

The uneven geography of research on “environmental migration”

Etienne Piguet¹  · Raoul Kaenzig¹ · Jérémie Guélat¹

Published online: 19 May 2018

© Springer Science+Business Media, LLC, part of Springer Nature 2018

Abstract Climate change and environmental hazards affect the entire world, but their interactions with—and consequences on—human migration are unevenly distributed geographically. Research on climate and migration have their own geographies which do not necessarily coincide. This paper critically confronts these two geographies by presenting the first detailed mapping of research in the field of environmentally induced migration. After a brief review of the geography of research on climate change, the paper presents an overview of nearly 50 years of case studies on the basis of CliMig, a bibliographic database of 1193 scientific papers and books on climate/environmental change and migration, among them 463 empirical case studies. We analyze the locations of these case studies, the academic affiliations of their researchers, and the origin of their funding. Mapping the locations of case studies worldwide points toward blind spots in the research and identifies “overstudied” areas. We describe the methodologies used in the studies and present a typology of environmental hazards. Our results show that research on environmental migration is mainly done in countries of the Global South, whereas climate science research in general is focused on countries of the Global North. We contend that the peculiar geography of environmental migration cannot be explained solely by the uneven vulnerability of southern populations to the environment. It must also be understood through the lens of post-colonial and

This paper was presented at the Hugo conference: <http://events.ulg.ac.be/hugo-conference/>.

We would like to thank Suzy Blondin, Loïc Bruening, Christine Diacon, and Aronne Watkins for their help in maintaining the CliMig database.

✉ Etienne Piguet
Etienne.piguet@unine.ch

Raoul Kaenzig
Raoul.Kaenzig@unine.ch

Jérémie Guélat
jeremie.guelat@gmail.com

¹ Institute of Geography, University of Neuchâtel, CH-2000 Neuchâtel, Switzerland

securitization studies as the result of a framing of “environmental refugees” (and refugees in general) as an intrinsically “southern problem” and as a security risk for the North. This paper is an original contribution to the literature on the North-South divide in scientific research and will help to outline future directions of investigation.

Keywords Environmental migration · Geography of science · Climate change · Bibliometric analysis · Spatial scientometrics

Introduction

From Alexandria to ancient China and Baghdad, science has always demonstrated a specific geography (Dorn 1991; Ronan 1983). Recently, several authors have suggested spatializing the tools of scientometrics to analyze the geographic distribution of scientific publications (Frenken et al. 2009), while others draw attention to the constitutive significance of “place and space, site and situation, locality and territoriality” for scientific production (Livingstone 1995: 5). Few investigations regarding the specific field of climate and environmental change science have been conducted. Those which do exist suggest interesting interpretations of the North-South divide that emerges in the production of knowledge (Blicharska et al. 2017; Pasgaard and Strange 2013) and call for a “better [understanding] of the geographical imbalances in climate change knowledge production and its exchange between nations and regions, including why it has emerged and persists” (Pasgaard et al. 2015: 279). Climate change is global and borderless, but climate science is not!

To our knowledge, mapping environmentally induced migration research has not been attempted to date.¹ The only exception is Obokata et al. (2014) in this very journal. The authors take the opportunity of an overview of 31 empirical papers on environmentally related international migration listed in ISI Web of Science to produce a map locating case studies. The authors do not attempt to explain this emerging geography of research in detail, but their map confirms that—as with the geography of climate science in general—this geography is far from homogeneous.² In this context, our paper endeavors to produce a much broader and comprehensive mapping of existing studies on environmental change and migration by confronting different hypotheses regarding historical and geographical drivers. Whereas research on the geography of science—and more specifically, the North-South divide—is focused on research practices (Crawford et al. 2017), language (Clavero 2011), origin, and funding (Blicharska et al. 2017), we add a specific focus on the locations of case studies, with contrasting results.

Questions and hypotheses

When, where, and with which specific focuses did research on environmental migration emerge? Who are the researchers, and what are their methods? What is the geography

¹ We presented some preliminary results and hypotheses in (Piguet and Laczko 2014) and in one section of the *Atlas of environmental migration* (Ionesco, Mokhnacheva, & Gemenne 2016) showing regional overviews and a brief discussion of the geography of research.

² The imbalance of climate science on the specific issue of impacts, adaptation, and vulnerability is mapped by the IPCC in the 2014 assessment on the basis of ISI data (IPCC, 2014b: 38).

of this research in terms of the locations of case studies and the affiliations of researchers and funding? How can these factors be explained?

Several families of hypotheses can help to explain this geography of research. The geography of climate science shows a clear bias of research against developing regions of the world, with fewer case studies being conducted and fewer researcher affiliations in those areas.³ This North-South divide is marked by differentials of economic resources dedicated to funding research, levels of educational, and brain drain (which leads to a relative shortage of locally based researchers). In addition, authors point toward the impact of institutional governance that influences the production of research and facilitates it in Northern countries (Blicharska et al. 2017; Ho-Lem et al. 2011; Karlsson et al. 2007). We call these “development inequalities.”

A second line of explanation—frequently used to explain the “Southern bias” of development research, and more in line with classic geographic environmental interpretations—posits that more research should be undertaken in Southern countries because, according to IPCC reports (IPCC 2014a), they are not only at higher risk of being adversely affected by climate change and environmental hazards than Northern countries, but that these risks are exacerbated by economic inequalities (Neumayer et al. 2014). This pattern was rejected in the case of climate research in general—which is more focused toward Northern countries⁴—but one could argue that the case of migration is different, as the phenomenon is linked with environmental determinants by a long tradition of research (Piguet 2013). Such environmental interpretations would also be in agreement with classic accounts of the geography of scientific development. In his “geography of science” Dorn considers “soil, climate, hydrology, and topographical relief as well as demographic fluctuations & latitude” as the determining forces of scientific enterprise in history (Dorn 1991: xi). We call this explanation “environmental determinism.”

The vigorous critique of environmental determinism in general, and of the “Dornian” explanation of the geography of science by environmental differences in particular (Livingstone 1995), leads us to a third family of explanations which forwards the particular gaze of researchers on “environmental migrants” and the way this category is constructed. Our hypothesis is that the post-colonial imagination—which sees the archetypal victim of climate change as a poor peasant from the South—might disproportionately attract researchers and research funding to the South. In addition, some interpretative tools in the literature of securitization argue that many contemporaneous issues have gained salience in public debates due to being framed as threatening (Buzcan et al. 1998). Indeed, the issue of migration and climate change has often been considered a security issue for rich countries supposedly threatened with a flood of “environmental refugees” from the South (Boas 2015). Such “securitized” subjects receive disproportionate attention

³ Pasgaard et al. conducted a bibliometric analysis of 15,000 scientific climate change publications. They show that the publications on climate change generally both concern (i.e. the case study country) and are produced (i.e. the author country) by developed countries and BRICS countries (China, India, and Brazil). Regarding environmental science in general, Karlsson et al. show that more than 80% of papers are published in and about temperate and cold eco-climatic zones and only 13% on sub-tropical and tropical zones, although these eco-climatic zones account for more than 52% of the world’s land area (Karlsson et al. 2007).

⁴ Pasgaard et al. tested the impact of mean annual temperatures, low mean annual precipitations, and the fact of being a small island state (SIS) on the number of publications. The correlations revealed negative with the first and last indicator (=more research in colder countries / less research in SIS), insignificant with precipitations.

compared to non-securitized subjects, independently of the level of human damage they might cause. We call this third line of explanation “post-colonial/securitization.”

In addition to these three main families of hypotheses, more practical considerations—such as political stability, absence of risks of violence for researchers, availability of English speakers, proximity, and accessibility of fieldwork locations—might be taken into account in order to explain the geography of research (Blicharska et al. 2017). This “pragmatic” explanation interacts with the three others.

This paper is divided into five parts. In the next section (“Methodology”), we discuss the construction of our bibliographic database as well as the way we created the variables for our analysis. In the third section (“Results”), we reconstruct the history of environmentally induced migration research. Although this is not the core of our paper, our database allows a unique chronology that deserves interpretation and supports the analysis. In the fourth section (“Discussion”), we map case studies (where?), affiliated institutions and sources of funding (who?), methodologies (how?), and the hazards most often linked to migration (why?). In the final section, we discuss the results as they pertain to the aforementioned lines of hypothesis. In addition—and in homage to this special issue—we present the research of Graeme Hugo and its specific geography. Hugo is among the researchers with the largest geographical scope of inquiry, which justifies the publication of this paper in a special issue dedicated to his memory.

Methodology

As exhaustively as possible, we take into account existing scientific literature on the environment and human migration.⁵ One way to collect such publications is to search the ISI Web of Science using keywords. This is the strategy chosen by Obokata et al. for literature on international environmental migration (Obokata et al. 2014) and by Pasgaard et al. for climate science in general (Pasgaard et al. 2015). The IPCC enlarges the pool by tapping into the larger SCOPUS database (IPCC 2014b). Our strategy differs because we have a bibliographic database specifically dedicated to migration, the environment, and climate change. The CliMig database (see Appendix) developed by systematically tracking new publications in scientific journals, books, and reports according to a set of strict guidelines and on the basis of solid experiences of literature reviews in other contexts (Berrang-Ford et al. 2011; Pullin and Stewart 2006).

