Working paper

A systematic review of empirical evidence on migration influenced by environmental change in Africa

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Abstract

BACKGROUND

Despite an increase in scholarly and policy interests in the impacts of environmental and climate change on migration, empirical knowledge in the field remains varied, patchy and limited. Generalized discourse on migration influenced by environmental change frequently leads to an oversimplification of the complex channels through which environmental change influences the migration process. The role of environmental and climate change in driving migration reported in existing studies seems to vary from one extreme to the other – from limited and rather indirect role to significant impacts – preventing us from drawing a conclusive evidence.

OBJECTIVE

This paper seeks to systematize the existing empirical evidence on migration influenced by environmental change with a focus on Africa, the continent most vulnerable to climate change.

METHODS

We combine elements of a systematic evidence assessment with a more reflexive form of evidence-focused literature review. 53 qualitative and quantitative studies selected from the comprehensive "Climig database" on the influence of environmental change on migration are systematically analyzed based on the framework of the multi-dimensional drivers of migration.

RESULTS

Environmental change influences migration in Africa in an indirect way i.e. through affecting other drivers of migration including sociodemographic, economic and political factors. How and in what direction environmental change influences migration depends on socioeconomic and geographical contexts, demographic characteristics and type and duration of migration.

CONCLUSIONS

It is not possible to draw a universal conclusion whether environmental change will increase or suppress migration in Africa since it is context-specific.

CONTRIBUTION

The review provides a first systematic and comprehensive summary of empirical evidence on environmental driver of migration in Africa considering direct and indirect pathways through which environmental change influence internal and international migration.

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1 Introduction

The relationship between environmental change and migration has gained public attention in the past couple of years. This is reflected in increasing news stories specifically about climate induced migration/displacement amidst a decline in reports about climate change in general since the beginning of the decade (Randall 2015). A severe prolonged drought coupled with poor resource management and governance in Syria, for instance, was claimed to be a driver of conflict and consequently outmigration of millions of Syrians from their home country (Gleick 2014; Kelley et al. 2015). As a consequence, surge in migrant and refugee arrivals in Europe and the potential security threat are linked with climate change in media and policy (Sterly et al. 2016). Many scholars, however, raised concern about the overemphasis on the importance of environmental stress as a major driver of migration in Syria (De Châtel 2014; Fröhlich 2016) as well as "excessively alarmist" estimates and predictions of environmental migrants (Gemenne 2011). In fact, migration is a complex phenomenon and it is difficult to empirically establish a direct, causative relationship between climate change and migration.

Understanding the linkages between climate change and migration hence is an empirical question. Increase in data availability and improvement in tools and techniques contributed to a steady rise in empirical studies on environmental change and migration (Fussell et al. 2014). Particularly, since 2010 (until 2016), on the average 20 papers on climate change or environmentally induced migration using quantitative methods have been published per year (Hoffmann et al. 2018). Likewise, given the research topic that crosscuts disciplinary boundaries, interdisciplinary collaborations among environmental and migration researchers, geographers, demographers, economists and sociologists have become more common (Kniveton et al. 2008; McLeman 2013). However, despite the increasing number of empirical studies on the topic, empirical knowledge in the field remains varied and patchy (Hunter et al. 2015; Piguet et al. 2011). There is no conclusive evidence on the direction and magnitude of the influence of environmental change on migration which can range from limited and rather indirect role (de Haas 2011) to significant impacts (Marchiori & Schumacher 2011).

In particular, the complexity of the migration phenomenon itself coupled with a wide range of climatic change and its impact on livelihoods, indicate that addressing the linkage between those two processes cannot be formulated in a simple manner. Accordingly, Black et al. (2011) proposed a conceptual framework which captures the direct and indirect impacts of environmental change on migration decisions. The framework puts emphasis on key drivers of migration, namely, economic, political, social and demographic factors and how environmental change interacts with these drivers in influencing migration decisions. Owing to its evidence base design, it is possible to apply the framework to empirically assess migration processes accounting for different drivers and the interactions between them.

To that end, this paper seeks to systematize the existing empirical evidence on migration influenced by environmental change with a focus on Africa based on Black et al.'s (2011) framework on drivers of migration. We combine elements of a systematic evidence assessment with a more reflexive form of evidence-focused literature review. The paper focuses explicitly on empirical literature on Africa for two reasons. First, the reason why we focus on Africa is due to the fact that the livelihoods of the majority of African population rely on agriculture. With very low levels of irrigation, livelihoods in this region are particularly vulnerable to climate change (Serdeczny et al. 2017). Africa therefore is likely to be more exposed the impacts of environmental change on migration (if any) than other continents (Niang et al. 2014). Second, Africa migration has attracted significant attention not only among the media and policy makers but also academic scholars (Flahaux & De Haas 2016; Schoumaker et al. 2013). It is perceived that migration from Africa is high and increasing, particularly mass migration driven by poverty, warfare and environmental change directed towards Europe (Castles et al. 2014). However, Flahaux and De Haas (2016) argue that these assumptions are not necessarily backed up by sound empirical evidence. Our study thus will shed light on Africa migration particularly in the context of environmental driver of migration – which has recently drawn increasing interest in media coverage.

By systematically analysing 53 empirical qualitative, quantitative and mixed-methods studies selected from the comprehensive "Climig database" (Piguet et al. 2018) on the influence of environmental change on migration in Africa, the contribution of this paper to the field of environmental migration is three folds. First, the paper provides new synthesised evidence on climate related migration. Considering both quantitative and qualitative studies, the paper identifies common patterns and interactions between migration drivers whilst using qualitative studies to deepen the knowledge on the processes of migration decision-making. This way we are able to comprehensively capture the relationship between environmental change and migration from both the macro- and micro-level perspectives. Second, the paper offers a comprehensive review of evidence on environmental migration in Africa from 1989 to May 2017. There are two previous review studies focusing on Africa. Covering 13 case studies of environmentally induced migration in the Sahel, a previous review study by Jónsson (2010) only considered micro-level studies focusing on migration of an individual or a household. A more recent study by Morrissey (2014) provides a review of over 30 studies to synthesise attempts at modelling the environment-migration nexus in sub-Saharan Africa. Our study offers an improvement from previous studies since it spans across a longer and more recent time periods. Furthermore, we cover a wide range of environmental migration studies in Africa ranging from micro-level studies to macro-level studies, actual migration and migration intention. Third, the paper is of policy relevance. Given the common narrative of mass migration driven by war/conflict and environmental pressure from Africa to Europe, it is vital to investigate whether there is empirical evidence supporting this claim. The results from this review thus can inform a policy planning both in sending and receiving countries.

The remainder of the paper is organised as follows. The next section elaborates the framework of drivers of migration put forward by Black et al. (2011). Section 3 describes methods and procedures of our systematic literature review and presents the database. Section 4 describes the results. The final section discusses the key findings and concludes.

2 Conceptualising migration and environmental change

Research on the relationship between environmental change and human mobility has a long history and has gained currency in the past decades (Piguet et al. 2011)[1]. Piguet (2013) points out the environment has played a central role in migration research in early works of geographers such as Friedrich Ratzel (1903) or Ellen Churchill Semple (1911), but disappeared as an explanatory factor in the beginning of second half of the last century. Environmental driver of migration reappeared again in the 80s and 90s through growing concern of environmental issues and the potential impacts of climate change. Different disciplines – demography, geography, sociology, social anthropology to name a few – have contributed to the conceptualisation of the environment-migration nexus. Furthermore, the field is characterised by a close interaction between science and policy (Gemenne 2011).

There is a consensus that the relationship between migration and environment is complex and multifaceted (Hugo 2011). The difficulty to capture the phenomenon is expressed by the myriads of terms and definitions that seek to address the link (Aufenvenne & Felgentreff 2013; Müller et al. 2012; Renaud et al. 2007; Warner et al. 2010). The literature, as the Foresight (2011, p.34) consternates, is characterised by the "unwieldy and imprecise collection of terms and phrases". In a collection by Müller et al. (2012), which does not claim completeness, 16 different terms and over 20 definitions were identified. The terminology ranges from "environmental refugee" – a termed coined by El Hinnawi (1985), which has been heavily criticized by scholars (Black 2011; Castles 2002) but is still popularly used in the media and by policy makers – to "migration influenced by environmental change" – a phrase used by the Foresight (2011) that seeks to avoid simplification and capture the complex nature of the relationship. Most of the terms have in common that they focus on the impact of environment on human mobility and take into consideration temporal (e.g. permanent and seasonal migration, slow and rapid-onset events) and spatial (e.g. internal and international movements) dynamics. But the terms differ in terms of which aspect of the environment is included - some definitions include human-induced stresses such as industrial accidents, building of dams etc. (e.g. El-Hinnawi 1985), some refer only to specific aspects of the environment such as the climate (e.g. Bronen 2010).

The terms can be differentiated in two additional important aspects. The first refers to the degree of autonomy of the population on the move: while those terms that refer to "refugee" and "displacement" focuses solely situations where people have limited agency and are forced to move (climate refugees Brown 2008; environmental displacee Dun et al. 2007), the term "migration" (environmental migrant Laczko & Aghazarm 2009) seek to capture forced as well as voluntary movements that can occur in the context of environmental change. This has significant implication on the scope of the phenomena that the term refers to.µ The second aspect refers to the manner how causality is expressed: On the one hand, most terms imply the possibility to clearly attribute the impact of environmental factors on human mobility and by doing so express a mono-causal relationship between some aspects of the environment and human mobility (e.g. environmental

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[1] See Piguet (2013) for elaborated and detailed remarks on the history and the development of the research on environmental change and migration. See Black et al. (2011), Hunter, Luna, and Norton (2015) for an overview.

refugee, environmental migrants etc.). On the other hand, the above mentioned phrase "migration influenced by environmental change" seek highlight that environmental change does most often not influence migration decision directly but mediated through other existing drivers of migration as well as other variable on different scales.

