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Research Article

Migration influenced by environmental change in Africa: A systematic review of empirical evidence

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Abstract

BACKGROUND

Despite an increase in scholarly and policy interest regarding the impacts of environmental change on migration, empirical knowledge in the field remains varied, patchy, and limited. Generalised discourse on environmental migration frequently oversimplifies the complex channels through which environmental change influences the migration process.

OBJECTIVE

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

METHODS

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We select 53 qualitative and quantitative studies on the influence of environmental change on migration from the comprehensive Climig database and systematically analyse the literature considering the multidimensional drivers of migration.

RESULTS

Environmental change influences migration in Africa in an indirect way by 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 the type and duration of migration.

CONCLUSIONS

The contextually contingent nature of migration–environment relationships prevents us from drawing a universal conclusion, whether environmental change will increase or suppress migration in Africa. However, this study unravels the complex interactions between the nature and duration of the environmental pressure, the livelihood of the populations, the role of kinship ties and the role of demographic differentials on migration response.

CONTRIBUTION

The review provides an initial systematic and comprehensive summary of empirical evidence on the environmental drivers of migration in Africa. It also discusses the implications of the scale, materials, and methods used in the 53 studies.

1. Introduction

The relationship between environmental change and migration has gained public attention in both the media and political discourse in the past several years (Bettini 2013). This is reflected in increasing numbers of news stories and reports specifically about climate-induced migration and displacement (Climate and Migration Coalition 2015). Likewise, there has also been a considerable accumulation of empirical evidence on environmental and climate-related migration in academic literature (Piguet, Kaenzig, and Guélat 2018; Hoffmann et al. 2019). Given the research topic, which cross-cuts disciplinary boundaries, interdisciplinary collaborations among environmental and migration researchers, geographers, demographers, economists, and sociologists have become more common (Kniveton et al. 2008; McLeman 2013). There has also been an advancement in the conceptual and methodological approaches tackling the interrelationship (Fussell, Hunter, and Gray 2014; Piguet 2010). However, despite the increasing number of studies on the topic, empirical knowledge in the field remains varied and patchy (Hunter, Luna, and Norton 2015; Piguet, De Guchteneire, and Pécoud

2011). There is no conclusive evidence regarding the direction and magnitude of the influence of environmental change on migration, which can range from playing a limited and rather indirect role (de Haas 2011) to having significant impacts (Marchiori and Schumacher 2011).

The recent World Bank report which warns that climate change will be a major driver of future internal migration flows in sub-Saharan Africa, South Asia, and Latin America provides an example of the difficulty of estimating and predicting the number of environmental migrants (Rigaud et al. 2018). There is indeed a high degree of uncertainty as reflected in a wide range of the numbers of climate migrants estimated in different scenarios: between 91 and 143 million in the pessimistic scenarios and between 31 and 71 million in the climate-friendly scenarios (Rigaud et al. 2018). What is consistent across all scenarios is the fact that the numbers of potential migrants are predicted to be the highest in Africa.

Africa is considered to be one of the region's most vulnerable to climate change and climate variability due to its geographical characteristic of vast semiarid areas, high reliance on rain-fed agriculture (only 5% of cultivated area is under irrigation, compared to the world average of 21%) (FAO 2016), and low adaptive capacity. Accordingly, some authors such as Werz and Hoffman (2016) take an "excessively alarmist" approach (Gemenne 2011) in the estimates and predictions of numbers of environmental migrants, arguing that a high level of vulnerability coupled with demographic pressure will lead to the influx of climate migrants from vulnerable regions in sub-Saharan Africa to Europe. Other scholars, on the other hand, have raised concerns about the overemphasis on the importance of environmental stress as a major driver of migration from Africa (Omobowale et al. 2019; Zickgraf 2019).

To shed light on the issues and to provide guidance for researchers to navigate through the increasingly complex body of evidence, this paper seeks to systematise the existing empirical literature on migration influenced by environmental change with a focus on Africa. We combine elements of a systematic evidence assessment with a more reflexive form of evidence-focused literature review. The literature is selected from the comprehensive Climig Database: Migration, Climate Change and the Environment (Piguet, Kaenzig, and Guélat 2018). We employ Black et al.'s (2011a) heuristic framework on drivers of migration to organise and systematise the evidence.

The paper focuses explicitly on empirical literature on Africa for two reasons: First, the majority of the African population rely on agriculture as a primary source of livelihood. 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 to the impacts of environmental change on migration than other continents (Niang et al. 2014). Second, African migration has attracted significant attention among the media (for recent examples see Lindsay 2018; Elliott 2019) and

policymakers (Natale, Migali, and Münz 2018). By systematically addressing existing empirical research, our study provides a sound basis for a more evidence-based discussion of this highly politicised issue. In comparison to other reviews on migration in the context of environmental change, our review is broader in scope geographically (compared to Brüning and Piguet 2018; van der Land, Romankiewicz, and van der Geest 2018) and methodologically more systematic (compared to Jónsson 2010; Morrissey 2014).

The remainder of the paper is organised as follows: The next section provides an overview of the scientific debate on migration and the environment and provides the broader context for the review. Section 3 describes the methods and procedures of our systematic literature review and presents the database. Section 4 describes the results, and section 5 discusses the key findings. The paper concludes with section 6.

2. Migration and environmental change: A brief sketch of the debate

Research on the relationship between environmental change and migration has a long history and has gained currency in the past decades (Piguet, De Guchteneire, and Pécoud 2011).⁵ Piguet (2013) points out that the environment played a central role in migration research in the early works of geographers such as Friedrich Ratzel (1903) or Ellen Churchill Semple (1911) but disappeared as an explanatory factor at the beginning of the second half of the last century. Interest in environmental drivers of migration reappeared again in the 1980s and 1990s due to growing concern over environmental issues and the potential impacts of climate change on livelihoods and well-being. Different disciplines – demography, geography, sociology, and 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 involved in capturing the phenomenon is expressed by the myriads of terms and definitions that seek to address the link (Aufenvenne and Felgentreff 2013; Müller et al. 2012; Renaud et al. 2007; Warner et al. 2010). The literature, as the Foresight Report (Government Office for Science 2011: 34) points out, 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

⁵ See Piguet (2013) for elaborated and detailed remarks on the history and development of the research on environmental change and migration. See Black et al. (2011a) and Hunter, Luna, and Norton (2015) for an overview of the current discussion.

terminology ranges from “environmental refugee” – a term coined by El-Hinnawi (1985), which has been heavily criticised by many scholars (Black 2011; Castles 2002) but is still popularly used in the media and by policymakers – to “migration influenced by environmental change” – a phrase used by the Foresight Report (Government Office for Science 2011) that seeks to avoid simplification and capture the complex nature of the relationship. What most of the terms have in common is that they focus on the impact of the environment on human mobility and take into consideration temporal (e.g., permanent and seasonal migration or slow- and rapid-onset events) and spatial (e.g., internal and international movements) dynamics. But the terms differ with respect to which aspect of the environment is included: Some definitions include human-induced stresses such as industrial accidents and the introduction of dams (e.g., El-Hinnawi 1985), while some refer only to specific aspects of the environment such as the climate (e.g., Bronen 2010).