One great asset of the comprehensive CliMig database is that it stays strictly focused on scientific literature. We include gray literature on the basis of the IPCC guidelines (IPCC 2013) provided that the results have not been subsequently published in a peer-reviewed document. The exhaustiveness of the database is confirmed by tests of robustness made in comparison with searches on SCOPUS and the ISI Web of Science, but most of all by the comparison with regional synthesis of literature published by experts around the world (Piguet and Laczko 2014).

⁵ Migration is defined here in line with the International Organization for Migration as “a move across an international border or within a State away from the habitual place of residence of the migrant, regardless of the person’s legal status; whether the movement is voluntary or involuntary; what the causes for the movement are; or what the length of the stay is” (<https://www.iom.int/who-is-a-migrant>).

CliMig is the first bibliographic database to specifically concentrate on migration, the environment, and climate change. It contains 1193 publications, among them 463 case studies.⁶ The references are gathered with a rigorous and transparent methodology aimed at detecting all publications focused on migration, the environment, and climate change. These publications are sorted using strict criteria, including types of literature.⁷ Each reference was carefully assigned a set of fixed keywords to insure coherence and reliability of analysis. This allowed us to create the following set of variables:

“Case studies” (versus other studies: synthesis, overviews, opinions, etc.): A case study is a scientific inquiry with an empirical component for which a methodology can be identified (see variable “Methods”). A specific area or a country can be considered as the object of study within a provided case study if it is analyzed on the basis of empirical material (including secondary literature in the case of historical analogue). The depth of the analysis can therefore vary significantly between a case study entirely dedicated to one country and a case study which paints an overall picture. Regional overviews—i.e., Kaenzig and Pigué (2014) about the Latin American continent—are not considered case studies. However, empirical papers based upon a supranational (i.e., continent) level are included in the database, for example, Thiede et al. (2016) on climate variability and interprovincial migration in South America. As mentioned above, $N = 463$ case studies.

“Case study locations”: The location corresponds to the place where the case study has been conducted. All case studies which mention the continent and the country/countries are integrated within the database (North America, Latin America, Europe, Africa, Asia, Pacific-Oceania, and the Middle East). In this paper, however, we only refer to countries. If a paper covers multiple case study locations, we count all the countries studied. For examples, in Banerjee et al. (2011), “Labour migration as a response strategy to water hazards in the Hindu Kush-Himalayas”, four countries were counted. Therefore, $N = 532$ locations, representing 106 different countries.

“Locations of affiliated institutions”: The origin of the author is defined as the country of the university (or research center) affiliated with the researchers at the time of the paper’s publication.⁸ If several authors affiliated in the same country wrote a paper, the location (country) is integrated only once. For example, Henry et al. (2004) = Belgium (Henry and Piché) + Canada (Lambin) + Burkina Faso (Ouédraogo). This leads to $N = 602$ author affiliations, representing 62 different countries.

“Case studies funding origin”: The origin of research funding is often (but not always) mentioned in the papers. We recorded the country where the funding institution is based, i.e., AXA Group France = France; MacArthur Foundation = USA. If there were no financial indications in the paper, nothing is counted. Funds provided by the

⁶ The database is continuously updated, but for the purposes of this paper, the references are counted until 31 December 2016.

⁷ A full description and more information about methodological precision and the CliMig database can be found in Appendix 1 or online: https://www.unine.ch/geographie/Migration_and_Climate_Change.

⁸ An alternative approach would be to analyze authors’ migration backgrounds, as some authors affiliated in the North are originally from the South; however, collecting such information is extremely complex and was beyond the scope of this project.

European Commission are counted as if the EU was a country (see Fig. 10). In consequence, $N = 223$ funding for a total of 28 different funding countries.

“Methods”: A typology of the variety of methods used in this field has been suggested by Piguet (2010), who synthesized the main features and empirical results of each family of methods.⁹ Based on this typology, we focus on six research method families:

- Spatial analysis: statistical models based on area characteristics
- Multilevel: multilevel analysis based on area and individual characteristics
- Survey: analysis of individual data based on large sample surveys (> 100)
- Historical analogues: analysis based upon past episodes of environmental change and migration
- Hotspots: indexes of vulnerability, scenarios, regional descriptive case studies
- Qualitative: qualitative field case studies using ethnographic methods

As with the location of the case studies, a single research project can be conducted with various methods. Therefore, the database contains more methods ($N = 522$) than case studies ($N = 463$), meaning that 59 studies are based on a combination of methods.

“Hazards”: Different hazards are identified in the literature as potential drivers of migration (Piguet 2008). Following this conventional classification, we took into consideration those hazards generally linked to climate: droughts, floods, hurricanes, rises in sea level, and rainfall. Tsunamis, volcanic eruptions, and earthquakes were excluded. As with previous variables, a study can focus on multiple hazards ($N = 478$).

The CliMig database has limitations, such as the language of publication. Since global academic literature is dominated by English and widely disseminated by English-language scientific journals, our monitoring does cover that language exhaustively. We include papers in other languages where possible but may have missed some publications if they were not quoted in English papers. The main consequence of this would be to underestimate local publications not written in English. We believe that this risk remains marginal for three reasons: (1) CliMig is fully accessible online and therefore open to new contributions and contributors, (2) the database has been discussed at various international conferences where experts in the field(s) reported and subsequently included missing references,¹⁰ and (3) experts have conducted numerous regional case studies and integrated their references into the database (Piguet and Laczko 2014).

⁹ Considering the growth of empirical research on the topic, finer methodological categories—as well as evolutions in the use of various methods—can be identified (Fussell et al., 2014; Neumann & Hilderink, 2015). Our broad typology has the advantage of stability and simplicity.

¹⁰ International conference attendance is also often biased toward the North, but conferences organized, for example, by the International Geographical Union (IGU) or the International Association for the Study of Forced Migration (IASFM) attract growing numbers of researchers from the South (see the statistics of the IGU/Beijing Congress 2016: <https://igu-online.org/annual-reports/>).

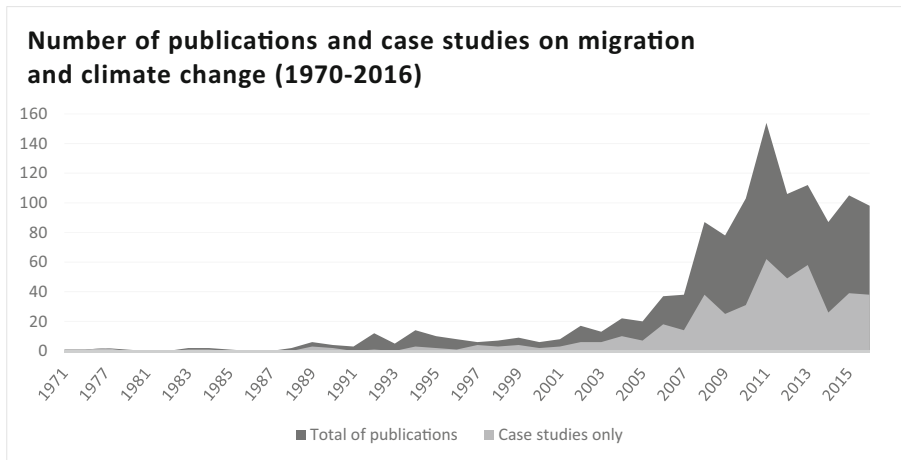


Fig. 1 The evolution of the publications ($N=1187$) and case studies ($N=461$) on migration and climate change between 1970 and 2016. Source: CliMig, University of Neuchâtel, 2017

Results

This chapter is divided into five sections: The history of the research (when?), methods used (how?), the most studied hazards (why?), the geography of case studies (where?), and authors and their funding (who?). The analytical approach of this geography is developed in the “Discussion” section.

When? Emergence of the issue and number of publications through time

Despite the fact that the founders of migration studies (e.g., Ratzel and Ravenstein) have all mentioned the natural environment as a factor influencing human mobility, this determinant faded from migration theories over the course of the twentieth century, as an increased focus was placed upon economic drivers (and as any reminiscence to natural determinism was to be avoided) (Piguet 2013). Only a few isolated publications were the exception (Brooks 1971; Huntington 1922; Petersen 1958; Sly and Tayman 1977; Swift 1977; Taylor 1949; Waddell 1975; White 1945; Wolpert 1966). As seen in Fig. 1,¹¹ this began to change in the 1980s with a surge of scientific studies in the field of environmental change and migration that culminated in 2011. This increase echoes the trend regarding research on impacts, adaptation, and vulnerability noted by IPCC (IPCC 2014b: 38), but the rate of increase is much greater regarding migration.¹²

The majority of publications present a synthesis of existing research or are focused on concepts, theory, and methodology, but the number of case studies—in light gray—is impressive (and follows a similar trend of increase). Currently, that number is approximately 40 publications per year. We will now identify a selection of “landmark

¹¹ The exhaustive CliMig bibliographic base contains 1193 scientific papers and books on climate/environmental change and migration, but Figure 1 dates from 1970 and therefore includes 1187 publications.