The multiplicity of terms addressing the migration environment nexus is also an expression of the broad range of ways the relationship has been conceptualised. Early contributions from authors such as El Hinnawi (1985) or Myers (2002) address the relationship in a rather simplistic stimulus response model and embed displacement in a neo-malthusian narrative by linking it to population growth and resource degradation. Similar lines of argumentation can still found in technically sophisticated modelling approaches such as work on sea-level rise and population displacement in the United States (Hauer 2017). These contributions have been criticised for its uni-causal focus, over-simplification of migration processes, lack of consideration of agency and a range of adaptive options an individual can draw upon. On the opposite, the majority of scholars draw on existing approaches in migration studies and insights from a broad range of disciplines in order to capture the relationship (see Black et al. 2011; Hunter et al. 2015). Bilsborrow (1992), for instance, considers out-migration as one of the demographic responses to resource scarcity in the context of population pressure but also highlights the importance of social, political, economic context that influences the nature of the relationship. Based on the insights from hazard research, Perch-Nielsen (2008) points out the range of adaptive options – including migration – that people have in order to deal with environmental stresses. Likewise, livelihoods research has helped to contextualise migration and environmental relation as an aspect of vulnerable livelihoods systems (McLeman & Smit 2006). Other scholars have pointed to the importance of considering the connectedness and networks established through migration for the understanding of migration in the context of environmental change (Sakdapolrak et al. 2016). An important contribution to the conceptualisation of the migration-environment nexus is the "drivers of migration framework" by Black et al. (2011) which emphasises that the understanding of migration in the context of environmental change needs to take into account the interplay of factors on different scales (macro, meso and micro). This framework is employed as the guiding frame for the analysis of the reviewed studies as described below.

3 Methods: A systematic review

Numerous case studies regarding the processes that drive migration including the contribution of environmental change have been carried out. However, to date, no systematic review on the African countries has been performed. A methodological approach combining elements of a systematic evidence assessment with a more reflexive form of evidence-focused literature review employed in this study would enhance the understanding of the influence of climate change on migration processes.

Using the comprehensive Climig database - the most update list of publications about "Migration, Environment and Climate Change" (Piguet et al. 2018), 227 references correspond to the outputs with the keyword "Africa" were extracted. The literature search was conducted in May 2017. Then, a Rapid Evidence Assessment (REA) was conducted following the procedure described in Cummings et al. (2015). The research and analysis process started with a precise review question "In what combinations of contexts does environmental change interact (or not) with migration?" and the structured literature search from the database with a clear protocol and rationale for how the search has been performed (Figure 1). The first screening stage was mainly the exclusion of studies without an empirical nature and those with non-English languages. Then, the appraisal of the quality of evidence was considered in the second stage by taking into consideration the type, design and quality

of the studies. After applying a systematic scoring system, 60 studies were selected and analysed. A final quality check was performed to exclude the papers based on method producing limited evidence (e.g. expert based interview).

Figure 1: Scoping review's flowchart

1. Climig original dataset
With the key word AFRICA
N= 227 references

Exclusion of duplicates, studies in non-english languages and irrelevant type of studies (not empirical)

2. References whose abstract, introduction, conceptual framework and material & methods were reviewed
N= 106 references

Exclusion of studies with a low score (based on the conceptual framing, the methodological transparency and the relevance to the research topic of the review)

3. Published articles entirely reviewed
N= 60 references

Final quality check with a special focus on the method used. Exclusion of studies with evidence on migration-environment nexus only based on expert interviews

4. Final list of the articles including at least one case study which draw empirical evidence on the migration- environmental change nexus
N=53 references

Applying the inclusion – exclusion criteria yielded 53 papers published from 1989 to 2017 as presented in Figure 1 and Table 1. Four studies examined the environmental change- migration nexus by using data on countries of the Sub-Saharan African (SSA) continent (one paper with a broader perspective: 116 countries included SSA (Cattaneo & Peri 2016) and three papers with a special focus on countries in the SSA (Barrios et al. 2006; Neumann et al. 2015; Suckall et al. 2017). 22 articles used a comparative approach dealing with case studies of more than one country. 11 studies examined the relationship between environmental change and migration at a national scale. The most frequent situation encompasses the local case studies (subnational studies). 26 case studies[2] have been carried out, covering mainly the West of Africa on one side, and Ethiopia and Tanzania in the East.

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[2] Some of the case studies of the articles having a comparative approach are also counted at local cases, when that is relevant. Therefore, the 53 papers reviewed lead to more than 53 specific analyses.

Table 1: Summary of 53 papers included in the review

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environ-mental data based on the year	environmental data used	Type of environ-mental stressor	Migration	migration data based on the year	Sample size	Data source
1	Abu et al. (2014)	migration intentions in response to major stressors	quantitative (binary logistic regression)	Forest-savannah transition zone Ghana	2007-2009	perceived environmental stressors (scoring for severity), irregular rainfall and bushfire major stressors	multiple	internal migration; defined	2009	200 HH	CCLONG Project survey
2	Adaawen (2015)	migration dynamics, climate change impact on agrarian livelihoods	qualitative/ quantitative	Bongo district, Northern Ghana	not specified	perceived data (rainfall variability, food scarcity), reported environmental data used for description of the study site	multiple	internal & international migration; return migration; in-migration; not defined	not specified	120 HH, 57 interviews, 4 FGD	Own data
3	Afifi (2009)	nexus between land degradation, water shortage and migration	qualitative	Egypt	2009	perceived data (reported water scarcity and land degradation)	multiple	internal migration; defined	2009	30 Interviews	Own data
4	Afifi (2011)	Environ-mentally induced economic migration	qualitative/ quantitative	Niger: Niamey, Tillabéri	1967-2009	perceived data, reported stress: droughts, soil degradation, deforestation, shrinking of lake Chad	multiple	Internal & international migration; return migration; not defined	2008	60 migrants, 20 non-migrants, 25 experts	Own data
5	Afifi et al. (2012)	refugees' perception of climate change in their home countries	qualitative	Ethiopia; Uganda	1992-2011	reported data (rainfall variability, temperature variability)	multiple	Refugees; internal migration & international; short & long-term migration; not defined	2011	not specified	Own data
6	Afifi et al. (2014)	relationship between rainfall shortage and out-migration	qualitative/ quantitative	Tanzania: Kilimanjaro District	1950s-2000	perceived data (rainfall variability, drought, water shortage)	multiple	internal migration; short & long-term migration; defined	2013	165 HH	Own data

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environ-mental data based on the year	environmental data used	Type of environ-mental stressor	Migration	migration data based on the year	Sample size	Data source
7	Afriyie et al. (2018)	adaption strategies of households to periodic flooding	qualitative (AVA Framework)	Ghana: Central Gonja District	1974-2010	reported data (flood statistics, rainfall variabilities), perceived data	single	internal migration; short-term; not defined	2011	60 HH, 14 FGDs	Own data
8	Barrios et al. (2006)	role of climate change in Urbanization patterns	quantitative (econometric analysis)	Sub Saharan African Countries	1960-1990	rainfall data set from IPCC as proxy for climatic change	single	internal migration (urbanisation as proxy indicator); not defined	1950-2000	36 sub-Saharan African countries	census data
9	Bleibaum (2008)	drivers of migration and the linkage with climate change	qualitative	Senegal: Peanut Basin and River Valley	2008	perceived and reported environmental stressors (drought, lack of water, low soil fertility)	multiple	internal migration; short-term & long-term migration; not defined	2008	27 migrants	Own data
10	Carr (2005)	interviewing of economic, social and environmental drivers of migration	qualitative (interviews, small-scale survey)	Ghana: Dominase, Pankrum, Yensunkwa	not specified	perceived and reported environmental stressors (declining rainfall, soil degradation)	multiple	internal migration; short & long-term migration; not defined	1997-2000	90 interviews, 50 in survey	Own data
11	Cattaneo and Massetti (2015)	interaction environmental change and migration	quantitative	Ghana, Nigeria	1961-1990/ GCM climate 2 periods: 2031-2060/ 2071-2100	Gridded climate data; monthly mean temperatures and precipitation/ Climate change scenarios	multiple	internal & international migration; defined	2010/2011; 2005/2006	various	Nigeria General Household Survey, Ghana Living Standard Survey
12	Cattaneo and Peri (2016)	analysis of differential warming trends across countries on probability of migration	quantitative	116 countries	1960-2000	mean temperature for each country	multiple	internal (urbanisation as proxy indicator) & international migration; defined	1960-2000	116 countries	bilateral migrant stocks in 116 countries; census