Furthermore, the terms can be differentiated in two important additional ways. The first distinction refers to the degree of autonomy of the population on the move. While those terms that refer to ‘refugee’ and ‘displacement’ focus solely on situations where people have limited agency and are forced to move (for climate refugees, see Brown 2008; for environmental displacement, see Dun, Gemenne, and Stojanov 2007), the term ‘migration’ (for environmental migrant, see Laczko and Aghazarm 2009) seeks to capture forced as well as voluntary movements that can occur in the context of environmental change. This has significant implications regarding the scope of the phenomena that the term refers to. The second difference refers to the way causality is expressed. On the one hand, most terms imply the possibility of clearly attributing the impacts of specific environmental factors to aspects of human mobility and by doing so express a monocausal relationship between some aspects of the environment and human mobility (e.g., environmental refugee or environmental migrants). On the other hand, the above mentioned phrase “migration influenced by environmental change” seeks to highlight that environmental change most often does not influence migration decisions directly but is mediated by other existing drivers of migration as well as other variables 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 terms of 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 be found in technically sophisticated modelling approaches such as work on sea-level rise and population displacement in the United States (Hauer 2017) and in Bangladesh (Davis et al. 2018). These contributions have been criticised for their monocausal focus, oversimplification

of migration processes, and lack of consideration of agency and the range of adaptive options an individual can draw upon. On the other hand, the majority of scholars draw on existing approaches in migration studies and insights from a broad range of disciplines in order to capture the complexity of the relationship (see Black et al. 2011a; Hunter, Luna, and Norton 2015). Bilsborrow (1992), for instance, considers outmigration as one of the demographic responses to resource scarcity in the context of population pressure but also highlights the importance of social, political, and economic contexts that influence the nature of the relationship. Based on the insights from hazard research, Perch-Nielsen, Bättig, and Imboden (2008) point out the range of adaptive options – including migration – that people have to deal with environmental stresses.

Subsequently, more recent research on the migration–environment nexus has broadened and diversified its focus conceptually and methodologically. Scholars have moved beyond the question of how the environment migration influences the migration decision and ask how migration might contribute to climate-change adaptation (McLeman and Smit 2006; Gemenne and Blocher 2017) and resilience building (Sakdapolrak et al. 2016; Rockenbauch and Sakdapolrak 2017; Tebboth, Conway, and Adger 2019). Furthermore, the one-sided focus on mobile populations has been supplemented by research on different forms of immobility, including trapped populations (Zickgraf 2018; Ayeb-Karlsson, Smith, and Kniveton 2018). On a conceptual level, the adoption of concepts such as mobility (Boas et al. 2018) and trans-locality (Porst and Sakdapolrak 2018), the acknowledgement of the temporal (Barnett and McMichael 2018) and emotional (Parsons 2018) dimensions, and the role of non-linearity and thresholds (Adams and Kay 2019; McLeman 2018) has enhanced our understanding of the migration–environment nexus. Indeed, in the past couple of decades, the field of environmental change and migration has achieved scientific progress both theoretically and empirically.

3. Methods: A systematic review

Accordingly, this review strives to comprehensively identify, appraise, and synthesise the relevant empirical studies published in English on the topic of migration influenced by environmental change in Africa. A systematic review is particularly valuable as a means of reviewing the evidence on this particular question, as there is a need to assess the quality of the evidence available and identify a number of consistent conclusions. Using the comprehensive Climig database – the most updated list of publications about “Migration, Environment and Climate Change” (see Pigué, Kaenzig, and Guélat 2018 for a detailed description of the scope of the database as well as search and maintenance methods) – 227 references corresponding to outputs with the keyword “Africa” were

extracted. The literature search was conducted in May 2017. At this time, the Climig bibliographic database comprised about 1,200 scientific papers and books on climate/environmental change and migration, including more than 450 empirical case studies. A Rapid Evidence Assessment was then conducted following the procedure described in Cummings et al. (2015). This study examines the state and strength of knowledge on a specific topic. It looks at what we know about that topic in the literature, drawing mainly on primary and secondary research studies. The research and analysis process started with the overarching leading question, “How does environmental change influence migration patterns?” Then, the literature search from the database is conducted with a clear structured protocol and rationale for how the search is performed (Figure 1). The first screening stage was mainly the exclusion of studies without an empirical nature and those written in 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 limited method-producing evidence (e.g., expert-based interviews).

Figure 1: Scoping review’s flowchart

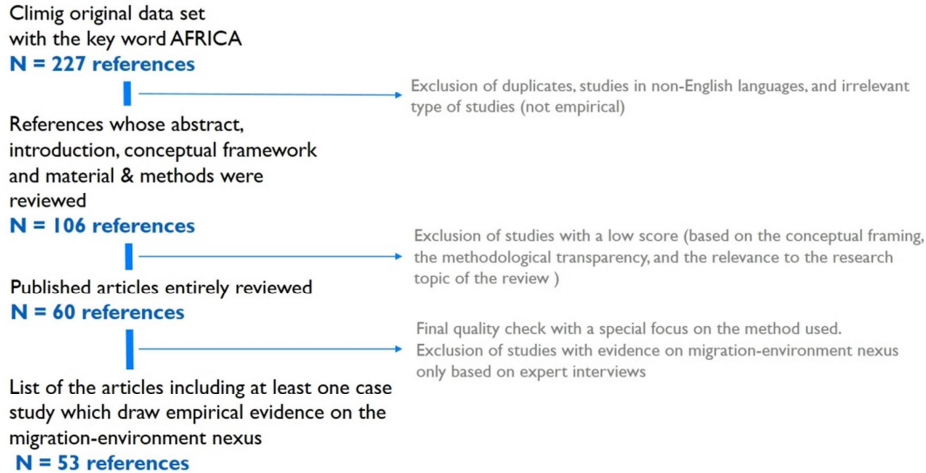


Table 1: Summary of 53 papers included in the review

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environmental data based on the year	Environmental data used	Type of environmental 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 in 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 and international migration; return migration; in-migration; not defined	not specified	120 HH, 57 interviews, 4 FGD	own data
3	Affi (2009)	nexus between land degradation, water shortage, and migration	qualitative	Egypt	2009	reported data (scarcity and land degradation)	multiple	internal migration; defined	2009	30 interviews	own data
4	Affi (2011)	environmentally induced economic migration	qualitative/quantitative	Niger: Niamey, Tillabéri	1967–2009	perceived data, reported stress: droughts, soil degradation, deforestation, shrinking of Lake Chad	multiple	internal and international migration; return migration; not defined	2008	60 migrants, 20 non-migrants, 25 experts	own data
5	Affi 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 and international; short- and long-term migration; not defined	2011	not specified	own data
6	Affi, Liwenga, and Kewzi (2014)	relationship between rainfall shortage and outmigration	qualitative/quantitative	Tanzania: Kilimanjaro District	1950s–2000	perceived data (rainfall variability, drought, water shortage)	multiple	internal migration; short- and long-term migration; defined	2013	165 HH	own data