¹² The IPCC notes a doubling of the number of publications between 2005 and 2010, whereas our data shows a multiplication by five over the same time span.

papers” and crucial moments that explain the evolution of these publications, as well as four successive time periods.

1985–1990: the (re-)emergence era

Global debate over migration and climate change began in the second half of the 1980s. Three reports played a crucial role: one by the United Nations Environmental Program (UNEP), one by the Worldwatch Institute, and one by the Intergovernmental Panel on Climate Change (IPCC) (El-Hinnawi 1985; IPCC 1990; Jacobson 1988). The UNEP report brought the term “environmental refugee” to the fore, and the IPCC report explicitly forecasted that “[Global warming] could initiate large migrations of people, leading over a number of years to severe disruptions of settlement patterns and social instability in some areas” (IPCC 1990: 20). A series of scientific debates, international conferences, and publications followed (Appleyard 1992; Lassailly-Jacob and Zmolek 1992; Suhrke 1994). This corresponds with a publication peak in the 1990s (14 publications in 1994, for example).

1990–2002: the debate era

Scientific production remained steady for a decade before spiking in the early 2000s with a record high of 17 publications in 2002. This period was characterized by a polarized debate (that continues today) between “alarmist” discourse and skeptical replies (others may say maximalists vs minimalists (Suhrke 1994)). The alarmist discourse was dominated by authors with an ecological or environmental background—Norman Myers—who was undoubtedly a key figure of the maximalist argument—highlighted the threat of environmental refugees by claiming that it “(...) promises to rank as one of the foremost human crises of our times” (Myers 1997: 175). He projected 150 million refugees by the end of the twenty-first century and then upgraded his estimation to 200 million in 2002 (Myers 2002). Though the accuracy of those numbers remains unverified, they had a tremendous impact and still appear in media and advocacy campaigns today (Gemenne 2011b).

The skeptical discourse criticized the use of environmental refugee terminology and the deterministic approach of alarmist scholars. The papers of geographers McGregor (1993) and Black (2001) as well as anthropologist Kibreab (1997) can be considered landmark publications in this trend. Black states that “one of the ironies of writing on environmental refugees has been that whilst purporting to highlight a ‘forgotten’ category of forced migrant, which is ignored by international policy makers, this literature in practice serves only to differentiate a single cause of migration, which often forms part of a set of reasons why an individual or family may be forced to relocate” (2001: 12). Castles’ (2002) synthesis paper “Environmental change and forced migration: Making sense of the debate” marked a break in this discussion by offering a nuanced perspective, outlining the political implications—and possibly harmful consequences—of using inadequate terminology. The papers in this decade are fundamental because they bring to light the complexity of studying the mechanisms of the environment-migration nexus. They paved the way for more pragmatic empirical and evidence-based research.

2002–2011: the pragmatic era

Since 2002, the pace of publication has increased dramatically, producing 87 papers in 2008 (38 empirical case studies) and 154 papers in 2011 (62 empirical studies). During this period, case studies represented a growing proportion of publications, fluctuating between 30 and 49%.

The peak in 2008 follows the 2007 IPCC report which was awarded the Nobel Peace Prize and corresponds to the results of the EU-funded Each-For project (EACH-FOR 2007; Jäger et al. 2009). For the first time, the link between environmental change and migration was explored using a common methodological framework, with a focus on the role of environmental factors in migratory patterns. This global project ran 23 case studies combining qualitative interviews, standardized questionnaires, and documentation analysis. Despite the difficulty of combining and synthesizing context-dependent data, the project brought many researchers together to study the topic for the first time and resulted in numerous field-specific publications. In 2011, implementation of the large-scale multi-site Foresight Project (Foresight 2011) significantly advanced the debate with publications whose focus was less upon the drivers of migration than on the way migration—and other forms of human mobility (including the risk of immobility)—could be an efficient way to adapt to global environmental changes (Black et al. 2011; Findlay 2011; Foresight 2011).

2011–2016: remaining gaps and new questions

Production declined after 2011 but remained reasonably high (106, 112, 87, 105, and 98 papers were published respectively between 2012 and 2016). Researchers are currently debating new topics regarding environmental migration, including mobility as a coping strategy (Afifi et al. 2015; Bettini et al. 2016; Black et al. 2011; Feli and Castree 2012; Gemenne and Blocher 2017; Loebach 2016; Methmann and Oels 2015; Sakdapolrak et al. 2013; Scheffran et al. 2012), policies of mobility and relocation (Bukvic 2017; Maldonado et al. 2013; Marino 2012; McDowell 2011; Stal 2011), legal issues (Cournil 2011; Koser 2011; McAdam 2014; Warner et al. 2014), gender issues

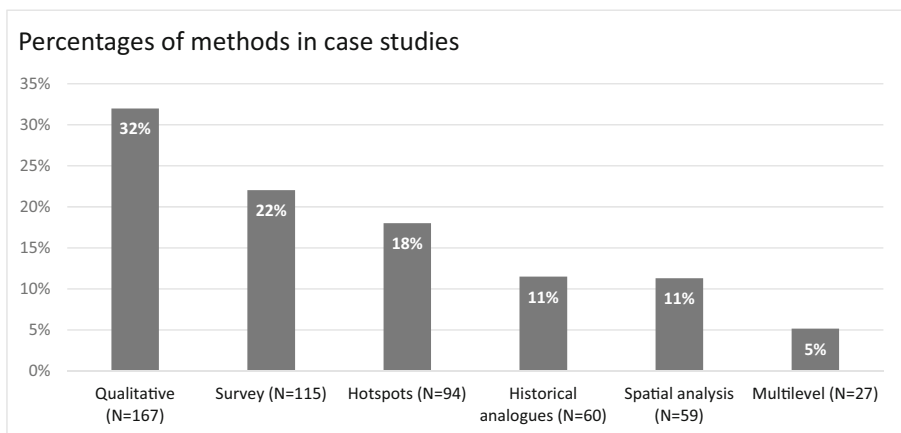


Fig. 2 Percentage of methods used in case studies. Source: CliMig, University of Neuchâtel, 2017 ($N = 522$; an article can use multiple methods)

(Chindarkar 2012; Hunter and David 2011; Sen 2016), destination areas and urban areas (Findlay 2011; Maurel and Tuccio 2016; Nawrotzki et al. 2015). Recent discussions point out the lack of a robust theoretical framework in this field of research (Baldwin 2014; Greiner and Sakdapolrak 2016; Hunter et al. 2015; McAdam 2013; Murphy 2014; Upadhyay et al. 2015). Some initiatives advocate methodologies such as agent-based modeling (Cai and Oppenheimer 2013; Entwisle et al. 2016; Kniveton et al. 2011; Smith 2014; Walsh et al. 2013) and, more generally, the need to work with quantitative data on a larger scale (Bilsborrow and Henry 2012; Milan et al. 2014; Piguet 2010).

Graeme Hugo's research on migration and environmental change

During his prolific career, Graeme Hugo published 18 papers on environmental change and migration. According to CliMig, his first papers were released in 1996 and 1999. Less than 10 years later, Hugo had significantly increased his rate of publication to a minimum of two publications per year! In 2015, he authored his last paper on migration and environment. This makes him the most prolific author on the topic, with a wide geographical focus on Southeast Asia, Northwest China, the Horn of Africa, and the Pacific (Bardsley and Hugo 2010; de Sherbinin et al. 2011; Gioli et al. 2015; Hugo 1996, 1999, 2008, 2010, 2011a, b, 2012a, b, c, 2013; Hugo and Bardsley 2014; Hugo and Tan 2013; Hugo and Zewdu 2014; Tan et al. 2015, 2013).

How? Analysis of methods used in case studies

The previous chapter reconstructed the history of scientific production on environmental change and migration, including conceptual, theoretical, and synthesis papers. The following chapters will focus on empirical case studies only. This allows us to present methods, identify hazards, and discuss the geography of research.

