative
300 comparative analysis (QCA). This is a set-theoretic approach that aims to detect causal relationships
301 within data (Schneider and Wagemann, 2012). The causal relationships between the potential influence
302 factors and each phenomenon can be described as being either necessary[2], sufficient[3] or non-existent.
303 In particular, QCA identifies whether (combinations of) various causal conditions (~ independent
304 variables) are necessary and/or sufficient for an outcome of interest (~dependent variable), which in
305 our case was out-migration. If a relationship between these influence factors and migration was
306 detected, we used the notion of causal factors or causal relationships.

307 QCA is a powerful tool for depicting complex causal patterns characterized by conjunctural causation
308 (conditions only have an impact if other conditions are present or absent) and equifinality (several
309 different combinations of conditions can result in the same outcome) (Ragin, 1987; Schneider and
310 Wagemann, 2012). Research has long highlighted that migration decisions can be explained by plentiful
311 – and equally valid – pathways of intertwined direct and indirect migration drivers (equifinality).
312 Migration decisions, including northern Ethiopia (e.g., Hermans and Garbe, 2019), typically can only
313 be explained by the interaction of several factors (conjunctural causation) (de Haas, 2010; Foresight,
314 2011). Consequently, QCA was especially appropriate in the context of this study. Furthermore, QCA
315 allows the integration of qualitative and quantitative data in the context of medium- and large-N
316 research designs. Hence, it combines the advantages of large-N statistical analyses (generalizability
317 beyond a few cases and high replicability) and in-depth case studies (deep knowledge of the respective
318 context and the data used) (Hughes and Nix, 1989).

319 To integrate different kinds of data and run the QCA algorithm that identifies necessary and sufficient
320 (combinations of) conditions, we needed to employ a calibration procedure. In other words, we
321 translated our (largely qualitative) empirical information from the interviews into numerical formats.
322 As our outcome was binary (migration/non-migration), we employed the crisp-set, binary version of
323 QCA (Schneider and Wagemann, 2012). Hence, we defined whether each household was a member in
324 the set of cases where a certain condition was present (1) or not (0). In line with good practices in
325 QCA (Schneider and Wagemann, 2012; Schneider and Rohlfing, 2013), we developed causal conditions

[2] The condition is a subset of the outcome. When the condition is present, the outcome is present.
[3] 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.

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 knowledge of the study. Section 2, section 3.5 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, 2018).

4.5. Theoretical assumptions and calibration

For our outcome of interest, a household[4] 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 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[5] (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 in section 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).

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

[5] 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).

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[6] (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 (Stark and Bloom, 1985; e.g., 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).

[6] 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).

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 (2015), 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.

Solution term	*migratexper* * (~*belgonly* + *non-farm*) → *migration*	
Solution coverage[7]	0.85 (17 out of 20 cases)	
Solution consistency[8]	1.00	
Causal pathway	*migratexper* * ~*belgonly*	*migratexper* * *non-farm*
Raw coverage[9]	0.75 (15 out of 20 cases)	0.70 (14 out of 20 cases)
Unique coverage[10]	0.15 (3 out of 20 cases)	0.10 (2 out of 20 cases)
Cases covered	15 out of 20	14 out of 20

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

422 **Table 2: Parsimonious solution term for sufficiency**

423 The robustness tests demonstrated the robustness of the main solution terms
424 (*migratexper*(~belgonly+non-farm)* → *migration*), which were exactly reproduced by 10 out of 15 tests (see
425 Table E.2 in appendix E). For the remaining five tests, the solutions showed a sub- or superset
426 relationship to the main solution, meaning that either the robustness test solutions were contained in
427 the main solution term (main solution was a superset of the test solution) or the main solution was
428 contained in the test solutions (main solution was a subset of the test solution). No robustness test
429 provided any results that contradict the main solution. In addition, for all performed tests, the causal
430 pathway containing the main solution had the highest raw coverage, with at least 0.69. All tests
431 performed, including the detailed explanations and respective parameters, can be found in appendix
432 E.

[7] 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.
[8] 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.
[9] 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.
[10] 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.

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 nb. 81, Hurni et al., 2007). Consequently, the Kiremt farmers have a higher agricultural diversity[11] 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

[11] 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.

462 farmers. These findings highlight the importance of mesolevel, agro-ecological features for shaping
463 migration, which have thus far been studied less than household or individual influence factors (but
464 see Tegegne and Penker, 2016).

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

480 Collectively, the two identified INUS conditions, ~*belgonly* and *non-farm*, highlight the relevance of
481 favorable environmental conditions and in situ livelihood diversification since both can increase the
482 economic resources of a household, which could be used for migration. This implies that migration as
483 adaptation is constrained for those lacking the respective resources – which are predominately the
484 most vulnerable ones – such as the Belg-dependent farmers, or for farmers that have limited access to
485 non-farm activities for reasons such as the remoteness of the kebele or gender or age. The importance
486 of economic resources for environment-related migration has long been recognized, but mainly in the
487 context of long-term and international (costly) migration (e.g., Gray and Mueller, 2012b). At our
488 research sites, various migration types in terms of distance and duration occurred, and our identified
489 causal pathways encompassed all of them, implying that the economic resources can enable several
490 types of migration and are not limited as facilitators for long-term or -distance migration. It is still
491 possible, however, that follow-up studies reveal important differences between short- and long-
492 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 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 (McLeman and Smit, 2006; e.g., 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

524 possible reason for these biases could be the general mistrust of the local authorities by the farmers
525 and their dependence on the support of the local authorities (Rahmato, 2009). Another reason for
526 inconsistent responses, which is also relevant for rainfall variability, may have been a mismatch
527 between the measured and perceived environmental changes (Murtinho *et al.*, 2013; e.g., Reyes-García
528 *et al.*, 2016). This may be because of aspects of vulnerability or cultural backgrounds influence local
529 perceptions (for Ethiopian studies, see Meze-Hausken, 2004; Rettberg, 2010; Adimassu, Kessler and
530 Stroosnijder, 2014). But while perceptions might differ from measured changes, it is the former in
531 which farmers base their decision and behavior (Hansen, Marx and Weber, 2004; Thomas *et al.*, 2007;
532 Silvestri *et al.*, 2012). Furthermore, our proposed main solution – although the solution coverage was
533 quite high – left three cases of migrating households unexplained (ID 3, 4 and 26). These three cases
534 had in common that the migrants within the household were solely female, whereas in all other
535 households, only men or both men and women migrated. Studies from the northern highlands showed
536 that there are gender-specific barriers for climate adaptation, including migration, associated with
537 differences in roles, responsibilities and access to resources (Gray and Mueller, 2012a; Mersha and Van
538 Laerhoven, 2016b). Although our study did not explicitly aim to analyze the influence of gender on
539 migration, the three unexplained cases suggest that migration evolves differently for women than for
540 men. Finally, our analysis did not capture migration for less than one month. Although such short-
541 term migrations were not reported during the household or migrant interviews, they still might occur.
542 They are however more difficult to recall, especially for other household members, compared to longer
543 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 (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 (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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611

612 **CRediT authorship contribution statement**

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

618

619 **Declaration of Competing Interest**

620 The authors declare that they have no known competing financial interests or personal relationships
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629

630 **Supplementary materials**

631 Supplementary material associated with this article can be found, in the online version, at
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