Table 1: (Continued)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environmental data based on the year	Environmental data used	Type of environmental stressor	Migration	Migration data based on the year	Sample size	Data source
7	Afriyie, Ganle, and Samios (2018)	adaptation 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, Bertinelli, and Strobl (2006)	role of climate change in urbanisation 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- and 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: Domimase, Pankrum, Yensunkwa	not specified	perceived and reported environmental stressors (declining rainfall, soil degradation)	multiple	internal migration; short- and 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 and 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) and international migration; defined	1960–2000	116 countries	bilateral migrant stocks in 116 countries; census

Table 1: (Continued)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environmental data based on the year	Environmental data used	Type of environmental 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)	north-west Benin, Nigeria	2005	perception of the interviewees (drought, shifting seasons, deforestation, soil erosion)	multiple	international migration; short- and long-term migration; defined	2013	63 UN 4 expert interviews	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 and permanent migration; resettlement; defined	1994–1995	2,000 HH	previous survey conducted 1994/95
16	Ezra and Kiros (2001)	multilevel analysis of rural outmigration 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	2,000 HH, data of 4,277 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 and international migration; temporary and permanent migration; short-cycle migration; defined	1982, 1989	327 HH 1982; 327 HH 1989	longitudinal panel study 1982 and 1989 CERPOD

Table 1: (Continued)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environmental data based on the year	Environmental data used	Type of environmental 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 and 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 and permanent migration; defined	1999, 2004, 2009	construct mobility histories of 3,100 individuals	Ethiopian Rural Household survey
20	Grolle (2015)	case studies of three famines that occurred in rural north-west Nigeria during the latter half of the twentieth century	qualitative	north-west Nigeria	1950s, 1970s, 1980s	reported data on three drought events (1950s, 1970s, 1980s)	single	internal migration; family migration; temporary and permanent migration; not defined	1988–1990	162 family heads	own data
21	Hamza, Faskaoui, and Fermin (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 return migration; defined	1998–2000	45 individuals	own data

Table 1: (Continued)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environmental data based on the year	Environmental data used	Type of environ- mental stressor	Migration data based on the year	Migration Sample size	Data source
23	Heaney and Winter (2016)	exploratory case study examining how climate-driven migration impacts the health perceptions and help-seeking behaviours of Maasai in Tanzania	qualitative	Tanzania	2013	perceived data	multiple	2013 internal migration; defined	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	2000 internal migration; permanent migration; defined	8 644 individuals	Migration Dynamics, Urban Integration and Environment Survey of Burkina Faso (EMIUB)
25	Henry, Boyle, and Lambin (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	1985 internal migration; defined	7 964,705	demographic data extracted from population census survey

Table 1: (Continued)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environmental data based on the year	Environmental data used	Type of environmental stressor	Migration	Migration data based on the year	Sample size	Data source
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 and international migration; defined	1960–1999	3,570 HH, collection of 9,612 biographies	Migration Dynamics, Urban Integration and Environment Survey of Burkina Faso (EMIUB)
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 and international migration; seasonal and temporary migration; defined	2012	905 HH	own data
28	Hunter et al. (2017)	temporary rural South African outmigration	quantitative	South Africa	2005–2007	proximate natural resource availability based on NDVI	multiple	internal migration; temporary migration; defined	2007	9,625 HH	Agincourt Health and Demographic Surveillance System (Agincourt HDSS)
29	Simatele and Simatele (2015)	interaction between environmental stress and 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

Table 1: (Continued)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environmental data based on the year	Environmental data used	Type of environ- mental stressor	Migration	Migration data based on the year	Sample size	Data source
30	Konseiga (2007)	motivation behind the important migration from Burkina Faso to Côte d'Ivoire	quantitative	Burkina Faso, Côte d'Ivoire	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 and permanent migration; defined	2000, 2002	401 HH	CAPRI survey
31	Koubi et al. (2016)	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	3,689 individuals 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	1,583 HH	Tanzania National Panel Survey (TZNPS)

Table 1: (Continued)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environmental data based on the year	Environmental data used	Type of environmental stressor	Migration data based on the year	Migration data based on the year	Sample size	Data source
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	2002, 2007	internal migration; temporary migration; defined	9,374 HH	Agricourt Health and Demographic Surveillance System (AHSS)
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	1999	internal migration; in- and return-migration; defined	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	2009	internal migration; not defined	361 migrants, 51 experts	own data

Table 1: (Continued)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environmental data based on the year	Environmental data used	Type of environ- mental stressor	Migration	Migration data based on the year	Sample size	Data source
36	Morrissey (2012)	relationship between environmental stress and rural-urban migration in northern Ethiopia	qualitative	Ethiopia	2009	perceived data	multiple	internal migration; temporary and permanent migration; not defined	2009	not specified	own data
37	Naudé (2008)	panel data on 45 countries spanning the period 1965 to 2005 is 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 1,000 inhabitants for 45 countries	UN Population division data 45 SSA countries (annual average for the ten 5-year periods)
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 and international migration; defined	1990–2000	not specified	CIECIN spatially explicit grid cell level migration data

Table 1: (Continued)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environmental data based on the year	Environmental data used	Type of environmental stressor	Migration	Migration data based on the year	Sample size	Data source
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	3,265 HH	Tanzania National Panel Survey (TZNPS)
40	Rademacher-Schulz, Schraven, and Mahama (2014)	interrelationship between rainfall variability, livelihood/food security, and migration in rural Savannah communities in northern Ghana	quantitative/ (HH survey, PRA, expert interviews)	Ghana	2011	perceived data	multiple	internal migration; seasonal migration; not defined	2011	158 HH	own data
41	Romanekiewicz and Doevenspeck (2015)	local perspective on migration with consideration of cultural norms and interpretation of weather events	qualitative (multisite ethnography)	Mali; Senegal	1961–2000; 2011/2012	local indicators on rainfall and vegetation (number of trees in the field); perceived data	multiple	internal and international migration; permanent migration; not defined	2011, 2012	not specified	own data
42	Smith (2014)	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, scenarios from literature	single	not defined	2012	1,000 individuals; 165 HH	own data