The following figure shows the percentage of each method used in environmental migration case studies (Fig. 2). Qualitative approaches are the most mobilized by

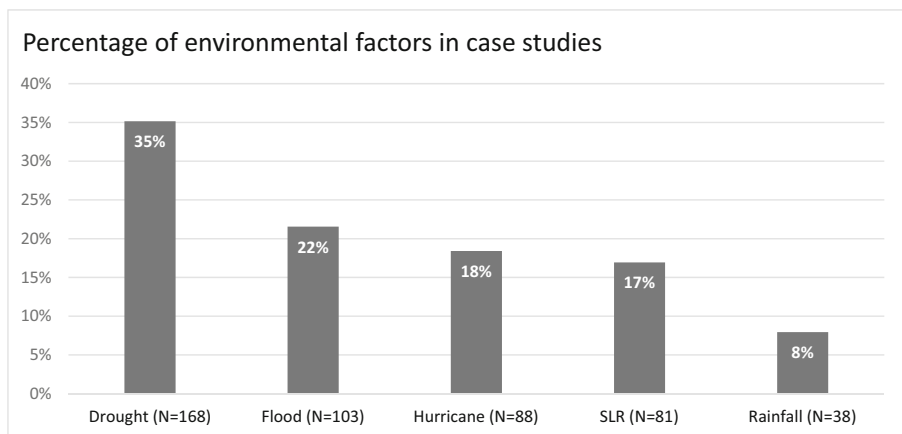


Fig. 3 Percentage of environmental factors in case studies: drought, flood, hurricane, SLR, and rainfall ($N=478$; an article can contain multiple hazards)

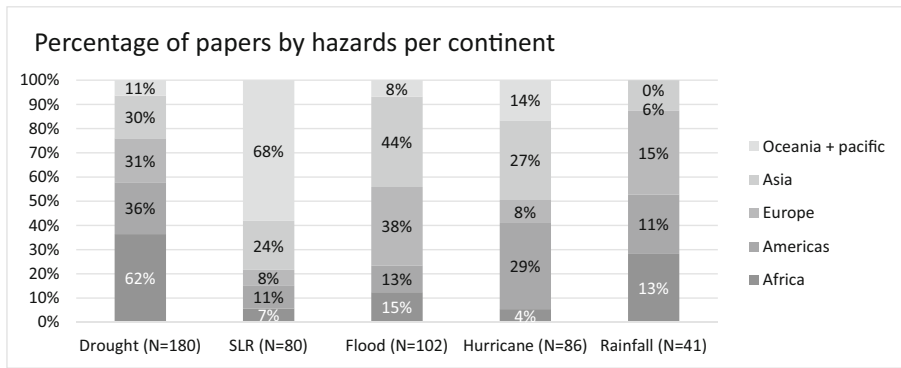


Fig. 4 Percentage of environmental factors: drought, SLR, flood, hurricane, and rainfall ($N = 489$; an article can contain multiple hazards and/or multiple continents)

researchers and represent a third of all empirical publications (32%), followed by surveys (22%), hotspots (18%), historical analogues (11%), spatial analyses (11%), and multilevel approaches (5%). The proportion of methods in use is fairly constant over time.

The field is methodologically diverse, due to the interdisciplinary nature of research in the social sciences (including economics). Nevertheless, the combination of qualitative and quantitative methods in a single paper remains infrequent.

Most of the studies use a qualitative approach due to pragmatic considerations of research project resources in a context where secondary data remain scarce, as field-work study is costly. A researcher (or a group of researchers) spending time in situ has to calculate the necessary resources for logistics (i.e., accommodation) as well as the time needed to conduct field research. In this context, qualitative approaches conducted by individuals or small groups of researchers are less expensive, since they usually do not require significant infrastructure in terms of logistics and are therefore a suitable option for young researchers. In comparison, designing large panel questionnaires which include a broad array of environmental questions, or combining local

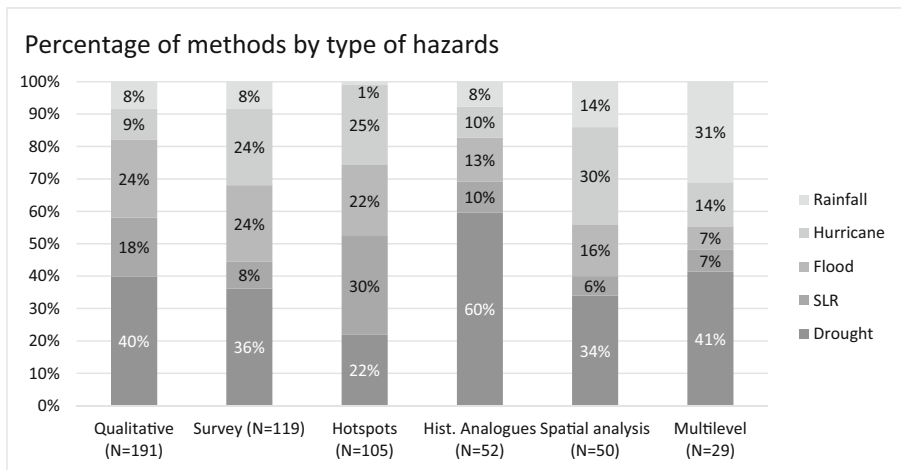


Fig. 5 Percentage of methods employed by type of hazard. Source: CliMig, University of Neuchâtel, 2017 ($N = 546$; an article can contain multiple methods and/or multiple hazards)

The world's case studies

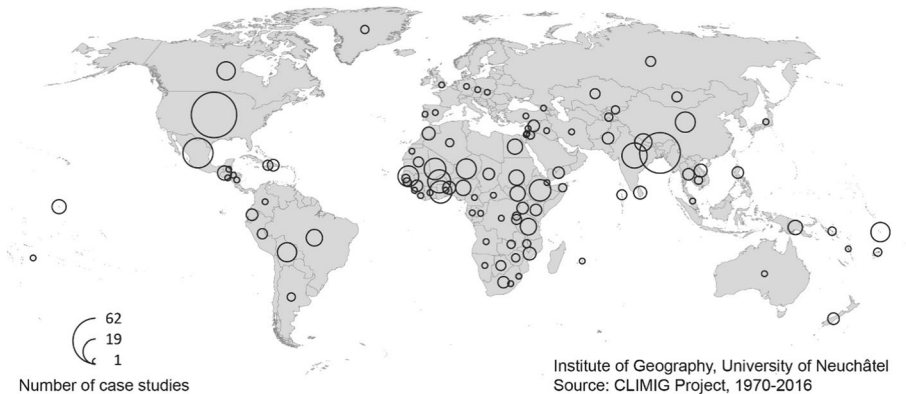


Fig. 6 Countries where case studies on migration and climate change have been conducted ($N=532$; an article can contain multiple case study locations)

information on environmental evolutions with repeated waves of questionnaires, is costly. Other methods also face numerous obstacles. Spatial analyses or multilevel approaches may necessitate the use of hard-to-access databases (environmental/climatic data, demographic data, etc.), and data on migration, for instance, are often incomplete and subject to inaccuracies.¹³

As we will see in the following chapter, the choice of methods also involves the type of environmental hazard being studied.

Why? Analysis of case study hazards

Drought and desertification are the subject of 35% of case studies, followed by flood and torrential rains (22%), hurricane (18%), sea level rise (17%), and rainfall (8%), although the latter represents 8% of published papers and overlap to a certain extent with studies on floods and droughts (Fig. 3).

The distribution of studied hazards in case studies seems to be determined mainly by the environmental characteristics of the places under investigation. To analyze this hypothesis, we focused on the continent level and determined the percentage of hazards being assessed in empirical literature for each.

Figure 4 shows that droughts and desertification are the most studied hazards in Africa (62%). This continent (including all the sub-Saharan countries) is characterized by severe drought, where water availability is the main environmental concern, particularly for rural populations. Droughts are also an important issue in the Americas (36%)—they are studied widely in the USA (14 articles) and Mexico (13 articles)—and more marginally in Central and South America.

Hurricanes appear to be a prominent hazard for the Americas (29%). Katrina, which impacted New Orleans in 2005, played a significant role: 21 papers are specifically

¹³ For a general discussion on qualitative versus quantitative methodologies see Goertz & Mahoney, 2012. For a discussion of the challenges of quantitative methods in the field of environmental migration see Fussell et al., 2014.

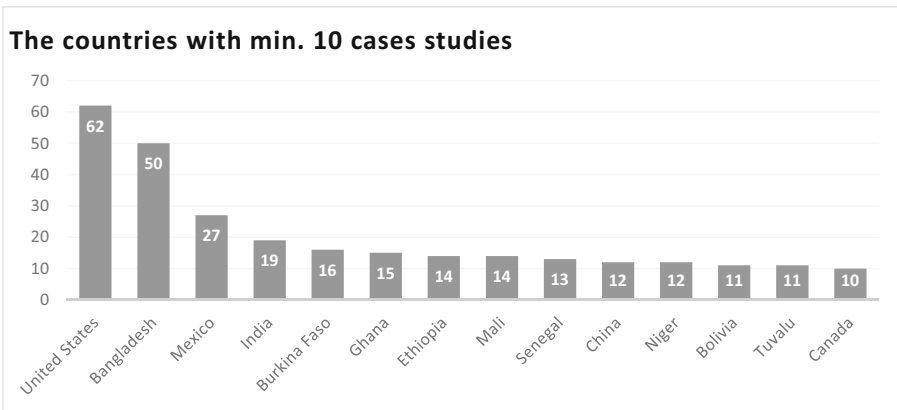


Fig. 7 Countries where a minimum of ten case studies on migration and climate change have been conducted

dedicated to this storm out of a total of 29 papers on hurricanes in general—or other hurricanes, like Rita and Andrew—within the USA.

Floods are prominent in Europe (38%) and the Asiatic continent (44%); however, the number of publications is by far much higher for the latter (5 papers on floods for Europe and 56 for Asia). Bangladesh, one of the most flood-prone countries on earth, plays an important role in this respect with 26 publications.

Not surprisingly, sea level rise (SLR) features overwhelmingly in Oceania and Pacific Island studies (68%). Twenty-five of 37 case studies in that region focus on SLR. In Asia, this hazard is assessed in 30 articles.

A clear link exists between the type of hazard and the methods chosen for studying migratory consequences, as shown in Fig. 5.