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environ-mental data based on the year	environmental data used	Type of environ-mental stressor	Migration	migration data based on the year	Sample size	Data source
13	Doevenspeck (2011)	soil degradation and interaction of social, political drivers of migration	qualitative/ quantitative	Benin	1991, 1992, 2004	perceived data (soil degradation, environmental degradation)	single	Internal migration; not defined	2000-2005	431 HH; 83 narrative interviews	Own data
14	Dreier and Sow (2015)	Bialaba Farmers migration patterns	qualitative (Grounded Theory)	northwest Benin, Nigeria	2005	perception of the Interviewees (drought, shifting seasons, deforestation, soil erosion)	multiple	international migration; short-term & long-term migration; defined	2013	63 Interviews; 4 Expert Interviews	UN Population division data 45 SSA countries (annual average for the ten 5-year periods)
15	Ezra (2001)	effect of environmental change and persisting food insecurity on demographic behaviour	quantitative	Ethiopia: Tigray, Wello North Shewa	1997	perception of ecological degradation (shortage of rain, food insecurity) reported data on four major droughts and famines	single	internal migration; temporary & permanent migration; resettlement; defined	1994-1995	2000 HH	Previous survey conducted 1994/95
16	Ezra and Kiros (2001)	multi-level analysis of rural out-migration in Ethiopia 1984-1994	quantitative	Rural Ethiopia	1800-1994	perceived data from the survey on land degradation and drought	single	internal migration; defined	1994-1995	2000 HH, data of 4277 persons	previous survey for PhD Dissertation
17	Findley (1994)	migration patterns of families in Mali during drought of 1983-1985	quantitative	Upper Senegal River Valley, Senegal and Mali	1983-1989	retrospective perceived data on drought	single	internal & international migration; temporary & permanent migration; short-cycle migration; defined	1982, 1989	327 HH 1982; 327 HH 1989	longitudinal panel study 1982 and 1989 CERPOD

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environ-mental data based on the year	environmental data used	Type of environ-mental stressor	Migration	migration data based on the year	Sample size	Data source
18	Gray (2011)	effects of soil characteristics on human migration or other social outcomes for vulnerable households	quantitative	Kenya, Uganda	2004, 2007	household soil sample data (soil quality, soil degradation	single	internal migration; temporary & permanent migration; defined	2004, 2007	900 HH longitudinal interviews	longitudinal survey, part of REPEAT Project
19	Gray and Mueller (2012)	investigates the impact of drought on the population mobility in rural Ethiopia over a decade	quantitative	Rural Ethiopia	2002, 2008	HH data and satellite image data on drought	single	internal migration; temporary & permanent migration; defined	1999, 2004, 2009	construct mobility histories of 3100 individuals	Ethiopian Rural Household survey
20	Grolle (2015)	Case studies of three famines that occurred in rural northwest Nigeria during the latter half of the twentieth century are presented.	qualitative	northwest Nigeria	1950s, 1970s, 1980s	reported data on three drought events (50s, 70s, 80s)	single	internal migration; family migration; temporary & permanent migration; not defined	1988-1990	162 family heads	Own data
21	Hamza et al. (2009)	relation between environmental degradation and migration	qualitative	Morocco		reported data on multiple environmental factors	multiple	internal migration; temporary migration; not defined	2008	30 migrants, 30 non-migrants, experts	Own data
22	Haug (2002)	focuses on a pastoralist group heavily hit by drought in the 1980s and forced to leave their home area	qualitative (participatory methods)	Northern Sudan	1998-2000	perceived data	single	internal migration; forced migration; return migration; defined	1998-2000	45 individuals	Own data

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environ-mental data based on the year	environmental data used	Type of environ-mental stressor	Migration	migration data based on the year	Sample size	Data source
23	Heaney and Winter (2016)	exploratory case study examines how climate-driven migration impacts the health perceptions and help-seeking behaviours of Maasai in Tanzania	qualitative	Tanzania	2013	perceived data	multiple	internal migration; defined	2013	28 individuals	Own data
24	Henry, Schoumaker and Beauchemin (2004)	impact of rainfall conditions on Sahelian livelihoods	quantitative (event history analysis)	Burkina Faso	1960-1998	rainfall indicators, use of water conservation techniques	multiple	internal migration; permanent migration; defined	2000	8644 individuals	Migration Dynamics, Urban Integration and Environment Survey of Burkina Faso (EMIUB)
25	Henry et al. (2003)	modelling interprovincial migration in Burkina Faso	quantitative (census data combined with environmental data)	Burkina Faso	1960-1984	Climatic and land degradation variables (drought frequency, precipitation, severity of soil degradation, logged cotton yield, percentage of cultivated land area)	multiple	Internal migration; defined	1985	7,964,705	Demographic data extracted from population census survey
26	Henry et al. (2004)	influence of environmental change on migration in Burkina Faso	quantitative	Burkina Faso	1960-1999	rainfall (global monthly precipitation), land degradation via estimation of the RUE (rain use efficiency)	multiple	Internal & international migration; defined	1960-1999	3570 HH, collection of 9612 biographies	Migration Dynamics, Urban Integration and Environment Survey of Burkina Faso (EMIUB)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environ-mental data based on the year	environmental data used	Type of environ-mental stressor	Migration	migration data based on the year	Sample size	Data source
27	Hummel (2016)	interactions between climate change, environmental degradation and migration in the West African Sahel	qualitative/ quantitative (mixed methods)	Mali, Senegal	2012	from the HH survey, perception of Interviewees	multiple	Internal & International migration; seasonal & temporary migration; defined	2012	905 HH	Own data
28	Hunter et al. (2017)	temporary rural South African out-migration	quantitative	South Africa	2005-2007	proximate natural resource availability based on NDVI	multiple	Internal migration; temporary migration; defined	2007	9625 HH	Agincourt Health and Demographic Surveillance System (Agincourt HDSS)
29	Simatele, D. and Simatele, M. (2015)	Interaction between environmental stress, economic and political factors as migration drivers	qualitative (participatory methods)	Southern Zambia	2009-2010	perceived data on multiple climatic stressors	multiple	internal migration; permanent migration; not defined	2009-2010	30 HH	Own data
30	Konseiga (2006)	motivation behind the important migration from Burkina Faso to Cote d'Ivoir	quantitative	Burkina Faso, Ivory coast	2000, 2002	comparison of areas according to an amount of rainfall (low/medium rainfall with threshold of 400mm/ yearly rainfall level of 400 mm = low/ medium = 450mm per year)	multiple	International migration; seasonal & permanent migration; defined	2000, 2002	401 HH	CAPRi survey

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environ-mental data based on the year	environmental data used	Type of environ-mental stressor	Migration	migration data based on the year	Sample size	Data source
31	Koubi et al. (2016)	examines migration decision-making and individual perceptions of different types of environmental change (sudden vs. gradual environmental events)	quantitative	Uganda, Vietnam, Cambodia, Nicaragua, Peru	2013-2014	perceived data, choice of studied region related to environmental conditions	multiple	internal migration; permanent migration; defined	2013-2014	3689 individuals migrants and non-migrants	Own data
32	Kubik and Maurel (2016)	analysis of migration as a response of rural households to weather shocks	quantitative	Tanzania	2008, 2009	SPEI index, crop production estimated by using agricultural and weather data, index is used as a proxy for drought	multiple	internal migration; permanent migration; defined	2008/2009-2010/2011	1583 HH	Tanzania National Panel Survey (TZNPS)
33	Leyk et al. (2012)	developing migration models considering spatial non-stationarity and temporal variation – through examination of the migration-environment association at nested geographic scales	quantitative	South Africa	2000-2002, 2007	proximate natural resource availability based on NDVI	multiple	internal migration; temporary migration; defined	2002, 2007	9374 HH	The Agincourt Health and Demographic Surveillance System (AHDSS)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environ-mental data based on the year	environmental data used	Type of environ-mental stressor	Migration	migration data based on the year	Sample size	Data source
34	Meze-Hausken (2000)	adaptation capacity of subsistence farmers in Northern Ethiopia	qualitative (rapid rural appraisal)	Ethiopia	1999	reported drought, perceived data - analysis of migrant's behaviour and living conditions before and after the onset of previous droughts	multiple	internal migration; in- & return migration; defined	1999	104	Own data
35	Morrissey (2013)	explores dominant mobility narratives among populations whose livelihoods are exposed to a range of environmental stresses	qualitative	Ethiopia	2009	perceived data	multiple	Internal migration; not defined	2009	361 migrants, 51 experts	Own data
36	Morrissey (2012)	relationship between environmental stress and rural-urban migration in Northern Ethiopia	qualitative	Ethiopia	2009	perceived data	multiple	internal migration; temporary & permanent migration; not defined	2009	not specified	Own data
37	Naudé (2008)	panel data on 45 countries spanning the period 1965 to 2005 are used to determine the main reasons for international migration from SSA	quantitative	Sub Saharan African Countries	1974-2003	frequency of any kind of natural disaster per country and environmental pressure: land under irrigation	multiple	international migration; defined	1965-2005	net migration per 1000 inhabitants for 45 countries	UN Population division data 45 SSA countries (annual average for the ten 5-year periods)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environ-mental data based on the year	environmental data used	Type of environ-mental stressor	Migration	migration data based on the year	Sample size	Data source
38	Neumann et al. (2015)	analysing spatial patterns of environmental drivers of migration in drylands by performing a cluster analysis on spatially explicit global data	quantitative	Burkina Faso, Brazil	2000; 1970-2000	spatially explicit information of environmental conditions (annual mean precipitation, aridity, drought frequency, land degradation, soil constraints, cropland and pasture), NDVI	multiple	internal & international migration; defined	1990-2000	not specified	CIECIN Spatially explicit grid cell level migration data
39	Ocello et al. (2014)	examines the roles played by droughts or floods, crop diseases, and severe water shortages in inter-district migration in Tanzania	quantitative	Tanzania	2008-2009	perceived data	multiple	internal migration; defined	2008-2009	3265 HH	Tanzania National Panel Survey (TZNPS)
40	Rademacher-Schulz et al. (2014)	Interrelation-ships between rainfall variability, livelihood/ food security and migration in rural Savannah communities in Northern Ghana	qualitative/ quantitative (HH survey, PRA, expert interviews)	Ghana	2011	perceived data	multiple	internal migration; seasonal migration; not defined	2011	158 HH	Own data