Table 1: (Continued)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environmental data based on the year	Environmental data used	Type of environmental stressor	Migration	Migration data based on the year	Sample size	Data source
43	Sov 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 and 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
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 and 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 and forced migration; defined	2011	total population of Ghana, 203 HH census	Ghana's population and housing census different years, own survey

Table 1: (Continued)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environmental data based on the year	Environmental data used	Type of environmental stressor	Migration	Migration data based on the year	Sample size	Data source
47	Van der Geest, Vrieling, and Dietz (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- and outmigration; 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 and 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-Saharan Africa	not specified	reported data on drought, deforestation, land degradation	multiple	international migration; defined	not specified	47 individuals	own data
50	Mortimore (1989)	link between environmental change and migration in course of time	qualitative/quantitative	Nigeria	1973–1974	perceived data	multiple	internal and international migration; resident and nonresident 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 food	multiple	internal and international migration; temporary and permanent migration; defined	2011	4,000 HH	own data

Table 1: (Continued)

No.	Author's name (Year of publication)	Key topics	Methods	Area	Environmental data based on the year	Environmental data used	Type of environmental stressor	Migration	Migration data based on the year	Sample size	Data source
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: 7 focus groups in 6–8 participants	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	international migration; temporary and permanent migration; defined	2009–2010	2,000 HH (rural and urban)	Morocco Household and Youth Survey (MHYS)

Note: FGD – Focus Group Discussions; HH – Households; MENA – Middle East and North Africa; NDVI – Normalized Difference Vegetation Index; PRA – Participatory Rural Appraisal.

In all 53 references, we sought 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. (2011a) served as a heuristic device to structure and systematise the evidence gathered from the literature. Following the framework, we extract – if it exists – evidence about the economic, political, social, demographic, and environmental drivers; factors on the micro level (personal and household) and meso level (intervening obstacles and facilitators); and the interaction between the different factors. Using this approach, all the necessary information on the effects of environmental factors on migration in Africa were collected. The key micro-, meso-, and macro-scale interactions that result in migration–environment associations were reported and analysed for each paper. Ultimately, considering that the key concepts ‘migration’ and ‘environment’ may refer to 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

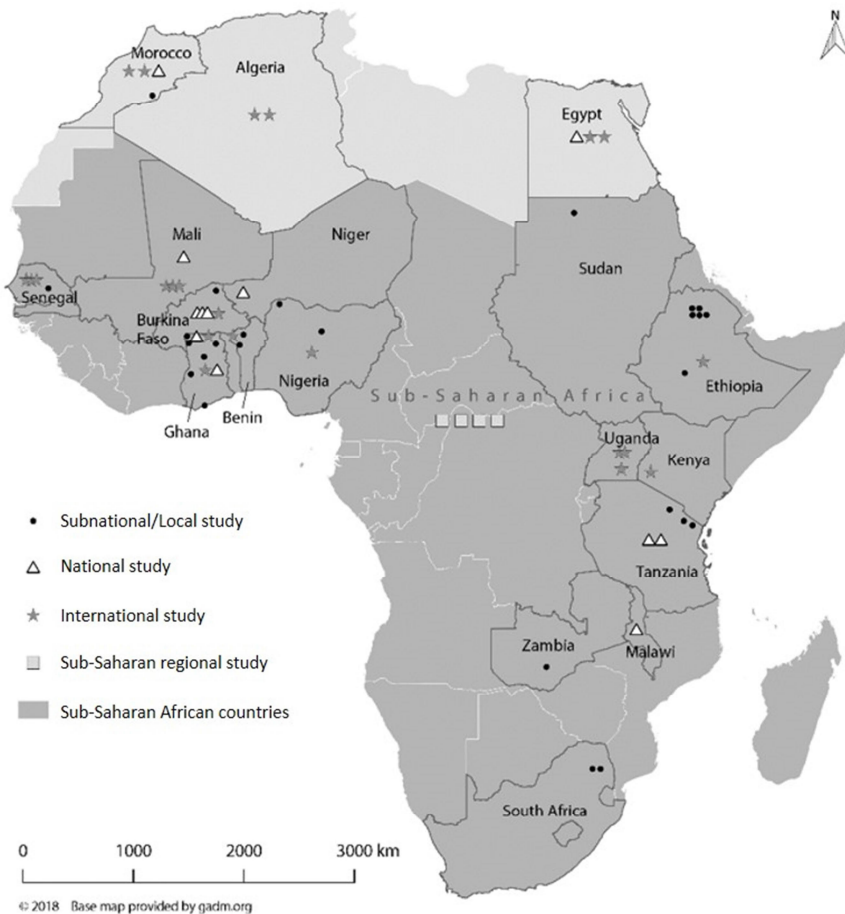
In this section, we present a summary of the nature of research on environmental change and migration in Africa, including the key findings from the review. First, we provide an overview of the number of studies conducted over the past 28 years and their geographical scope. Second, we assess the methods applied in the literature. Third, we carve out how the literature conceptualises migration and the environment in different strands of research. Lastly, we highlight how the research articles included in our sample address the interaction between migration and the environment.

4.1 Trends and geographical scope

Applying the inclusion/exclusion criteria yielded 53 papers published from 1989 to 2017, as presented in Figure 1 and Table 1. Four studies examine the environmental change–migration nexus by using data on countries of sub-Saharan Africa (SSA); one paper adopts a broader perspective by focusing on all 116 countries, including SSA (Cattaneo and Peri 2016); and three papers have a special focus on countries in the SSA (Barrios, Bertinelli, and Strobl 2006; Neumann et al. 2015; Suckall, Fraser, and Forster 2017). There are 22 articles that use a comparative approach dealing with case studies

from more than one country. A total of 11 studies examine the relationship between environmental change and migration at a national scale. The most frequent study design is the local case studies (subnational studies); 26 case studies⁶ have been carried out, covering mainly West Africa on one side and Ethiopia and Tanzania in East Africa (see Figure 2).