For all types of methods, drought and desertification remain the most studied hazards. It is particularly significant for historical analogues approaches, where 60% ($N=31$) of case studies are dedicated to this topic. The Dust Bowl period in the USA (Gilbert and McLeman 2010; McLeman et al. 2010; McLeman et al. 2008) and

Origin of the case studies' authors

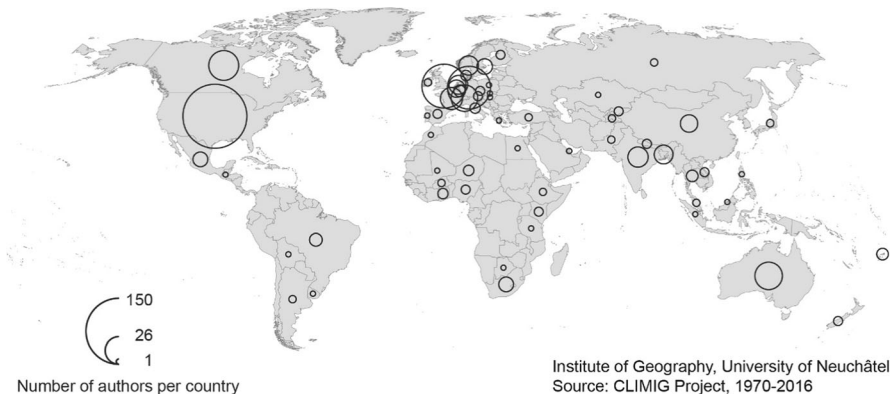


Fig. 8 Origin of the case studies' authors ($N=602$; articles with multiple origins are calculated for each author)

episodes of droughts in Africa (Brunk and Gronenbom 2004; Findley 1994; Gray and Mueller 2012; Mortimore 2010; Pedersen 1995) are representative of this trend. Qualitative approaches are used for all kind of hazards. Methodologies based on surveys show a similar tendency, but they are employed less often for SLR. The elevation of the oceans is addressed by studies mobilizing hotspot methodologies. In general, empirical research utilizing spatial analyses and multilevel methodologies are respectively focused on hurricanes and rainfall.

Where? Mapping the world's case studies

The following chapter will now address the geography of empirical case studies, as only the latter can be linked to a country or region.

Figures 6 and 7 indicate the locations of the 463 case studies in 106 countries. The most studied countries are the USA (62 case studies), Bangladesh (50 studies), and Mexico (27 case studies), followed by a group of countries with between 10 and 20 studies (India, Burkina Faso, Ghana, Ethiopia, Mali, Senegal, China, Niger, Bolivia, Tuvalu, and Canada). The remaining countries were the subjects of fewer than 10 case studies. With the exception of the USA, most studies took place in Southern countries, with an impressive focus on Africa and South Asia. Nevertheless, there is a lack of studies in specific areas of the South considered vulnerable to global environmental change, such as the Caribbean coast of South America, North Africa, and Central Asia. No clear chronological changes can be seen in that geography, and the bias toward the USA and Southern countries remains constant during the period under review.¹⁴

Who? The origin of the authors and their sources of funding

Figure 8 shows the origin of the researchers in terms of institutional affiliations, with a clear concentration in Europe and North America. The USA is by far the most prominent with 150 of 602 authors based there, followed by the UK (72), Germany (68), Canada (33), Australia (28), Switzerland (26), France (18), and India (15). Fifty-four countries have fewer than 15 resident authors, while 186 countries do not host institutions linked to environmental migration publications.

An alternative indicator is presented in Fig. 9, which identifies the number of case studies in each country compared with the number of case studies where at least one author is affiliated with a research institution of the same country. This indicator measures the level of “insider look” and shows that only the USA, Canada, Brazil, and China case-studies are in majority prepared with at least one locally affiliated author. Such “insider” case studies also exist in Bangladesh, Mexico, India, and some African countries, but these remain a small minority.

Figure 10 presents the origin of the case studies' funding, and the similarities to Fig. 8 are obvious. Again, the position of Europe and North America is dominant. This bipolarization is even more pronounced than the author's origin and shows a quasi-nugatory impact from the rest of the world (except for Australia, and to a lesser extent China, India, Argentina, South Africa, Japan, and a few others).

¹⁴ The two first case studies identified in our database were conducted respectively in Brazil (Brooks, 1971) and New Guinea (Waddell, 1975).

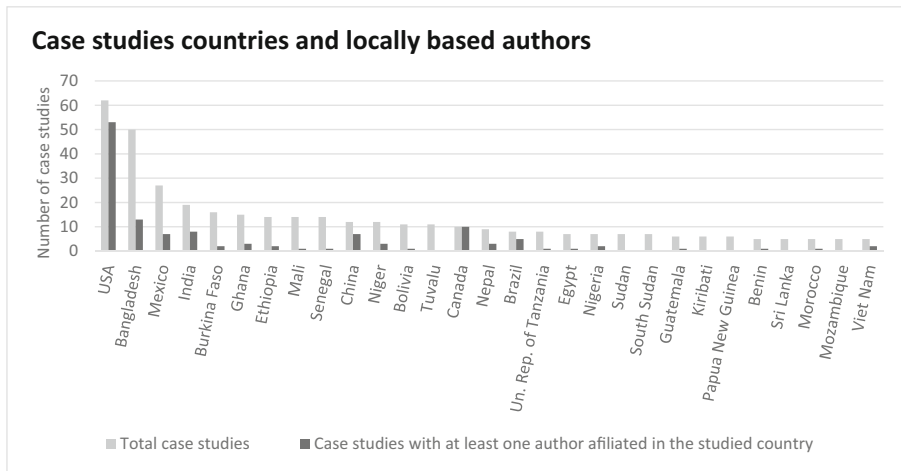


Fig. 9 Number of case studies per country and the number of authors affiliated in an institution hosted within this country ($N = 382$; countries with fewer than five case studies are not included). We added one important missing reference by Senegalese colleagues (Sall et al. 2011) during the final stage of this paper. This reference is not counted in the other analysis

Discussion

Our results reveal that the migration/environment nexus has attracted impressive scientific attention since the beginning of the twenty-first century, with a massive rise in recent years. Research has addressed the impacts of a variety of environmental hazards on migration—from droughts to hurricanes and sea level rise—and made use

Origin of the case studies' fundings

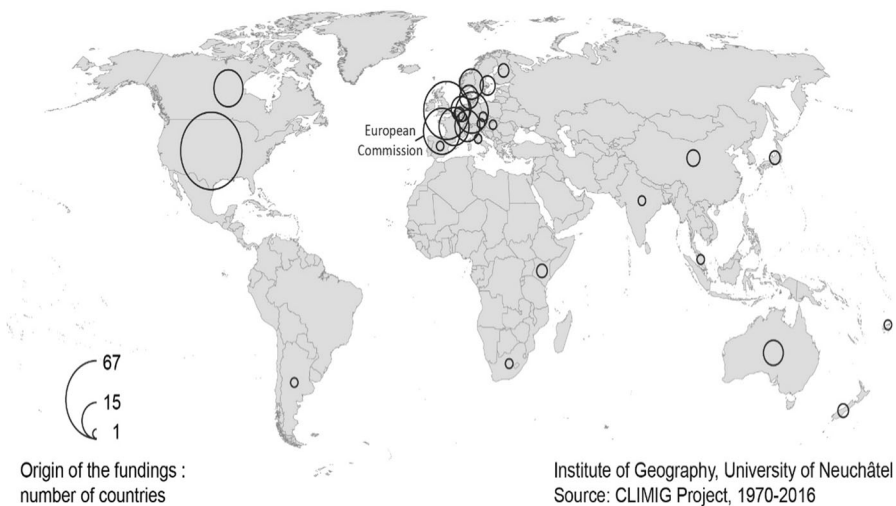


Fig. 10 Origin of the case studies' funding ($N = 223$; the origin of the funding is calculated when mentioned in the article)

of a wide spectrum of methodologies. Although case studies were conducted in more than 100 countries, important geographic imbalances remain. Our results contradict the literature on the geography of climate science in general, which suggests a bias *away* from Southern countries, whereas we document a bias *toward* these countries. Meanwhile, we confirm that—just as in climate science in general—authors and their funding are overwhelmingly linked to Northern countries; insider look case studies in the South remain the exception (Blicharska et al. 2017). This chapter will discuss these geographic results on the basis of the four families of hypotheses formulated in the introduction (see “Questions and hypotheses”).

Development inequalities

Our results regarding case studies largely contradict the development hypothesis that was central to explaining the geography of climate science in general. Countries with more resources and larger environmental footprints are not where more research on the possible migratory consequences of climate change is being done. The case of Europe is striking: Only a handful of case studies were identified there, indicating that privileged countries consider themselves immune to mass displacements (Mulligan et al. 2014). The same argument, put differently, can explain this attitude: Instead of encouraging more research, development can give certain countries a Promethean illusion of immunity. With enough economic resources, environmental changes—such as sea level rise in the Netherlands—can be faced without heavy consequences for local populations. Symmetrically, such differential adaptive capacities make Southern countries more vulnerable to environmental hazards (Neumayer et al. 2014). Meanwhile, the mapping of author affiliations and funding sources—contrary to the mapping of case studies—largely confirms the North-South imbalances in science in general and climate science in particular: Funding and researchers come from the North to perform case studies in the South.