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environ-mental data based on the year	environmental data used	Type of environ-mental stressor	Migration	migration data based on the year	Sample size	Data source
41	Romankiewicz and Doevenspeck (2015)	local perspective on migration with consideration of cultural norms and interpretation of weather events	qualitative (multisited ethnography)	Mali, Senegal	1961-2000; 2011/ 2012	local indicators on rainfall and vegetation (number of trees in the field); perceived data	multiple	internal & international migration; temporal & permanent migration; not defined	2011, 2012	not specified	Own data
42	Smith (2014)	describes the conceptual and practical development and testing of the Rainfalls Agent-Based Migration Model – Tanzania (RABMM-T)	quantitative	Tanzania	2012	rainfall indicators (three-months-local rainfall variability) historical data and scenarios from literature	single	not defined	2012	1000 individuals; 165 HH	Own data
43	Sow et al. (2014)	explores archives and narratives of African migrants in north-western Benin and north-eastern Ghana	qualitative	Benin, Ghana	2012, 2013	reported data from archives	multiple	internal & international migration; in-migration; not defined	2012, 2013	35 HH, 4 FGD, 25 interviews	Own data
44	Suckall et al. (2017)	examines how climate change may affect the migration decisions of rural farmers in SSA	qualitative/ quantitative (HH survey, FGD, interviews)	Sub Saharan African Countries	2009, 2010	Perceived data on climatic stresses and shocks	multiple	internal migration; not defined	2009, 2010	255 HH, 75 interviews, 93 FGD	Own data

| No.	Author's name (Year of publication)	Key topics	Methods	Area	Environ-mental data based on the year	environmental data used	Type of environ-mental stressor	Migration	migration data based on the year	Sample size	Data source
45	Van der Geest (2011a)	nexus between environmental degradation and migration in northern Ghana	qualitative/ quantitative	Northern Ghana	1982-2002	vegetation data (NDVI and GIMMS Data), rainfall data	multiple	internal & international migration; defined	2000	regional n = 10 district n = 110	life histories, Focus Group Discussions, Ghana's 2000 population and housing census data
46	Van der Geest (2011b)	determine the importance of the environment as a driver of North-South migration in Ghana	qualitative/ quantitative	Ghana	1970s, 1980s	NDVI Data on rainfall vegetation and crop yields at district level and survey perception at the individual level	multiple	internal migration; voluntary & forced migration; defined	2011	Total Population of Ghana, 203 HH	Ghana's population and housing census different years, own survey
47	Van der Geest et al. (2010)	trends in correlations between migration and vegetation cover	quantitative (census data combined with NDVI)	Ghana	1981-2006	Vegetation cover NDVI Data	multiple	internal migration; in- & out-migration; defined	2000	regional n = 10 district n = 110	Ghana's 2000 population and housing census
48	Van der Land and Hummel (2013)	examining the role of formal education in environmentally induced migration as one characteristic of social vulnerability to environmental change.	qualitative/ quantitative	Mali, Senegal		mentioning that study areas face climatic change like reduction of rainfall, drought	multiple	internal & international migration; not defined	2012	905 HH, 60 Interviews	Own data
49	Veronis and McLeman (2014)	environment as a driver of migration to overseas, Canada	qualitative (Focus group Interviews)	Horn of Africa, francophone Sub-Sahara Africa	not specified	reported data on drought, deforestation, land degradation	multiple	international migration; defined	not specified	47 individuals	Own data

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environ-mental data based on the year	environmental data used	Type of environ-mental stressor	Migration	migration data based on the year	Sample size	Data source
50	Mortimore (1989)	link between environmental change and migration in course of time	qualitative/ quantitative	Nigeria	1973-1974	perceived data	multiple	internal & international migration; resident and non-resident migration; not defined	1973-1974	not specified	survey
51	Adoho and Wodon (2014)	migration as a response strategy of households in the MENA region to environmental stress	quantitative	Algeria, Morocco, Syria, Yemen, Egypt	2011	perceived data from survey on drought and flood	multiple	internal & international migration; temporary & permanent migration; defined	2011	4000 HH	Own data
52	Grant, Burger and Wodon (2014)	interaction of weather patterns, perception of climate change and migration in the MENA region	qualitative (Focus group Interviews)	Algeria, Morocco, Syria, Yemen, Egypt	2010; 2012	perceived environmental change from focus group interviews	multiple	internal migration; not defined	2010; 2012	each group: 6-8 participants	7 Focus Groups in Morocco, Syria, Egypt
53	Nguyen and Wodon (2014)	Impact of extreme weather events on migration in Morocco	quantitative	Morocco	2009-2010	Perceived environmental change, weather events from survey data	multiple	internal & international migration; temporary & permanent migration; defined	2009-2010	2000 HH (rural and urban)	Morocco Household and Youth Survey (MHYS)

Figure 2: Map of distribution of case studies by country.
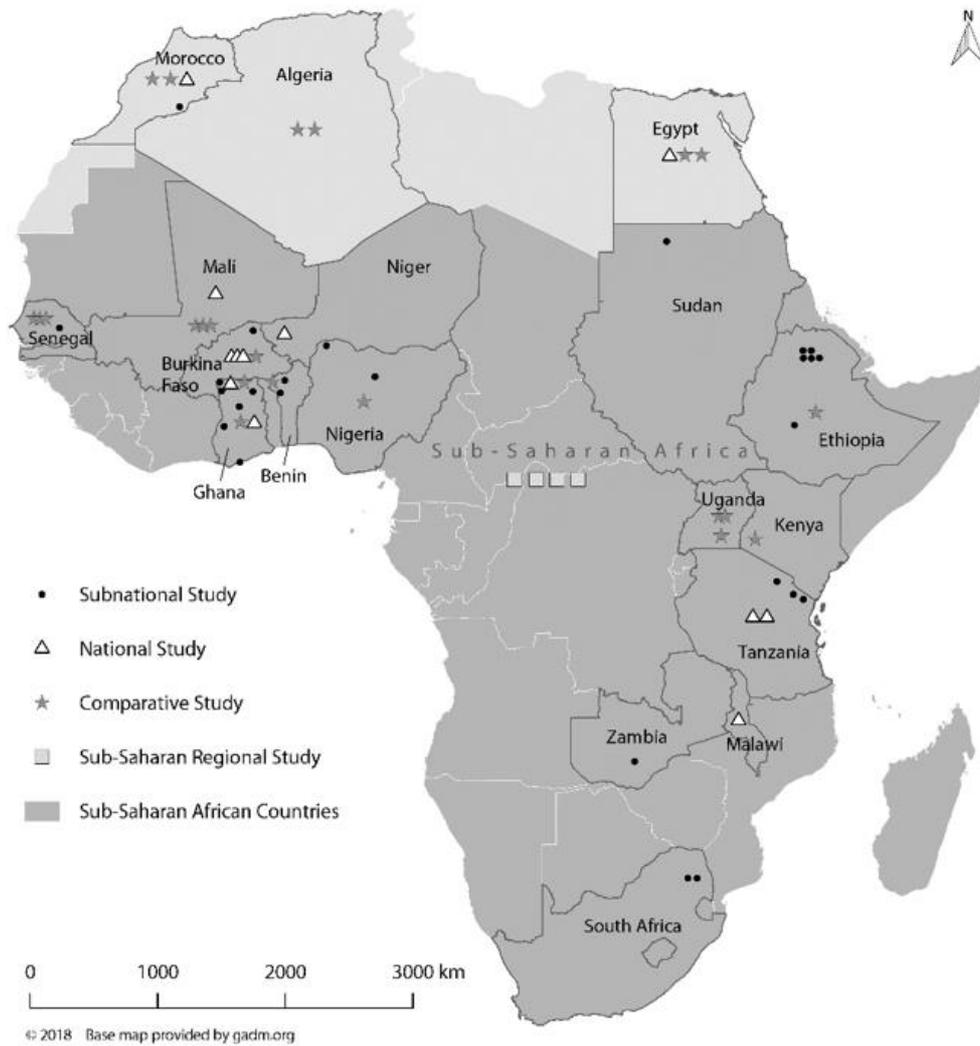
In all 53 references, we seeked to extract the existing empirical evidence on migration influenced by environmental change. To do so, the framework on drivers of migration from Black et al. (2011) has been applied (Figure 3). Conceptualised as a pentagon, the framework groups migration drivers into five categories: social, political, economic, environmental and demographic. This enables us to scrutinize in each case study how environmental change has interacted (or not) with the other drivers and under which circumstances the migration decision has been decided or would be made (migration intentions). All the literature review and analysis of the studies/data were performed with the reference software Mendeley in combination with a spreadsheet software.