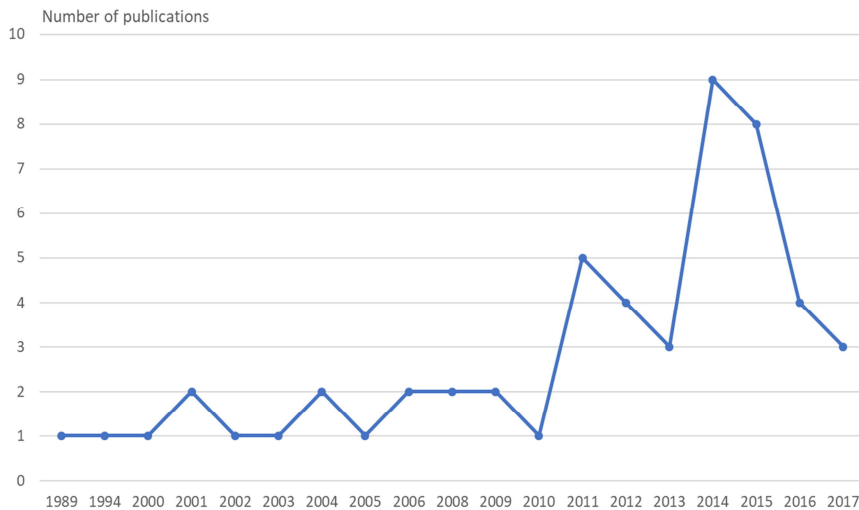
Figure 2: Map of distribution of case studies by country



⁶ Some of the case studies in the articles that adopted a comparative approach are also counted at local cases, when that is relevant. Therefore, the 53 papers reviewed in fact encompass more than 53 specific cases.

Figure 3 presents the number of publications focusing on Africa that are included in this review arranged 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, which has intensified significantly, particularly since 2010 (Piguet, Kaenzig, and Guélat 2018). This is likely to be attributable to improvements in climate and migration data as well as statistical tools and techniques (Fussell, Hunter, and Gray 2014).

Figure 3: Number of selected publications over time



4.2 Methodological overview: Type of methods used

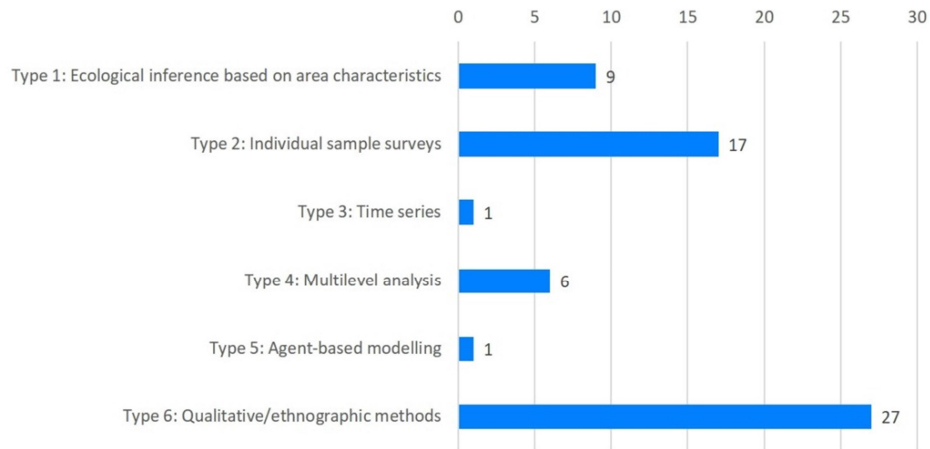
In terms of the type of methods used, we apply a six-group typology presented by Piguet (2010) in his review of research methods used in empirical research focusing on the environment–migration nexus. The first four typologies characterise different research designs, data, and levels/units of analysis in quantitative research.

- Type 1: ecological inference analysis based on area characteristics where migration and environmental factors are measured at the aggregate level.
- Type 2: individual sample surveys, where both migration and environmental data is collected at the individual or household levels.

- Type 3: time series analysis, which practically measures the correlation between environmental factors and migration over time.
- Type 4: multilevel analysis that differs from Type 2 only for environmental data, which is collected at the ecological level, while migration information is measured at the individual or household levels.
- Type 5: agent-based modelling, which is a simulation of the behavioural responses of individuals and households to environmental pressure based on the assumptions of a researcher. This modelling is thus not necessarily based on empirical evidence like other approaches.
- Type 6: qualitative/ethnographic methods, including face-to-face interviews, focus group interviews, and 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 4. This shows that the most common method used in the literature reviewed is some kind of qualitative/ethnographic method ($n = 27$). 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 subjective 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 outmigration in a geographical unit) or at the individual or household levels (e.g., regressing climatic and/or environmental factors measured at the ecological level and estimate their effects 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, the availability of satellite imagery and environmental or climate data coupled with improvement of computation tools in recent years facilitate the conducting of multilevel analysis (Fussell, Hunter, and Gray 2014). There are not many studies that belong to the category time series (Type 3) possibly because migration data is often not available over relatively short time intervals (i.e., weekly or monthly).

Figure 4: Typology of empirical studies on environmental change and migration



4.3 The multiple dimensions of environment and migration

Most of the empirical case studies included in the review were carried out after 2010, which was after the methodological overview by Piguet (2010) on the environment–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 behaviour and environmental evolutions at temporally and spatially comparable scales” (Piguet 2010: 6). Meanwhile, a later literature review of research on the environmental dimensions of migration by Hunter, Luna, and Norton (2015) points out the need for clarification and critical examination of the definition of ‘migration’ and the ‘environment,’ and questions 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 the foundation for this evidence review.

4.3.1 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 53) – that is, 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 together in a common pot named environmental stressors.

One distinction of the characteristic of the environmental component is related to the rapidity of the process: slow-onset event vs. rapid or extreme weather-related event. A strong assumption refers to the speed of the phenomena that might result in various human consequences and migration decisions. For instance, combining a large national survey of individual biographies with environmental data including rainfall (global monthly precipitation) and land degradation via an estimation of the rain-use efficiency, Henry et al. (2004) concludes 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 a migration response to environmental stressors, it is important to distinguish between rapid- and slow-onset events.

Another distinction emerges as to 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, Lutz, and Jiang 2016). Consequently, there is no universal perception of the degree of severity of the impacts, which are perceived in the same way everywhere and by everyone (Dessai et al. 2004; Marx et al. 2007; Piguet 2010).

The notion of perception is therefore fundamental in defining the environmental stressors. Indeed, most of the environmental data is 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 use the observed or measured environmental data but the perceived and self-reported data.

As in Ocello et al. (2015), one of the most frequent questions used when collecting perceived data on the environmental component is “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, floods, landslides, and crop diseases is then given. The observed environmental stressors recognised as such by the interviewees can

also be ranked using a severity score to assess the migration intentions in response to major stressors (Abu, Codjoe, and Sward 2014).

In understanding the role of the environment as a migration driver (or the absence of it) by directly questioning the respondents, the question of the environmental factor can be 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 show that environmental stress was not mentioned by the participants as a key driver of migration.

Within the empirical study using objectively measured environmental data, the most frequently used sources are earth-observation-based data, including all information extracted from satellite imageries, local or national meteorological data, or models from weather stations. From the geolocated environmental data, 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 based their analyses on an estimation of the natural resource availability via the NDVI.