Environmental determinism

The disproportionate number of case studies conducted in Southern countries may be due to the severe consequences of climate change forecasted in those regions. Environmental vulnerability associated with the socio-economic vulnerability of poorer populations—what Francis Hallé coined “tropicality” (Hallé 2010)—leads to displacement, which attracts researchers and funds to such areas. This is probably true for countries like Bangladesh, which is very vulnerable to climate change and, with high rates of internal and cross-border migration, is also the most empirically studied. This environmental argument might also explain the amount of research conducted in the USA: In no other rich countries did environmental hazards—such as Hurricane Katrina in 2005—cause such considerable levels of displacement. On the contrary, Western Europe has experienced fewer dramatic consequences of climate variability and is therefore gathering less attention from researchers on environmental migration. However, the environmental postulate does not sufficiently explain the uneven geography of research globally, since some places at high risk—Central Asia, northern Africa, South America, etc.—remain very poorly documented.

Post-colonial—securitization

Northern countries appear very interested in sending researchers and funding studies to document migration and environmental change in the South. As mentioned previously, climate science geography in general showed on the contrary that rich countries prefer to study climate issues on their own territory (Pasgaard et al. 2015). We explain this contradiction by the specific geographic imagination associated with the figure of the climate refugee. Contrary to degrees of temperature, parts per million of CO₂, or millimeters of sea level rise, migrants are, to quote the former chair of IPCC Rajandran Pachauri, “the human faces of climate change” (Gemenne 2011a; Piguet 2013). This figure of the “climate migrant” seems to have captured the Western imagination just as that of “war refugee” (Lubkemann 2008). In this context, the fact that Africa and South Asia appear to be the most studied is not surprising, as these regions correspond to the stereotype of poor populations as helpless victims (Malkki 1995). They also focalize a post-colonial Western gaze which is seen on the covers of many flagship publications about migration and climate change (Collectif Argos 2010; Global Humanitarian Forum 1996; Warner et al. 2009): Victims of environmental change are represented as poor, dark-skinned, and colorfully dressed. The issue of migration and the environment is thus racialized (Baldwin 2013), and no studies address issues such as the possible emigration of white, Swiss touristic operators from ski regions lacking snow due to climate change.

Framing environmental migration as a Southern issue is reinforced by notions of security threats associated with climate change (Gemenne et al. 2014) and the environment (Pasgaard et al. 2017). These securitization trends have been witnessed in many spheres of contemporaneous societies—from mega-sporting events to sinking islands (Bruner 2017)—as a process through which “ordinary” issues are elevated to security issues that need to be controlled and regulated with “extraordinary” means (Munster 2012). It is exemplified by the case of migration, which has only recently been framed as a security issue (Boas 2015). As seen in the historical part of our paper, the rise in the number of case-studies on environment and migration in 2007–2008 coincides precisely with military reports. In 2007, the Center for Naval Analysis on security and climate change stated: “The greatest concern will be [the] movement of asylum seekers and refugees who due to ecological devastation become settlers” (CNA’s Military Advisory Board 2007: 18). That same year, the fear of migration was seen in the United Nations Security Council’s first debate on the impacts of climate change (McNamara 2007) and clearly found their way into scientific discourse, as seen in Reuveny and Moore, for whom: “[a]s climate change continues, environmental degradation will rise in some areas, promoting out-migration. Migrants will most likely come from LDCs [less-developed countries]; (...) as a result, there may be more legal and illegal attempts to enter DCs [developed countries], which may ultimately lose control over incoming migration” (Reuveny and Moore 2009: 476). One example that fits especially well with our results is the 2010 report “Climate change and immigration: Warnings for America’s southern border” which attempted to analyze the “migration risk” for the USA posed by climate change in Latin America (Ross 2010). As we have seen, Mexico is characterized by a high number of case studies conducted mostly by US-affiliated scholars. Taking into account the Western post-colonial imagination as well as the process of securitization of migration issues, the number of studies conducted in Southern countries is not surprising.

Pragmatic

In combination, our lines of explanation allow a convincing narrative to explain the geography of research on migration and environmental change, though more prosaic explanations play a role in amplifying or reducing the intensity of research—such as the existence (or lack) of local research centers on migration or climate change.¹⁵ Some regions are under-researched due to poor accessibility for researchers caused by conflict or violence (Syria, Libya, Iraq, South-Sudan, etc.), dictatorial regimes or political constraints (North Korea, Myanmar, etc.), or a lack of freedom of expression and freedom of research (Iran, Central Asia, etc.). In these situations, the likelihood of conducting secure and independent fieldwork is very low. In other regions, migratory patterns have only been studied in relation to the dominant conflict in the area (Colombia, Eritrea, etc.), rather than from the perspective of environmental migration. As in many studies of forced migration, the “infrastructures of international humanitarianism,” from international hotels to translation services (Pascucci 2016), might also play a role. Finally, the third parameter is related to the pre-established relationships of migration between two countries. Mexico, for example, with its strong history of emigration to the USA, has been the focal point of a large volume of research carried out by North American researchers. This argument often sends us back to issues of post-colonialism, as is the case with studies conducted on the Indian subcontinent (India, Bangladesh, Nepal, etc.) by researchers from the UK, or in Western Africa by French researchers.

Conclusions

Pasgaard et al. concluded their most recent paper on the geography of climate change research with “(...) a concern about scientific climate change knowledge being implemented to a lesser extent—and with fewer contextual and cultural concerns—in Africa and Latin America than in Europe, North America, and Asia, where relatively more researchers who produce the knowledge are also physically based” (Pasgaard et al. 2015: 286). This concern is shared by the IPCC in its most recent assessment report (IPCC 2014b: 38): “The unequal distribution of publications presents a challenge to the production of a comprehensive and balanced global assessment,” as well as by a large group of researchers who recently published a comprehensive set of recommended actions intended to bridge the North-South divide (Blicharska et al. 2017). Our results raise the same issue, but in a more contrasted way: Case studies on migration are in fact already numerous in the South. That is indeed good news, but not sufficient, as the research field still reflects a hemispheric asymmetry in the origins of researchers and their resources. Researchers based in the South need funding to conduct and publish more local research on environmental change and migration, while researchers based in the North—far from turning away from Southern countries—need to include Northern countries in comparative and multisided field research. Though it may come loaded with unjustified threats to security and post-colonial stereotypes, the issue of environmental migration remains a pressing and universal humanitarian challenge.

¹⁵ In places where such centres do exist, another issue (beyond the scope of this paper) would be to identify how widely their findings are disseminated in international journals, especially English-language ones, which play a dominant role in the international scientific landscape (Clavero, 2011).

Appendix.

The CliMig bibliographic database Compiled at the Institute of Geography of the University of Neuchâtel (Switzerland), the CliMig bibliographic database is the first comprehensive collection of resources which specifically concentrates on migration, the environment, and climate change. The project consists of a fully searchable version of the bibliography on the WEB that is continuously updated with new publications. It aims to provide a free major hub for researchers on this important topic worldwide. It could subsequently be completed with direct access to non-copyrighted PDF documents, statistical data and metadata, ongoing research projects, etc. CliMig uses the most advanced bibliographic research technologies to identify new publications, but the selection of materials, entries, and keyword attribution are done manually, ensuring scientific accuracy and coherence. CliMig is the culmination of professional data gathering in five stages:

Literature monitoring

The literature watch uses traditional sources (publishers' catalogs, e-alerts, group lists and discussions, newsletters, etc.) to monitor scientific literature. Tools such as Google Scholar alerts, Feedinformer, the Old Reader, Update Scanner, Queryfeed, and editors' alerts are added to the monitoring system in order to filter and locate gray literature (reports, working-papers, conference proceedings, etc.). The database welcomes published material submitted directly by authors or colleagues.

Selection of topics

To ensure coherence and comprehensiveness, references are included only if they focused on—or bring significant insights into—the following topics:

- Population displacement potentially caused by environmental change
- Displacement as a coping strategy due to environmental change
- Perception/representation of the migration/environment nexus
- Policies and legal issues related to migration and environmental change

In principle, the database does not include references focused on mobility in the context of post-disaster relief (e.g., cell phone data to monitor displacement), the impact of migration on the environment, the links between conflicts and environment, displacement linked to development/infrastructure projects, amenity migration (environment as a pull factor), vulnerability in general, and environmental change if unrelated to displacement of people.

Selection of relevant types of literature to be included

The CliMig database is focused on original research material. The selection of gray literature is based on IPCC procedure. The following types of publications are included:

- Articles in scientific (peer-reviewed) journals (journal article)
- Books published by scientific publishers (book)

Chapters of edited books published by scientific publishers (book chapter)
 Reports from scientific (peer-reviewed) research projects (report)
 Working papers based on scientific (peer-reviewed) research projects (report)
 Synthesis or research reports by NGOs – Administrations, UN bodies, etc. if they are based on original empirical work or represent a synthesis not available elsewhere (report)

Special issues of ‘large public’ reviews, journals, or encyclopedias can be included in the database if they bring additional insights

The database does not include magazine and newspaper articles, leaflets, advocacy documents, websites, blogs, entries in encyclopedias/dictionaries, or syntheses that do not bring original information.