Figure 3: The framework on drivers of migration (Black et al. 2011)
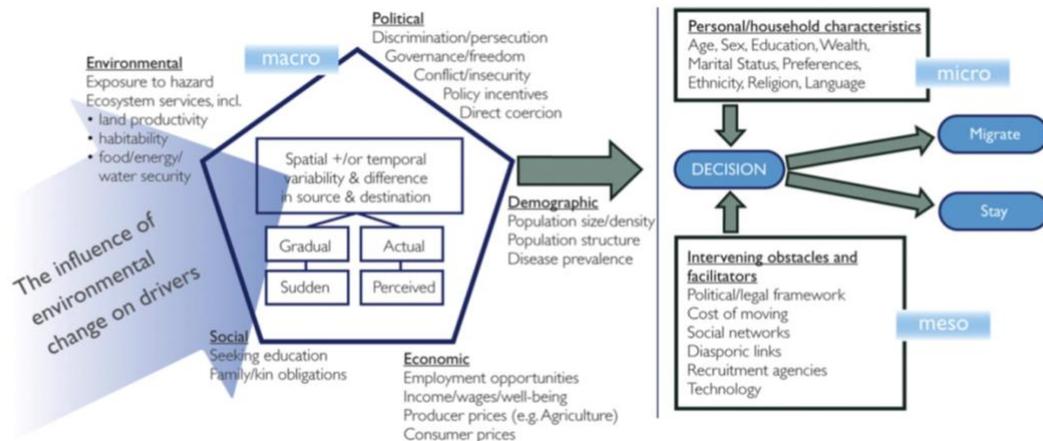
Through our approach, it is possible to collect all the necessary information in the current state-of-the-art on the role of environmental factors on migration in Africa. The key micro-, meso- and macro-scale interactions that result in migration–environment associations were reported and questioned for each paper. Ultimately, considering that the key concepts "migration" as well as "environment" are covering various realities, the definitions, materials and methods used were particularly scrutinised. The 53 articles selected represent not only a wide variety of empirical case studies related to how environmental change shapes migration decision making, but also a diversity of definitions of the terms, units of analysis, materials used, geographical scales, methods and contexts or livelihoods of interest.

4 Results: Assessing the environmental change and migration nexus: statement of the evidence and examination of the materials and methods used

In this section, we present a summary of the nature of research on environmental change and migration in Africa including the key findings from the review. Figure 4 presents the number of publications focusing on Africa that are included in this review by time period. The evolution of the number of case studies over time reflects the general pattern of publication activities in the field of migration and climate change that has intensified significantly, particularly since 2010 (Piguet et al. 2018). This is likely to be attributable to improvement in climate and migration data as well as statistical tools and techniques (Fussell et al. 2014).

**Figure 4: Number of selected publications over time**
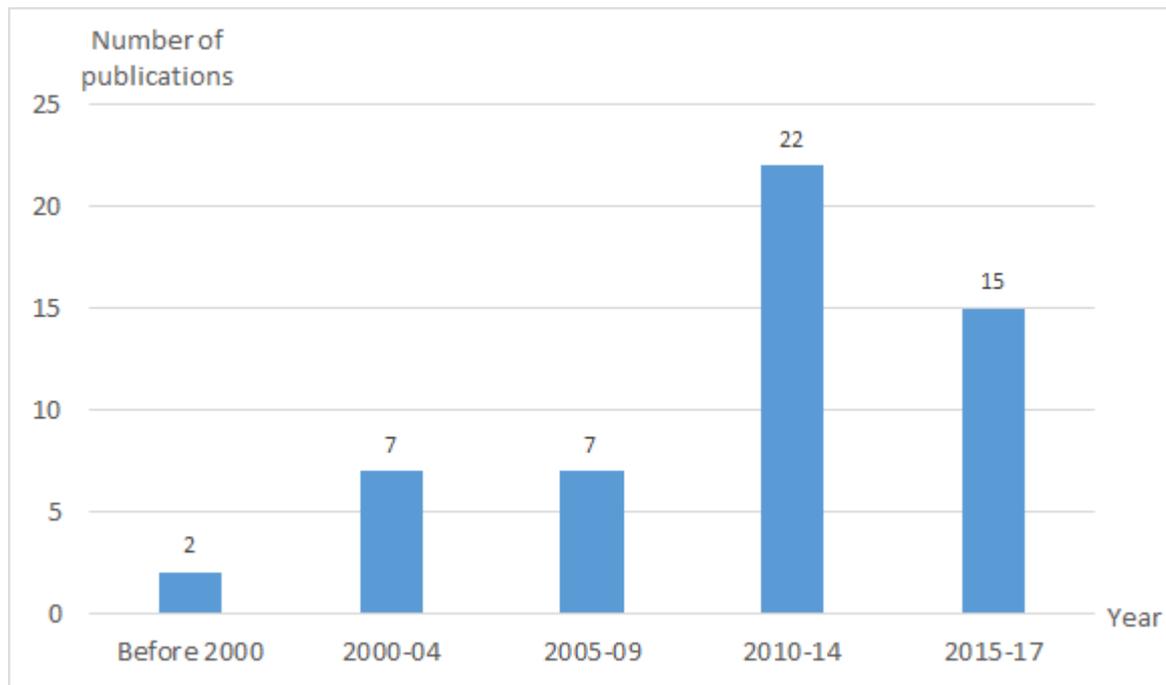
4.1. Methodological overview: Type of methods used

In terms of the type of methods used, we apply a six-group typology presented by Piguet (2010) in his review of research methods used in empirical research focusing on the environment-migration nexus. The first four typologies characterise different research designs, data and levels/units of analysis in quantitative research. *Type 1: ecological* inference is an analysis based on area characteristics where migration and environmental factors are measured at the aggregate level. On the opposite, Type 2 represents individual sample surveys where both migration and environmental data are collected at the individual or household levels. In this regard, Type 4: multilevel analysis differs from Type 2 only for environmental data which are collected at the ecological level whereby migration information is measured at the individual or household levels. Type 3 refers to time series analysis which practically measures the correlation between environmental factors and migration over time. Type 5: agent-based modeling (ABM) is a simulation of the behavioural responses of individuals and households to environment pressure based on assumptions of a researcher. ABM thus is not necessarily based on empirical evidence like other approaches. Finally, type 6 characterises qualitative/ethnographic methods ranging from face-to-face interviews, focus group interviews to expert interviews. In particular, this methodological distinction focuses on research that analyses the role and importance of the environmental driver of migration.

The distribution of Piguet's six typologies is presented in Figure 5. Figure 5 shows that the most common method used in the literature reviewed is a qualitative/ethnographic methods (n=27). For this type of study, the link between environmental factors and migration is generally established based on the perceptions of the interviewees. Qualitative research allows the subject to provide narratives about their perceptions and experience and addresses the complexity of migration decisions. For quantitative research, environmental factors are indirectly captured via individual perceptions in Type 2 (n=19) while in Types 1,3 and 4 they are measured objectively based on

observed environmental or climate data. For these types of quantitative research, it is possible to quantify the magnitude of the impact of environmental change on migration. This can be done at the aggregate level (e.g. regression analysis estimating the influence of climatic and/or environmental factors on the rate of out-migration in a geographical unit) or at the individual or household levels (e.g. regressing climatic and/or environmental factors measured at the ecological level on the probability of individual migration). The former corresponds to Type 1 in Piguet's definition (9 studies) while the latter belongs to Type 4 (6 studies). In particular, availability of satellite imagery environmental or climate data coupled with improvement of computation tools in recent years facilitate the conduction of multilevel analysis (Fussell et al. 2014). There are not many studies that belong to the category time series (Type 3) possibly because migration data are often not available in short time intervals i.e. weekly or monthly.

Figure 5: Typology of empirical studies on environmental change and migration
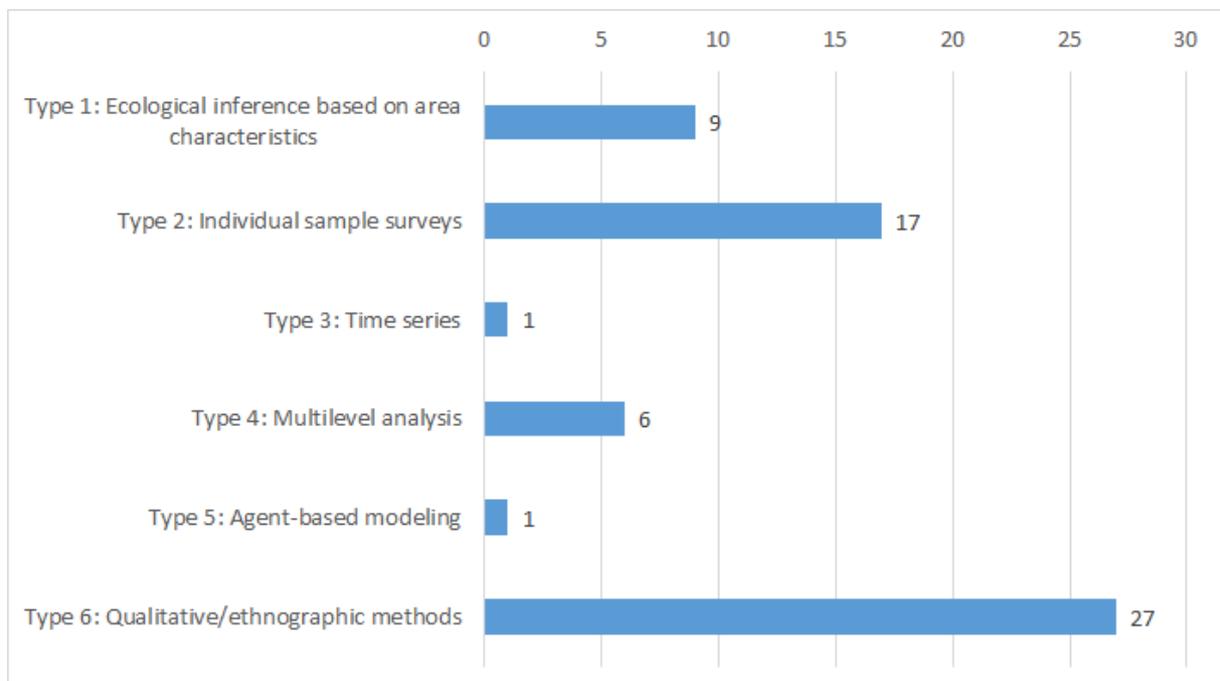
4.2. The multiple dimensions of environment and migration

Not only has a variety of methods been applied in this field, the definitions of migration or environment and the materials and data used to characterise them also cover a wide range of situations. Terminological clarifications are needed, following occasionally by a tricky confrontation between a desired definition and its possibility to be characterised by available data. The diversity of definitions, materials and methods of combining migration and environmental data present a major challenge in synthesising the key findings from the reviewed literature. This also raises a question on comparability of the studies.