4.3.2 Characterisation of the migration component

Similarly to the environmental component, the reviewed literature presents a broad range of different types of migration being studied. In the most basic sense, any definitions of population movement involve both spatial and temporal dimensions (King 2012). Furthermore, categorisation according to causes and purpose of migration is also possible. With regard to the spatial dimension of movements, 32 of the case studies focused on internal migration, 4 on international migration, and 16 considered both types of migration. A strong focus on internal migration reflects the established scientific evidence, including from 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, Sakdapolrak, and Warner 2012; Bleibaum 2008; Carr 2005; Dreier and 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, and skills, and clearly delineate the criteria for the selection of the respondents for focus group interviews. Other studies are more unspecific, referring, for example, to places where people migrated to in the past (e.g., Dreier and 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 household members who are considered migrants. The spatial and temporal criteria applied to identify absent members as migrants varies: Afifi, Liwenga, and Kwezi (2014) use a six-month threshold to differentiate between seasonal and permanent migrants; similarly Findley (1994) considers members who are not in the village for periods of between one and six months as “short-term cycle migrants” and those who left without returning in the reference period as “permanent migrants.” Other authors such as Hummel (2016) use a three-month 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 and Mueller 2012), or one’s place of birth (which is not equivalent to the place of residence) (Koubi et al. 2016). Some studies introduce additional criteria for the identification of migrants, such as whether absent members are still considered to belong to the household (e.g., Adoho and Wodon 2014), retain livelihood connections (Hunter et al. 2017), or send remittances (Cattaneo and Massetti 2015).

A third group of studies utilises existing data sources such as censuses to derive migrant stocks and counts migration as net-migration, that is, bilateral net-migration rates between countries (e.g., Cattaneo and Peri 2016; Naudé 2008) or provinces and regions (van der Geest 2011a; e.g., Henry, Boyle, and Lambin 2003). 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.

4.4 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 creates another challenge: whether it is 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 Black’s framework on drivers of migration (Black et al. 2011a), the study of the nexus between both components requires taking into account all the other 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, Codjoe, and Sward 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 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 that people will move out and follow the opportunity to have a better income when living in a drier area (i.e., 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 carried out at the household level, perceptions of environmental stressors expressed by members of the household, as well as their socio-demographic characteristics, do not require the use of a multilevel model for statistical analysis. Yet, the integration of a contextual effect (e.g., at the community level) rather than only individual-level factors would demand the use of multilevel modelling design (Laczko and Aghazarm 2009; Rabe-Hesketh and Skrondal 2006). Therefore, the interactions between individual- or household-level migration with the meso- or macro-level environmental data can only be studied with consideration of the multilevel modelling design. Amongst the 53 studies reviewed, only 7 papers employ multilevel framework⁷ (Cattaneo and Massetti 2015; Gray and Mueller 2012; Henry et al. 2004; Henry, Schoumaker, and Beauchemin 2004; Hunter et al. 2017; Kubik and Maurel 2016; Neumann et al. 2015). However, we could expect an increase in the use of

⁷ Strictly speaking, multilevel modelling would normally have a random intercept model. Most of these studies use only contextual-level data but do not really perform a multilevel analysis.

multilevel modelling in the coming years due to the necessity of assessing such interactions (Fussell, Hunter, and Gray 2014).

On another note, the qualitative methods allow the identification of interactions and give the possibility of understanding both measurable and unmeasurable factors underlying the migration decision of an individual. Qualitative approaches can also help to unravel the different factors that influence the migration decision process by following a multilevel reasoning. Different social levels (e.g., the individual, the household, and the community) can be investigated.

Each approach has its own limitations, and the benefits of using a combination of methods (mixed methods) thus deserve to be underlined. Mixed-methods studies allow the possibility of deeper insights and greater representativeness. Nine case studies from our selection (Table 1) combined qualitative and quantitative methods (however, only one explicitly referred to mixed methods).

5. The key evidence: From sound to contradictory statements

The empirical studies reviewed show that 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 gain insights into interactions between key macro-, meso-, and micro-scale factors that influence migration in the context of environmental change. The major patterns found from the review are described below.

5.1 No evidence that environmental change is a sole cause of migration

Amongst the empirical studies reviewed, none of the papers mentioned environmental change as a sole driver of migration. Although several papers have established the link between environmental impacts and migration decisions, these impacts are mediated through factors on the macro, meso, and micro level: economic, social, and political drivers (e.g., Afifi 2011; Afifi, Sakdapolrak and Warner 2012; Bleibaum 2008; Carr 2005; Doevenspeck 2011; Hamza, Faskaoui, and Fermin 2009; Morrissey 2012); social networks (e.g., Findley 1994; Haug 2002; Simatele and Simatele 2015); or characteristics of the household (e.g., Kubik and Maurel 2016; Leyk et al. 2012) and the migrants (e.g., Ocello et al. 2015; Suckall, Fraser, and Forster 2017). The evidence clearly supports the conceptualisation of multidimensional drivers of migration in the context of environmental change suggested by Black et al. (2011a). Elaboration on the interaction of macro-level drivers with environmental change remains rather vague in

most studies, while a handful of studies – particularly those applying a multilevel framework – provide detailed insights on how micro-level factors influences migration patterns under environmental change measured at the meso or macro levels.

5.2 Sensitivity of livelihoods matters when applying migration as a coping and adaptation strategy, but different types of migration react 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 non-resource-based livelihoods in their analysis indicate that environmental drivers 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 dependence on environment-sensitive economic activities are less vulnerable to environmental stress. This evidence is also present in quantitative studies which show that the effects of temperature change on migration is larger in countries (Cattaneo and Peri 2016) and households (Kubik and Maurel 2016) where the main source of income comes from agriculture. However, note that the relationship is negative: Higher temperatures suppress migration in countries where agriculture is a major economic activity. Some studies also embed migration in the context of livelihood vulnerability and in so doing show that migration is only one of many strategies households adopt in order to deal with environmental stress. Ezra (2001), for example, analyses a wide range of life-course transition responses to environmental stress in northern Ethiopia. Besides migration (both rural–rural and rural–urban), changes in marriage behaviour and fertility patterns can also be observed. Here the evidence is also not conclusive, as in some cases; environmental stress increases the propensity to migrate while in other cases migration decreases (Cattaneo and Massetti 2015; Ezra and Kiros 2006).

The empirical evidence in the reviewed studies also shows the differentiated influence of environmental stress on types of migration response (Findley 1994; Henry, Schoumaker, and Beauchemin 2004). There is evidence that international migration, which is more costly, declines during drought (Henry et al. 2004) whilst short-term internal migration increases (Findley 1994; Grolle 2015; Henry, Schoumaker, and Beauchemin 2004). 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 and Mueller 2012).