Implementation of specific keywords

CliMig keywords are assigned on the basis of a uniform procedure for all publications and manually entered to ensure scientific accuracy and clarity. For further details and usage, see https://www.unine.ch/geographie/Migration_and_Climate_Change.

Daily maintenance of CliMig

We work in collaboration with the Swiss Forum for Migration and Population (SFM), which uses the information-management platform Delicious to upload potential articles for CliMig. After articles of primary relevance to CliMig are selected, all references and keywords are entered into Endnote Desktop for researchers using Endnote Online. It takes roughly half a day per week to keep CliMig updated and maintained.

With a total of 1193 papers at the end of 2016, this bibliographical database is a unique resource providing a transparent overview of the field of migration and environment research. It allows for comparisons of various sets of meta-analysis on topics of migration and environment studies, both globally and over time.

Four families of keywords are used: “Area,” “Type - Method,” “Focus,” and “Environmental hazard.” The origin (country) of the author and the funding are also recorded.

Area	Type—method	Focus	Environmental hazard
World	Overview	Gender	SLR
Studies covering the whole world or without geographic specification.	Synthesis of existing literature or studies dealing with conceptual issues (no empirical case study)—also includes empirical work on the representation of CC (i.e., in the media)	Studies dealing with gender issues	Sea level rise

Area	Type—method	Focus	Environmental hazard
Asia	Type 1 Ecological models based on area characteristics (spatial analysis) ^a	Perception Representation and perception of actors	Hurricane
Europe	Type 2 Multilevel analysis based on area and individual characteristics	Migadapt Migration as an adaptation response	Flood
Africa	Type 3 Analysis of individual data based on large sample surveys (> 100)	DRR/EWS Disaster risk reduction/early warning systems	Drought
North America USA + Canada	Type 4 Historical analogues	Trapped Studies dealing with immobility	Rainfall
Latin America South America + Central America + Caribbean	Type 5 Indexes of vulnerability, hotspot identification, scenarios, regional case studies, etc.	Statelessness	Other Wildfire, landslides, etc. Also if no specific type is studied
Oceania Australia, New Zealand + Pacific Islands	Type 6 Qualitative field case studies using ethnographic methods and small samples questionnaires	Law Studies dealing with juridical aspects and policies	

^a Including economic models (e.g., general equilibrium)

Acknowledgments We would like to thank Suzy Blondin, Loïc Bruening, Christine Diacon, and Aronne Watkins for their help in maintaining the CliMig database.

References

- Afifi, T., Milan, A., Etzold, B., Schraven, B., Rademacher-Schulz, C., Sakdapolrak, P., & Warner, K. (2015). Human mobility in response to rainfall variability: opportunities for migration as a successful adaptation strategy in eight case studies. *Migration and Development*, 1–21. <https://doi.org/10.1080/21632324.2015.1022974>.
- Appleyard, R. T. (1992). Conference report: migration and the environment. *International Migration*, 30(2), 225.
- Baldwin, A. (2013). Racialisation and the figure of the climate-change migrant. *Environment and Planning A*, 45(6), 1474–1490.

- Baldwin, A. (2014). The political theologies of climate change-induced migration. *Critical Studies on Security*, 2(2), 210–222. <https://doi.org/10.1080/21624887.2014.932509>.
- Banerjee, S., Gerlitz, J. Y., & Hoermann, B. (2011). Labour migration as a response strategy to water hazards in the Hindu Kush-Himalayas. Retrieved from Kathmandu: <http://www.preventionweb.net/english/professional/publications/v.php?id=18632>
- Bardsley, D., & Hugo, G. (2010). Migration and climate change: examining thresholds of change to guide effective adaptation decision-making. *Population & Environment*, 32(2), 238–262. <https://doi.org/10.1007/s11111-010-0126-9>.
- Berrang-Ford, L., Ford, J. D., & Paterson, J. (2011). Are we adapting to climate change? *Global Environmental Change*, 21(1), 25–33. <https://doi.org/10.1016/j.gloenvcha.2010.09.012>.
- Bettini, G., Nash, S.-L., & Gioli, G. (2016). One step forward, two steps back? The fading contours of (in)justice in competing discourses on climate migration. *Geogr J* doi:<https://doi.org/10.1111/geoj.12192>.
- Bilsborrow, R., & Henry, S. (2012). The use of survey data to study migration–environment relationships in developing countries: alternative approaches to data collection. *Population & Environment*, 34(1), 113–141. <https://doi.org/10.1007/s11111-012-0177-1>.
- Black, R. (2001). Environmental refugees: Myth or reality? New Issues in Refugee Research (UNHCR Research Paper) (34).
- Black, R., Bennett, S. R. G., Thomas, S. M., & Beddington, J. R. (2011). Climate change: migration as adaptation. *Nature*, 478(7370), 447–449.
- Blicharska, M., Smithers, R. J., Kuchler, M., Agrawal, G. K., Gutiérrez, J. M., Hassanali, A., & Mikusiński, G. (2017). Steps to overcome the north–south divide in research relevant to climate change policy and practice. *Nature Climate Change*, 7, 21–27.
- Boas, I. (2015). *Climate migration and security: Securitisation as a strategy in climate change politics*. New York: Routledge.
- Brooks, R. H. (1971). Human response to recurrent drought in northeastern Brazil. *Professional Geographer*, 23(1), 40–44. <https://doi.org/10.1111/j.0033-0124.1971.00040.x>.
- Bruner, T. (2017). “Sinking islands” and the UNSC: Five modalities of mobilising science. *Geoforum*, 84, 342–353. <https://doi.org/10.1016/j.geoforum.2017.03.027>.
- Brunk, K., & Gronenbom, D. (2004). Floods, droughts, and migrations: the effects of Late Holocene lake level oscillations and climate fluctuations on the settlement and political history in the Chad basin. *Studien zur Kulturkunde*, 121, 101–132.
- Bukvic, A. (2017). Towards the sustainable climate change population movement: the Relocation Suitability Index. *Climate and Development*, 1–14. doi:<https://doi.org/10.1080/17565529.2017.1291407>.
- Buzan, B., Wæver, O., & De Wilde, J. (1998). *Security: A new framework for analysis*. Boulder: Lynne Rienner Publishers.
- Cai, R., & Oppenheimer, M. (2013). An agent-based model of climate-induced agricultural labor migration. Paper presented at the Agricultural & Applied Economics Association’s 2013 Annual Meeting, Washington D.C., August 4–6, 2013.
- Castles, S. (2002). Environmental change and forced migration: Making sense of the debate. New Issues in Refugee Research (UNHCR Research Paper) (70).
- Chindarkar, N. (2012). Gender and climate change-induced migration: proposing a framework for analysis. *Environmental Research Letters*, 7(2), 025601.
- Clavero, M. (2011). Language bias in ecological journals. *Frontiers in Ecology Environment*, 9(2), 93–94. <https://doi.org/10.1890/11.WB.001>.
- CNA’s Military Advisory Board. (2007). National security and the threat of climate change. In *Alexandria*. Virginia: Center for Naval Analyses.
- Collectif Argos. (2010). *Climate refugees*. Boston: MIT Press.
- Cornil, C. (2011). The protection of ‘environmental refugees’ in international law. In E. Piguet, A. Pécoud, & P. de Guchteneire (Eds.), *Migration and climate change* (pp. 359–387). Cambridge: Cambridge University Press.
- Crawford, G., Kruckenberg, L. J., Loubere, N., & Morgan, R. (2017). *Understanding global development research—fieldwork issues, experiences and reflections*. London: Sage.
- Dorn, H. (1991). *The geography of science*. Baltimore: The Johns Hopkins University Press.
- EACH-FOR. (2007). Research guidelines. Bonn: Environmental change and forced migration scenarios research project.
- El-Hinnawi, E. (1985). *Environmental refugees*. Nairobi: United Nations Environmental Program.
- Entwisle, B., Williams, N. E., Verdery, A. M., Rindfuss, R. R., Walsh, S. J., Malanson, G. P., & Jampaklay, A. (2016). Climate shocks and migration: an agent-based modeling approach. *Population and Environment*, 38(1), 47–71. <https://doi.org/10.1007/s11111-016-0254-y>.