As mentioned earlier, most of the empirical case studies were carried out after 2010, ie. after the methodological overview of Piguet (2010) on the environment and migration nexus. At this time, Piguet concluded that "Meta-studies that could assess the migratory impact of different factors on the basis of a collection of studies are as yet impossible. This is largely due to the lack of data available to measure migration behavior and environmental evolutions at temporally and spatially comparable

scales" (ibid, 2010:6). Meanwhile, a later literature review of research on the environmental dimensions of migration by Hunter, Luna, and Norton (Hunter et al. 2015, p.390) point out the need of clarification and critical examination of the definition of "migration" and the "environment" and questioning what is included and what is excluded. With this in mind, a comprehensive analysis of the definitions and data used for the environment and migration components lays foundation for this evidence review.

4.2.1. Characterisation of the environmental component

When studying the environment-migration linkages, most of the empirical case studies explore how manifestations of environmental variability such as droughts, change of rainfall patterns, land degradation and other weather-related events have affected people's migratory behaviour. The concept of environment encompasses climate stressors, natural disasters and any environmental degradation – often resulting in a combination of a climate-related event and a human made process. The focus could be on a single stressor (11 papers out of the 53) i.e. the impact of a drought event or on multiple stressors (42 papers). In the latter case, droughts, floods or various climatic events are considered in the study as a separate stressor or considered together in a common pot named environmental stressors.

One distinction of the characteristic of the environmental component is on the rapidity of the process: slow-onset event vs rapid or extreme weather-related event under a strong assumption that the velocity of the phenomena would result in various human consequences and migration decisions. For instance, combining a large national survey of individual biographies with environmental data such as rainfall (global monthly precipitation) and land degradation via an estimation of the rain use efficiency, Henry et al. (2004) concluded that people affected by land degradation are more likely to move compared to those from the areas affected by poor climatic conditions. It is assumed that migrations are more likely to be influenced by a slow-acting process such as land degradation than by episodic events such as droughts. The study implies that when considering migration response to environmental stressors, it is important to distinguish between rapid- and slow-onset events.

Another distinction is on the degree of exposure to the environmental stressors as well as their severity which would lead to a differential influence on the migration decision-making process. The impacts of environmental stressors are not distributed evenly across individuals, households, and communities (Muttarak et al. 2016). Consequently, there is no universal perception of the degree of the impacts, which are not perceived in the same way everywhere and by everyone (Piguet 2010; Dessai et al. 2004; Marx et al. 2007).

The notion of perception is therefore fundamental in defining the environmental stressors. Indeed, most of the environmental data are captured either by asking direct questions in the survey or by collecting information at the local level. Going back to the typology of Piguet (2010), most of the qualitative/ethnographic methods (type 6) as well as some papers based on Individual sample surveys (type 2) do not used the observed or measured environmental data but the perceived and self-reported one.

As in Ocello et al. (2015), one of the frequent questions to collect perceived data on the environmental component could be summed up as following: "Over the last 5 years, was your household severely affected negatively by any of the following events?" A list of environmental events such as droughts and floods, crop diseases could then be mentioned. The observed environmental stressors by the interviewees can also be ranked using a severity score to assess the migration intentions in response to major stressors (Abu et al. 2014).

In understanding the role of the environment as a migration driver (or the absence of it) via directly asking the respondents, we can assess whether the environmental dimension is explicitly mentioned. A study by Romankiewicz and Doevenspeck (2015) presents an example of the role of the environmental driver of migration which can be captured only when being prompted by the interviewers. When explicit questions about the possible linkages between environment and migration are avoided, the results shows that environmental stress was not mentioned by the participants as a key driver of migration.

This issue becomes less problematic when using objectively measured environmental data. In this case, the most frequently used data sources are earth observation-based data including all information extracted from satellite imageries, local or national meteorological data or models from weather stations. When geo-located environmental data are used, the most common indicators include: annual mean precipitation, aridity, drought frequency, land degradation, soil constraints, cropland and pasture and the Normalized Difference Vegetation Index (NDVI). Out of the 53 studies including in our review, 7 studies base

4.2.2. Characterisation of the migration component

Similar to the environmental component, the reviewed literature present a broad range of different types of migration being studied. In the most basic sense, any definitions of population movement involve a spatial and temporal dimensions (King 2012). Furthermore, categorisation according to causes and purpose of migration is also common. With regard to the spatial dimension of movements, 32 of the case studies focused at internal migration, 4 on international migration and 16 considered both types of migration. A strong focus on internal migration reflects the established scientific evidence also beyond Africa that migration in the context of environmental change is mostly short-distance and occurring within a country (Rigaud et al. 2018). Regarding the operationalisation of migration in the reviewed articles, we identify three patterns which are strongly linked to the methodological approach employed.

First, in the 17 studies using a qualitative approach, migration is captured by explicitly selecting migrants or persons with migration experience as well as relevant informants (e.g. left-behind household members) as a subject of interview (e.g. Afifi et al. 2012; Bleibaum 2008; Carr 2005; Dreier & Sow 2015; Wodon et al. 2014). The degree of specification with regard to migration-related demographic background of the interviewees varies highly. Veronis and McLeman (2014), for example, in their study of African migration to Canada, provide detailed information about their interviewees including country of origin, length of stay, immigration status, skills etc. and clearly delineate the criteria for the selection of the respondents for focus group interviews. Other studies are more unspecific, referring e.g. to places where people migrated to in the past (e.g. Dreier & Sow 2015) or to the places of origin (e.g. Afifi 2009).

Second, another group of studies capture migration through individual sample surveys - mostly by using household rosters to identify members with past migration experience or currently absent households members who are considered as migrants. The spatial and temporal criteria applied to identify absent members as migrants varies: Afifi, Liwenga, and Kwezi (2014) use six months threshold to differentiate between seasonal and permanent migrants; similarly Findley (1994) considers members who are not in the village between one and six months as "short-term cycle migrants" and those left without returning in the reference period as "permanent migrants". Other authors such as Hummel (2016) uses 3 months absence from the place of origin as a threshold. With regard to the spatial criteria the threshold ranges from having left home (e.g. Ezra 2001), the village (e.g. Findley 1994), the district (e.g. Gray & Mueller 2012) to place of birth (which is not equals the

place of residence) (Koubi et al. 2016). Some studies introduce additional criteria for the identification of migrants such as if absent members are still considered to be belong to the household (e.g. Adoho & Wodon 2014), retains livelihood connection (Hunter et al. 2017) or send remittances (Cattaneo & Massetti 2015).

A third group of studies utilises existing large-scale data sources such as censuses and counting migration as net-migration, that are bilateral net-migration rates between countries (e.g. Cattaneo & Peri 2016; Naudé 2008) or provinces and regions (e.g. Henry et al. 2003; van der Geest 2011a). Migration may also be captured indirectly such as in a study by Barrios, Bertinelli, and Strobl (2006) which compares 36 Sub-Saharan African countries using urbanisation as a proxy indicator for internal migration.

4.3. The nature of the nexus: linking environment and migration

Apart from inconsistencies in environmental and migration definitions and study designs and methods used, assessing and synthesising the effects of environmental stressors on migration encounter another challenge. Is it possible to empirically establish a direct link between environmental change and migration? Hunter, Luna and Norton (2015) have cautioned about the pitfalls of environmental determinism when exploring the migration–environment association. Indeed, the relationship between environmental stressors and migration, whatever the type and nature considered, should not be directly established without considering how the environmental dimension interacts with other factors at macro-, meso- and micro-scales.

Going back to the application of the Black's framework on drivers of migration (Black et al. 2011), the study of the nexus between both components requires taking into account all the others factors and contextual effects which could play a role in the migration–environment association. The absence of consideration of these interactions can apparently make the relationship between environmental change and migration spurious. In a study in Ghana (Abu et al. 2014), the link between environmental stress and household heads' intention to migrate is examined. Once socio-demographic factors are controlled for, there is no significant association between any of the climate-related stressors and intention of migration. In another study by Ocello et al. (2015), the relationship remained after accounting for relevant variables. It is found that being exposed to droughts or floods and to crop diseases or crop pests had a negative and statistically significant effects on migration even after controlling for socio-demographic factors.