5.3 There are 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 appearing to have the most consistent direction. Generally, young and middle-aged persons have higher intention and higher propensity to migrate (Abu, Codjoe, and Sward 2014; Adaawen 2015; Afriyie, Ganle, and Santos 2018; Bleibaum 2008; Carr 2005; Ezra 2001; Ezra and Kiros 2006; Gray 2011; Henry et al. 2004; Henry, Schoumaker, and Beauchemin 2004; Morrissey 2012, 2013; 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, Ganle, and Santos 2018; Hamza, Faskaoui, and Fermin 2009; Heaney and Winter 2016), possibly due to the gender-differentiated character of (re)productive work allocation within the household (Findley 1994). This is reflected in different types of migration engaged in by men and women: Labour migration increases for men in times of drought, whilst marriage migration declines for women (Gray and Mueller 2012). Sow, Adaawen, and Scheffran (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 expressed 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, Liwenga, and Kwezi 2014; Cattaneo and Massetti 2015; Ezra and Kiros 2006; Gray 2011; Ocello et al. 2015). On the other hand, wealth and education also facilitate the migration process. These households thus have a higher capacity to choose migration as an adaptation strategy if needed (Gray and Mueller 2012; Kubik and Maurel 2016). Education also determines types of migration: Long-term moves are more common among the highly educated, while the opposite is true for their less-educated counterparts (Henry, Schoumaker, and Beauchemin 2004).

5.4 The nature and duration of the environmental pressure results in different migration behaviours

Several studies point out that the nature of the environmental event determines the migration decision (van der Geest 2011b; Henry et al. 2004; Koubi et al. 2016; Nguyen

and 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 go in both directions, however. 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 increasing 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 reduce the probability of migrating overall.

Moreover, the temporal dynamics and duration of exposure 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. At the beginning of a drought, the households with more assets suffer less and migrate less, while the others might use migration as an adaptation. If the drought lasts, outmigration then becomes a strategy for everybody. Therefore, when options for coping strategies (other than migration) are reduced, this leads to a challenging situation for everyone. Rademacher-Schulz, Schraven, and Mahama (2014) also report the importance of timing. When a bad harvest is expected, season migration is shifted from a dry season to a rainy season. 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 most pronounced outside the growing season.

5.5 Social networks and kinship ties act as facilitators for migration

The review shows that social networks and kinship ties play a crucial role for migration in the context of environmental change, particularly in terms of facilitating migration and influencing destination decisions (Bleibaum 2008; Carr 2005; Doevenspeck 2011; Dreier and Sow 2015; Findley 1994; van der Geest, Vrieling, and Dietz 2010; Haug 2002; Simatele and Simatele 2015). Bleibaum (2008) refers to the importance of ethnic-

based networks that facilitate the migration from the studied 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 additionally highlights that these personal connections are important means through which migrants could claim access to land in the destination area. Doevenspeck (2011) describes kinship networks as an “indispensable condition” for migrants to be accepted and integrated in the new settlement for his case study in Benin.

5.6 Environmental surplus also influences migration patterns

While most studies focus on the influence of unfavourable environmental conditions such as droughts, floods, or land degradation on migration patterns, a few also highlight that favourable conditions (van der Geest 2011a; Henry, Boyle, and Lambin 2003) – or what Hunter et al. (2017) refers 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. Focusing on the place of destination, Henry, Boyle, and Lambin (2003), in their study on interprovincial 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 outmigration. Resource availability enables households to pursue migration as a strategy for livelihood diversification. Mortimore (1989) and van der Geest, Vrieling, and Dietz (2010) further highlight that the crucial factor influencing the migration decision is access to environmental resources. Therefore, it is not sufficient to consider the availability (either abundance or scarcity) of natural resources alone.

5.7 The nature of migration–environment relationships is contextually contingent

The review shows that the influence of environmental change on migration patterns is highly context dependent. Therefore, no specific direction in the relationship can be easily stated. According to the context, the role of environmental change on migration can be seen as a push factor as well as a factor in favour of immobility. Many studies applying a qualitative approach have given a rich picture of how different economic,

political, and social factors intersect with the impact of environmental change on migration decisions (e.g., Afifi, Liwenga, and Kwezi 2014; Bleibaum 2008; Carr 2005; Doevenspeck 2011). Bleibaum (2008), for example, points to issues influencing migration including land distribution, management of the irrigation system, and changing agricultural policies in the context of environmental change in Senegal. For instance, the mismanagement of the dam and irrigation infrastructure leads to an under-exploitation of the land available and to an unequal land distribution. Young people and women, in particular, face difficulties in accessing land and often see no other possibility than to migrate. Doevenspeck (2011) shows that only soil degradation does not automatically lead to migration. He emphasises the need to take the political and cultural context into account in order to understand the mobility of people from the densely populated and environmentally critical north-east of Benin. Numerous interviews confirm that legal uncertainty, especially regarding land tenure, appears to be the most important social driver for multiple migrations in rural Benin. Soil degradation exacerbates the situation. The role of contextual factors also becomes apparent in studies pursuing a quantitative approach (e.g., Findley 1994; Gray 2011; Gray and Mueller 2012). A good example is the study by Gray (2011) on the effect of soil quality on migration behaviour based on a longitudinal/panel survey and 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 costs of migration. Other studies show how, depending on geographical context, marriage migration may increase during a drought in Mali as a strategy to reduce household consumption (Findley 1994) but be reduced in Uganda when soil quality is poor (Gray 2011) and in rural Ethiopia during a drought (Gray and Mueller 2012) due to high costs of bride wealth. Therefore, scepticism is warranted when dealing with broad narratives that predict migration patterns due to local environmental changes.

There is also a gap between the components which theoretically can play a role in the migration decision process and their inclusion in empirical case studies. Some factors such as psychological characteristics (i.e., preferences or attachment to the place of origin) or political drivers (discrimination, persecution, or direct coercion) are very rarely considered and their effects are difficult to control. Even though they can be underlined during an individual interview, these factors are difficult to measure in quantitative studies.

5.8 The choice of scale for the observation and analysis of the environment change–migration nexus influences the evidence

Few papers deal with the idea that the issue of scale is key in understanding whether and how environmental change and the migration decision are connected (Hunter et al. 2017; Leyk et al. 2012; Neumann et al. 2015). It could also be legitimately asked if there are more or less appropriate 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 data set from the Agincourt Health and Demographic Surveillance System, Hunter et al. (2017) and Leyk et al. (2012) show that there is an association between the Normalized Difference Vegetation Index (NDVI) and temporary outmigration. However, the relation is complex, and its direction varies according to the scale of observation. A model at the scale of the rural South African study site has underlined that the proximity to natural resources results in more migration; while using village-scale models (local models for individual villages), the results appear far more heterogeneous (Hunter et al. 2017). The use of multi-scale models shows that the impact of natural resource access on the migration decision could lead in 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) also conclude 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 (the two observed hotspots of outmigration are Burkina Faso and northeast Brazil). However, national-level analyses for Burkina Faso (one of the hotspots) 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 we be able to construct relevant models reflecting the reality and its potential future.