In general, most papers address the interactions of the drivers either at the macro or micro level so as to avoid ecological fallacy. Frequently, the study of the association between the environmental component and the economic one is highlighted. Konseiga (2007) illustrates that the environmental driver plays a role by increasing the probability to move out and opportunity to have a better income when living in a drier area (migration as successful adaptation and a way to diversify income). The same direction is pointed out in Neumann et al. (2015) showing how environmental degradation acts as a push factor via the reduction of economic means.

For quantitative studies carrying out at the household level, a perception of environmental from the household as well as their socio-demographic characteristics do not require the use of a multi-level model for statistical analysis. Yet, the integration of a contextual effect (e.g. at the community level) and not only individual-level factors would demand the use of multilevel modeling (Rabe-Hesketh & Skrondal 2006; Laczko & Aghazarm 2009). Therefore, the interactions between individual- or household-level migration with the meso- or macro-level environmental data can only be done with consideration of the multilevel modeling framework. Amongst the 53 studies reviewed, only 7 papers

employ multilevel analysis (Neumann et al. 2015; Cattaneo & Massetti 2015; Gray & Mueller 2012; Henry, Schoumaker, et al. 2004; Henry, Piché, et al. 2004; Hunter et al. 2017; Kubik & Maurel 2016). However, we could expect an increased in the use of multi-level modelling in the coming years due to the necessity of assessing the interactions (Fussell et al. 2014).

On another note, the qualitative methods can identify interactions and give the possibility of understanding both measurable and unmeasurable variables underlying the migration decision of an individual. However, the absence of representativeness – the goal being not to draw a general pattern, does not allow us to inspect empirical regularities and to know if this pattern or human reaction is unique or corresponds to a common scheme.

So far, the paucity of the environmental variables remains a key issue: most indicators used are basic and concern either rainfall or natural disasters, leaving aside more elaborated indicators of climate change and environmental degradation. However, the tremendous interest of the environmental dimensions of migration and how to make feasible the measurement of this nexus suggests a fair enhancement of databases and implementation of integrative assessment (Hunter et al. 2015; Neumann & Hilderink 2015; Bilsborrow & Henry 2012). The project Terra Populus – providing global-scale data on human population characteristics, land use, land cover, climate and other environmental characteristics, can be seen as a leading example of the ambition of combining population and environmental data on a large scale (Ruggles et al. 2015).

4.4. The key evidence review: from sound to contradictory statements

The empirical studies reviewed lend support to the framework of drivers of migration proposed by Black et al. (2011). Generally, environmental factors interact with a complex array of contextual factors as well as individual- and household-level characteristics in shaping migration decision making. The systematic review allows us to draw insights into the key macro-, micro-, meso-scale interactions that predict migration–environment associations. The major patterns found from the review are described below:

1. No evidence that environmental change is a sole cause of migration

None of the reviewed empirical studies identified environmental change alone as a sufficient explanatory factor for migration. Several papers have established the link between environmental impact and migration decision, but these impacts are mediated through factors on the macro, meso and micro level, that is economic, social and political drivers (e.g. Afifi 2011; Afifi et al. 2012; Bleibaum 2008; Carr 2005; Doevenspeck 2011; Hamza et al. 2009; Morrissey 2012), social networks (e.g. Findley 1994; Haug 2002; Simatele & Simatele 2015), or characteristics of the household (e.g. Kubik & Maurel 2016; Leyk et al. 2012) and the migrants (e.g. Ocello et al. 2015; Suckall et al. 2017). The evidence clearly supports the conceptualisation of multi-dimensional drivers of migration in the context of environmental change suggested by Black et al. (2011). Elaboration on the interaction of macro drivers with environmental change remains rather vague in most studies, while a handful of studies - particularly those applying multi-level analysis - provide a detail insights on how micro level factors influences migration patterns under environmental change measured at the meso or macro levels.

2. Sensitivity of livelihoods matters for applying migration as a coping and adaptation strategy but different types of migration reacts differently in the context of environmental stress

Most of the reviewed empirical studies focus their analysis on rural livelihoods sensitive to environmental stresses such as small scale farmers, livestock herders and subsistence farming households. A few studies that also included none-resource based livelihoods in their analysis indicate that environmental driver of migration are mostly relevant for households that rely on natural resources for their livelihoods. Van der Land and Hummel (2013), for example, show that those with higher education and less dependent on environmental sensitive economic activities are less vulnerable to environmental stress. This evidence is also present in quantitative studies which shows that the effects of temperature change on migration is larger in countries (Cattaneo & Peri 2016) and households (Kubik & Maurel 2016) where the main source of income come from agriculture. However, note that the relationship is negative i.e. higher temperature suppresses migration in countries where agriculture is a major economic activity. Some studies also embed migration in the context of livelihoods vulnerability and by doing so shows that migration is only one of many strategies households adopts in order to deal with environmental stress. Ezra (2001), for example, analyses a wide range of demographic responses to environmental stress in Northern Ethiopia. Besides migration - rural-rural and rural-urban migration - changes in marriage behaviour and fertility pattern can also be observed. Here the evidence is also not conclusive as in some cases environmental stress increases the propensity to migrate and in other cases migration decreases (Cattaneo & Massetti 2015; Ezra & Kiros 2006).

The empirical evidence in the reviewed studies also shows the differentiated influence of environmental stress on types of migration response (Henry, Schoumaker, et al. 2004; Findley 1994). There is evidence that international migration which is more costly declines during drought (Henry, Piché, et al. 2004) whilst short-term internal migration increases (Findley 1994; Henry, Schoumaker, et al. 2004; Grolle 2015). Likewise, a similar environmental pressure can have differential impacts on other types of migration. For instance, in rural Ethiopia, drought increases men's labour migration but suppresses female marriage-related migration due to reduced affordability of marriage (Gray & Mueller 2012).

3. Demographic differentials in migration response

Migration response to environmental pressure is not uniform across population subgroups. Demographic characteristics including age, gender, wealth/economic status and education are key factors underlying migration patterns, with the effect of age on environmental migration appears to have the most consistent direction. Generally, young and middle aged persons have higher intention and higher propensity to migrate (Abu et al. 2014; Adaawen 2015; Afriyie et al. 2018; Bleibaum 2008; Carr 2005; Ezra & Kiros 2006; Gray 2011; Henry, Schoumaker, et al. 2004; Henry, Piché, et al. 2004; Morrissey 2013; Morrissey 2012; Ocello et al. 2015).

Gender plays a role both in terms of migration rate and types of migration. In general, men are more likely to migrate than women in response to environmental pressure (Afriyie et al. 2018; Hamza et al. 2009; Heaney & Winter 2016) possibly because women have less contribution in economic term as compared to their male counterparts (Findley 1994). This is reflected in different types of migration engaged by men and women with labour migration increases for men in time of drought whilst marriage migration declines for women (Gray & Mueller 2012). Sow et al. (2014) also show that marriage relations and migrations are affected by environmental stress. The findings underline that bride price payment could be seen as an avenue to accumulate wealth.

The effects of wealth and education on migration response to environmental shocks are in both directions. On the one hand, wealthier and more educated households have more available resources to draw upon when facing environmental shocks. In this case, these groups are less likely to migrate due to environmental pressure (Afifi et al. 2014; Cattaneo & Massetti 2015; Ezra & Kiros 2006; Gray 2011; Ocello et al. 2015). On the other hand, wealth and education also facilitate migration process. These households thus have higher capacity to choose migration as an adaptation strategy if needed to (Gray & Mueller 2012; Kubik & Maurel 2016). Education also determines types of migration whereby long-term moves are more common among the highly educated while the opposite is true for the lower educated counterparts (Henry, Schoumaker, et al. 2004). Likewise, education is also relevant to livelihoods whereby more educated households are less likely to rely on economic activities e.g. farming which are environmentally sensitive (Van der Land & Hummel 2013).

4. The nature and duration of the environmental pressure result in different migration behaviors.

Several studies point out that the nature of the environmental event determines the migration decision (Koubi et al. 2016; van der Geest 2011b; Henry, Piché, et al. 2004; Nguyen & Wodon 2014). The most frequent distinction is made between slow-onset and sudden-onset events. The effects of the nature of the environmental stressor on the migration decision are in both directions, though. Koubi et al. (2016) find that sudden-onset events such as storms or floods tend to increase the likelihood of migration whereas long-term, gradual environmental events such as salinity or drought, are unlikely to lead to migration but in fact decrease its likelihood. The reported empirical evidence shows that individuals prefer to stay and try to adapt to an environmental problem—instead of opting for the more uncertain and costly option of migration when facing long-term environmental shocks. For Henry et al. (2004), the findings support an opposite observation: migration seems to be more influenced by a slow-acting process such as land degradation than by episodic events such as droughts in Burkina Faso. Van der Geest (2011b), highlights the same findings for Ghana. Scarcity of fertile land was mentioned much more often as a reason to migrate than climate change or erratic rainfall. None of the respondents linked their migration decision with sudden-onset environmental events. The time dimension of the migration is added in the findings of Nguyen and Wodon (2014). They point out that a reduction in yields due to shortage of water would also increase permanent migration but at the same time reducing the probability to migrate.

Moreover, the temporal dynamics and duration of exposition to the environmental stressor would play a significant role. The findings from Meze-Hausken (2000) underline how time matters in her case study in Northern Ethiopia. If, at the beginning of a drought, those with more assets suffering less and migrate less, out-migration then becomes a strategy for everybody only after a certain period of time. When coping options (other than migration) are reduced, this leads to a challenging situation for everybody. For Rademacher-Schulz et al. (2014), time also matters by shifting seasonal migration during the dry season to rainy seasonal migration when a bad harvest is expected. Rainy season migration appears therefore as an adaptation to crisis or survival strategy running contrary to the local agricultural cycle in which migration is normally pronounced outside the growing season.

5. Social networks and kinship ties as facilitators for migration

The review shows that social network and kinship ties play a crucial role for migration in the context of environmental change, particularly in terms of facilitating migration and influencing destination decision (Bleibaum 2008; Carr 2005; Findley 1994; Doevenspeck 2011; Dreier & Sow 2015; Haug 2002; Simatele & Simatele 2015; van der Geest et al. 2010). Bleibaum (2008) refers to the importance of ethnic based networks that facilitates the migration from the study village to the city

and abroad. Carr (2005) also states that migration from the rural case study area in Ghana to peri-urban areas was strongly influenced by kinship. She additional highlights that these personal connection are important means through which the migrants could claim access to land. Doevenspeck (2011) describes kinship networks as "indispensable condition" to be accepted and integrated in the new settlement for his case study in Benin.

6. Environmental surplus also influences migration patterns

While most studies focus on the influence of unfavourable environmental conditions such as droughts, floods, land degradation on migration patterns, a few also highlight that favourable conditions (Henry et al. 2003; van der Geest 2011a) – or what Hunter et al. (2017) referred to as "environmental surplus" - can have an impact. This aspect is commonly a neglected issue in the research on the environment-migration nexus. The studies reviewed highlight that the conditions at the place of origin as well as the place of destination can be relevant. Focussing on the place of destination, Henry, Boyle, and Lambin (2003) in their study on inter-provincial migration in Burkina Faso show that migration patterns are influenced by favourable conditions at the place of destination concerning rainfall variability, land degradation and land availability. Environmental conditions in the place of destination can act as a pull factor for migration flows. Hunter et al. (2017) in their study from rural South Africa show that there is a positive relationship between availability and proximity to environmental resources or natural capital in the place of origin and out-migration. Resource availability enable households to pursue migration as a strategy for livelihoods diversification. An important aspect in this context is highlighted by Mortimore (1989) and van der Geest et al. (2010) who point out that it is not sufficient to address the availability (either abundance or scarcity) of natural resources, as the crucial question influencing migration decision is the question of access to environmental resources.

7. Context matters

The review shows that the influence of environmental change on migration pattern is highly context dependent. Many studies applying a qualitative studies have given a rich picture of how different economic, political and social factors intersects with the impact of environmental change on migration decisions (e.g. Afifi et al. 2014; Bleibaum 2008; Carr 2005; Doevenspeck 2011). Bleibaum (2008) for example points to issues related to land distribution, mismanagement of irrigation system and changing agricultural policies influencing migration in the context of environmental change in Senegal. Doevenspeck (2011) emphasises the need to take the political and cultural context into account in order to understand the (im-)mobility of people from the densely populated and environmental critical north-east of Benin. Based on a case study from rural Ghana, Carr (2005) shows how migration decisions are shaped by power-ridden societal negotiation processes around closely interweaving economic, social and environmental factors. The role of contextual factors also becomes apparent in studies pursuing a quantitative approach (e.g. Findley 1994; Gray 2011; Gray & Mueller 2012) . A good example is the study of Gray (2011) on the effect of soil quality on migration behaviour based on longitudinal/panel survey as well as empirically assessed soil quality data. The study shows that environmental factors have a differentiated effect on migration patterns: while worse soil quality increases migration in Kenya, the opposite is true for Uganda where migration increases with better soil quality. The authors argue that this is due to the different contextual factors in both countries and the different cost of migration. Other studies shows how, depending on a geographical context, marriage migration may increase during drought in Mali as a strategy to reduce household consumption (Findley 1994), but reduce marriage migration in Uganda when soil quality is poor (Gray 2011) and in rural Ethiopia during drought (Gray & Mueller 2012) due to high costs of bridewealth.

8. The choice of scale for the observation and analysis of the environment change- migration nexus influence the evidence

Few papers deal with the idea that the issue of scale is key in understanding if and how environmental change and migration decision are connected (Hunter et al. 2017; Leyk et al. 2012; Neumann et al. 2015). It could also been legitimately asked if there are right scales to observe and examine the nexus and avoid the so-called ecological fallacy. In the two case studies in South Africa using the same dataset from the Agincourt Health and Demographic Surveillance System, Hunter et al. (2017) and Leyk et al. (2012) showed that there is an association between NDVI and temporary outmigration. However, this relation is shown as complexed and its direction varies according to the scale of observation. A global model at the scale of the study site has underlined that the proximity to natural resources results in more migration, while using a village-scale model the results appear far more heterogeneous (Hunter et al. 2017). The use of multiscale models shows that the impact of natural resource access on the migration decision could lead to two opposite directions: an increase in natural resource access is associated with greater outmigration propensity for some households while decreasing the propensity for others, even in the same village (Leyk et al. 2012).

Neumann et al. (2015) concludes also that how the drivers of migration operate depends on the scale of the analysis. The results of their global scale cluster analysis suggest that land degradation is the most severe environmental constraint for both studied hotspots. However, national-level analyses for Burkina Faso (one of the hotspot) revealed that rainfall variability and soil degradation are approximately equally strong determinants of intra-provincial migration.

Following Smith (2014), we argue that only by adequately understanding and quantifying the multiple and interconnected components that contribute to livelihoods and migration decision-making at appropriate spatial and temporal resolutions would allow us to construct relevant models reflecting the reality and its potential future.

5 Conclusion: an attempt to systematise empirical evidence on migration influenced by climate change in African countries

Despite a substantial increase in empirical studies on environmental driver of migration since the beginning of this decade, research gaps in this field remain. The study of the migration-environment nexus and the collection of evidence of interactions has been hampered by differences in the definitions, conceptual frameworks, study designs, data structures and analytical methods and tools used. Indeed, the lack of agreement on measurements and definitions of migration and environmental factors as well as diverse spatial units and scales make it difficult to draw upon some universal conclusions on the relationship between environmental change and migration. Furthermore, different methods and statistical models used make the results incomparable. For systematisation of empirical evidence, a standardisation of empirical studies would then be required. In this case, each empirical case study could be seen as a piece of a common puzzle. When the pieces of the puzzle interlock, it then becomes possible to detect empirical space-time regularities in the environmental change and migration nexus. This urgency of a standardisation of local empirical case studies would also imply the necessity of harmonising and providing access to data and compel the researchers to be aware of assumptions in data collection models used.

Nevertheless, whilst these variations are problematic, at the same time they also add richness to the evidence. McLeman and Gemenne (2018) in fact call for more research using a wide range of methods. Whilst quantitative studies provide estimates of the directions and magnitudes of the impact of environmental change on migration, qualitative studies offer a better understanding of

more complex reality. As contexts matter and the interactions of drivers are key to understand how environmental change influences the migration process, mobilised a wide range of methods would enable to overcome the challenges of examining these complex interrelations. Indeed, some methodological efforts in the design of new empirical case studies deserved to be made in order to implement the Black et al.'s framework on drivers of migration (2011) and cover not just the different dimensions but also the interaction between them.

Notwithstanding the state of knowledge has improved over the recent years, more information is still needed on the links between different types of human mobility (voluntary migration, displacement, planned relocation) and climate change and other drivers, such as conflict. In the analyses, clear distinction could be made between types of environmental stressors, sudden and slow onset contexts, type of migration patterns and destination. More local studies, following specific targets could be carried out.

Yet, the finer the scale of observation is, the more heterogeneous the situation appears, meeting the individual specificities. Whether there is a right scale to examine the migration-environment nexus is an important question. An observation at a large scale could lead to some confusions between ecological correlations and individual correlations and result in the so-called ecological fallacy, that is some common patterns shared between populations from a fine scale are likely to be undetected. According to Arbia's second law of geography: "everything is related to everything else, but things observed at a coarse spatial resolution are more related than things observed at a finer resolution." (Tobler 2004, p.308). This suggests that aggregation has a smoothing effect. In this case, multiscale study could bridge the important gap between micro- and macro-level processes, by taking full advantage of both individual (family or household data) and geospatial data.

Finally, this review should bring some nuance on the debate whether environmental change does and will cause massive migration flows. If policy makers were to inquire about whether there would be climate-induced mass migration from Africa into Europe in the near future (Natale et al. 2018), the review would stand for a minimalist view, arguing that there would be limited direct impact of climate change. The common narrative of climate change affecting agriculture production, leading to livelihood disruptions and migration as a response to this environmental change, does not always hold. Some studies have, on the contrary, shown that migration is a costly process- and is only employed as one strategy amongst many other adaptive responses, and income and productivity loss due to climatic stressors could limit out-migration rather than being in favour of it.

Examining the role of environmental change as a driver of migration, this review highlights the contextually contingent nature of migration-environment relationships. The individual intentions to migrate therefore would particularly depend on both socio-economic and demographic factors as well as the characteristics of the place of origin. It is also difficult to predict potential countries of destination remains but it is highly possible that internal migration is likely to occur. The review has underlined that climate-related internal migration is more relevant because environmental-related migration is normally short distance by nature. Geographical proximity and existing economic and migration ties also determine the migration patterns. In this way, the context of both sending and receiving areas matters. The translocal perspective, rather neglected in the review, could thus be explored more systematically.

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