5.9 It is not possible to draw a universal conclusion based on implications from the data and methods used

Understanding why studies addressing similar research questions sometimes reach different conclusions is a common and frustrating problem for both researchers and research users. Whilst the contextually contingent nature of migration and

environmental change partially explain the inconclusive evidence on the relationship between environmental change and migration, a similar reasoning can possibly also be made for different data and methods used. Without comparable data and measures across a range of geographical and temporal contexts, it is impossible to make generalisations (Fussell, Hunter, and Gray 2014). We have thoroughly examined whether some patterns can be extracted from the 53 studies based on types of methods and data used. In fact, no specific patterns have been discovered whether in terms of the sources of migration data (census data, household surveys, primary data collection, etc.), the type of methods (quantitative, qualitative, or mixed methods) or models (type of regression, etc.), and the quality of the environmental information (measured or perceived).

It is worth noting that breaking down the 53 studies into different categories based on methods led to some difficulties in reaching conclusions about the nature of the relationship between environmental change and migration and the methods and data used. Firstly, this is due to the different formulations of the research questions that the studies attempted to reply. While most of the selected studies directly question the role and influence of the environmental driver(s), some others treat this as secondary in their research (see for instance Heaney and Winter 2015, who are interested in understanding how climate-driven migration impacts the health perceptions and help-seeking behaviours of Maasai in Tanzania). That often implies various considerations that must be taken into account in collecting materials and in characterising the types of migration or environmental change, as we have seen in section 4.3.

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 in the environmental dimensions of migration and technical improvement in the measurement of this nexus results in a fair enhancement of databases and implementation of integrative assessment (Bilsborrow and Henry 2012; Hunter, Luna, and Norton 2015; Neumann and Hilderink 2015). The project Terra Populus, which provides 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).

As of now, more than half of the case studies use their own data (primary collection), and the sampling methods employed are not always explicitly stated. Collecting data mainly at the household level does not appear as a specificity of case studies in Africa (Hunter, Luna, and Norton 2015). However, those types of studies seem privileged in the African context. Data based on secondary data sources such as data from the Demographic and Health Surveys (DHS) is pretty much absent despite

the suggestion from Bilborrow and Henry (2012) to use DHS in the study of the migration–environment relationship.⁸

When it comes to data from surveillance systems, it has been exploited in only one of our selected case studies (the Agincourt site in South Africa: Leyk et al. 2012; Hunter et al. 2017). However, this data is considered to be the best for establishing causal sequence by examining the same analytical units across time and establishing the temporal order of the environmental event or change and migration (Fussell, Hunter, and Gray 2014; Call et al. 2017). As long as geographic identifiers are available for households, surveillance sites offer unique opportunities to combine demographic and geographic information (Leyk et al. 2012). Demographic surveillance sites from the INDEPTH network number 48 in total, including 37 in the African continent. Due to the potentiality of the source, more case studies using health and demographic surveillance system data could be imagined in the near future (Bocquier 2016).

Finally, 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 about the comparability of the studies.

6. Conclusion: An attempt to systematise empirical evidence on migration influenced by climate change in African countries

Although Africa is expected to experience major impacts from climate change ranging from sudden-onset events, gradual disasters, and water scarcity to food insecurity (Niang et al. 2014), the results from our review suggest that climate change will not systematically generate mass migration from Africa to Europe and other continents. This is precisely because, as we highlighted earlier, migration is a complex phenomenon driven by the interactions among different demographic, socioeconomic, geographic, and environmental factors. Climatic and environmental factors may aggravate conflict, instability, and insecurity arising from worsening economic conditions, which are key migratory push factors in Africa (Conte and Migali, in this Special Issue). However, even though climate change will increase population exposure to environmental hazards, high levels of poverty mean that a large part of African populations do not have sufficient resources to be mobile. In fact, recent literature has highlighted the importance of considering ‘trapped’ populations who lack the physical,

⁸ The case study in Burkina Faso and Senegal on climate, migration, and food security by Nawrotzki, Schlak, and Kugler (2016) uses DHS and the data extraction system Terra Populus. However, the paper was added to the Climig data set in November 2017, whereas the literature research was conducted in May 2017. Therefore it has not been included in our 53 case studies.

social, and financial capital to migrate despite being highly vulnerable to climate change (Black et al. 2011b; Nawrotzki and DeWaard 2018; Zickgraf et al. 2016). Climate-related migration is in fact more likely in households or communities with a certain level of socioeconomic resources, by whom migration is adopted as an adaptation strategy (Riosmena, Nawrotzki, and Hunter 2018). Given the current level of economic development, climate change is unlikely to result in large numbers of international migrants from African countries. Only in socioeconomic development scenarios in which economic growth and human development will be achieved globally do we observe a projected increase in international migration from Africa, peaking around 2070–2075 in SSP1 from Shared Socioeconomic Pathways (Abel 2018). Other more pessimistic scenarios such as SSP3 and SSP4 foresee a decline in net migration from Africa.

Despite a substantial increase in empirical studies on environmental drivers 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 the employment of diverse spatial units and scales, make it difficult to draw 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 becomes possible to detect empirical space-time regularities in the environmental change and migration nexus. This urgent need for 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.

Although these variations may seem problematic, at the same time they also add richness to the evidence. In fact, McLeman and Gemenne (2018) 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 realities. As contexts matter and the interactions of drivers are key to understanding how environmental change influences the migration process, mobilising a wide range of methods would enable us to overcome the challenges involved in examining these complex interrelations. Indeed, some methodological efforts in the design of new empirical case studies deserve to be made in order to implement Black et al.'s framework on drivers of

migration (2011a) and cover not only the different dimensions but also the interaction between them.

Notwithstanding that the state of knowledge has improved over recent years, more information is still needed on the links between different types of human mobility (voluntary migration, displacement, or planned relocation) and climate change and other drivers, such as conflict. In the analyses, clear distinctions could be made between types of environmental stressors, sudden- and slow-onset contexts, type of migration patterns, and destinations.

Yet, the finer the scale of observation is, the more heterogeneous the situation appears, meeting the individual specificities. Whether there is the most appropriate scale at which 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 existing at a relatively fine scale are likely to go undetected. This follows 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: 308). This suggests that aggregation has a smoothing effect. In this case, a multi-scale 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 has brought some nuance to the debate on whether environmental change does and will cause massive migration flows. 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. As we have seen, some studies have shown that migration is a costly process and is employed as only one strategy amongst many other adaptive responses, and income and productivity loss due to climatic stressors could limit outmigration rather than being in favour of it.

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 trans-local perspective, rather neglected in most case studies, could thus be explored more systematically.

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