- Feli, R., & Castree, N. (2012). Neoliberalising adaptation to environmental change: foresight or foreclosure? *Environment and Planning A*, 44(1), 1–4.
- Findlay, A. (2011). Migrant destinations in an era of environmental change. *Glob Environ Chang*, 21(Supplement 1(0)), 50–58. <https://doi.org/10.1016/j.gloenvcha.2011.09.004>.
- Findley, S. E. (1994). Does drought increase migration? A study of migration from rural Mali during the 1983–85 drought. *International Migration Review*, 28(3), 539–553.
- Foresight. (2011). *Migration and global environmental change: Future challenges and opportunities*. London: Government Office for Science.
- Frenken, K., Hardeman, S., & Hoekman, J. (2009). Spatial scientometrics: towards a cumulative research program. *Journal of Informetrics*, 3(3), 222–232.
- Fussell, E., Hunter, L. M., & Gray, C. L. (2014). Measuring the environmental dimensions of human migration: the demographer's toolkit. *Global Environmental Change*, 28, 182–191. <https://doi.org/10.1016/j.gloenvcha.2014.07.001>.
- Gemenne, F. (2011a). How they became the human face of climate change: research and policy interactions in the birth of the “environmental migration” concept. In E. Piguet, A. Pecoud, & P. De Guchteneire (Eds.), *Migration and climate change* (pp. 225–259). Cambridge: Cambridge University Press.
- Gemenne, F. (2011b). Why the numbers don't add up: a review of estimates and predictions of people displaced by environmental changes. *Global Environmental Change*, 21S, 41–49.
- Gemenne, F., & Blocher, J. (2017). How can migration serve adaptation to climate change? Challenges to fleshing out a policy ideal. *The Geographical Journal*. <https://doi.org/10.1111/geoj.12205>.
- Gemenne, F., Barnett, J., Adger, W. N., & Dabelko, G. D. (2014). Climate and security: evidence, emerging risks, and a new agenda. *Climatic Change*, 123(1), 1–9. <https://doi.org/10.1007/s10584-014-1074-7>.
- Gilbert, G., & McLeman, R. (2010). Household access to capital and its effects on drought adaptation and migration: a case study of rural Alberta in the 1930s. *Population & Environment*, 32(1), 3–26. <https://doi.org/10.1007/s11111-010-0112-2>.
- Gioli, G., Hugo, G., Costa, M. M., & Scheffran, J. (2015). Human mobility, climate adaptation, and development. *Migration and Development*, 1–6. <https://doi.org/10.1080/21632324.2015.1096590>.
- Global Humanitarian Forum (Producer). (1996). The anatomy of a silent crisis. Retrieved from <http://www.ghf-ge.org/human-impact-report.pdf>
- Gray, C., & Mueller, V. (2012). Drought and population mobility in rural Ethiopia. *World Development*, 40(1), 134–145. <https://doi.org/10.1016/j.worlddev.2011.05.023>.
- Greiner, C., & Sakdapolrak, P. (2016). Migration, environment and inequality: Perspectives of a political ecology of translocal relations. In R. McLeman, J. Schade, & T. Faist (Eds.), *Environmental migration and social inequality* (pp. 151–163). Cham: Springer International Publishing.
- Henry, S., Piché, V., Ouedraogo, D., & Lambin, E. F. (2004). Descriptive analysis of the individual migratory pathways according to environmental typologies. *Population Environment*, 25(5), 397–422.
- Ho-Lem, C., Zerriffi, H., & Kandlikar, M. (2011). Who participates in the intergovernmental panel on climate change and why: a quantitative assessment of the national representation of authors in the intergovernmental panel on climate change. *Global Environmental Change*, 21(4), 1308–1317. <https://doi.org/10.1016/j.gloenvcha.2011.05.007>.
- Hugo, G. (1996). Environmental concerns and international migration. *Int Migr Rev*, 30(1), 105–131.
- Hugo, G. (1999). Environmental concerns and international migration. In V. Robinson (Ed.), *Migration and public policy* (pp. 575–601). Cheltenham: Edward Elgar Publishing.
- Hugo, G. (2008). Migration, development and environment. Geneva: IOM (International Organization for Migration).
- Hugo, G. (2010). Climate change-induced mobility and the existing migration regime in Asia and the Pacific. In J. McAdam (Ed.), *Climate change and displacement: Multidisciplinary perspectives* (pp. 9–36). Oxford: Hart Publishing.
- Hugo, G. (2011a). Future demographic change and its interactions with migration and climate change. *Global Environmental Change*, 21, Supplement 1(0), 21–33. doi:<https://doi.org/10.1016/j.gloenvcha.2011.09.008>.
- Hugo, G. (2011b). Lessons from past forced resettlement for climate change migration. In E. Piguet, A. Pecoud, & P. de Guchteneire (Eds.), *Migration and Climate Change* (pp. 260–288). Cambridge: Cambridge University Press.
- Hugo, G. (2012a). Climate change and migration: Some lessons from existing knowledge of migration in Southeast Asia. In L. Elliott (Ed.), *Climate change, migration and human security in Southeast Asia* (pp. 45–59). Singapore, Nanyang Technological University: S. Rajaratnam School of International Studies.
- Hugo, G. (2012b). Environmental migration. In D. R. Gallagher (Ed.), *Environmental leadership: A reference handbook* (chapter 88). London: SAGE Publications.

- Hugo, G. (2012c). *Introduction*. In *Migration and climate change*. Cheltenham: Edward Elgar Publishing.
- Hugo, G. (Ed.). (2013). *Migration and climate change*. London: Edward Elgar Publishing.
- Hugo, G., & Bardsley, D. (2014). Migration and environmental change in Asia. In E. Piguët & F. Laczko (Eds.), *People on the move in a changing climate: The regional impact of environmental change on migration* (pp. 21–48). Netherlands: Springer.
- Hugo, G., & Tan, Y. (2013). *Mobility and desertification: New evidence from rural household survey in the Minqin Oasis, Northwest China*. Paper presented at the Global Change and Resilience Conference (3rd : 2013 : Bmo), Czech Republic.
- Hugo, G., & Zewdu, G. A. (2014). *Cross-border migration and displacement in the context of the 2011–12 drought in the Horn of Africa: Final draft of a report to the Nansen Initiative*. Nansen Initiative (unpublished manuscript).
- Hunter, L. M., & David, E. (2011). Displacement, climate change and gender. In E. Piguët, A. Pecoud, & P. De Guchteneire (Eds.), *Migration and climate change* (pp. 306–330). Cambridge: Cambridge University Press.
- Hunter, L. M., Luna, J. K., & Norton, R. M. (2015). Environmental dimensions of migration. *Annual Review of Sociology*, 41(1), 377–397. <https://doi.org/10.1146/annurev-soc-073014-112223>.
- Huntington, E. (1922). *Civilization and climate*. New Haven: Yale University Press.
- IPCC. (1990). Climate change: The IPCC impacts assessment: Report prepared for intergovernmental panel on climate change by working group II. Retrieved from Canberra: www.ipcc.ch
- IPCC. (2013). Appendix A to the principles governing IPCC work: The procedures for the preparation, review, acceptance, adoption, approval and publication of IPCC reports. Retrieved from Geneva: <http://www.ipcc.ch/pdf/ipcc-principles/ipcc-principles-appendix-a-final.pdf>
- IPCC. (2014a). Climate change 2014: Synthesis report. Retrieved from Geneva: <https://www.ipcc.ch/report/ar5/syr/>
- IPCC. (2014b). Climate change 2014: Impacts, adaptation, and vulnerability (WG2) - technical summary. Retrieved from Geneva: <https://www.ipcc.ch/report/ar5/syr/>
- Jacobson, J. (1988). Environmental refugees: a yardstick for habitability. *Worldwatch Paper* (Washington, DC)(86).
- Jäger, J., Frühmann, J., Grünberger, S., & Vag, A. (2009). *EACH-FOR: Environmental change and forced migration scenarios: Synthesis report*. Retrieved from http://www.each-for.eu/documents/EACH-FOR_Synthesis_Report_090515.pdf
- Kaenzig, R., & Piguët, E. (2014). Migration and climate change in Latin America and the Caribbean. In E. Piguët & F. Laczko (Eds.), *People on the move in a changing climate: The regional impact of environmental change on migration* (pp. 155–176): Springer Netherlands.
- Karlsson, S., Srebotnjak, T., & Gonzales, P. (2007). Understanding the north–south knowledge divide and its implications for policy: a quantitative analysis of the generation of scientific knowledge in the environmental sciences. *Environ Sci Pol*, 10(7), 668–684. <https://doi.org/10.1016/j.envsci.2007.04.001>
- Kibreab, G. (1997). Environmental causes and impact of refugee movements: a critique of current debate. *Disasters*, 21(1), 20–38.
- Kniveton, D., Smith, C., & Wood, S. (2011). Agent-based model simulations of future changes in migration flows for Burkina Faso. *Global Environmental Change*, 21 Supplement 1(0), 34–40. doi:<https://doi.org/10.1016/j.gloenvcha.2011.09.006>.
- Koser, K. (2011). Climate change and internal displacement: Challenges to the normative framework. In E. Piguët, A. Pecoud, & P. De Guchteneire (Eds.), *Migration and climate change* (pp. 289–305). Cambridge: Cambridge University Press.
- Lassailly-Jacob, V., & Zmolek, M. (1992). Environmental refugees. *Refuge*, 12(1), 1–4.
- Livingstone, D. N. (1995). The spaces of knowledge: contributions towards a historical geography of science. *Environment and Planning D: Society and Space*, 13(1), 5–34. <https://doi.org/10.1068/d130005>.
- Loebach, P. (2016). Household migration as a livelihood adaptation in response to a natural disaster: Nicaragua and Hurricane Mitch. *Population and Environment*, 38(2), 185–206.
- Lubkemann, S. C. (2008). Involuntary immobility: on a theoretical invisibility in forced migration studies. *Journal of Refugee Studies*, 21(4), 454–475. <https://doi.org/10.1093/jrs/fen043>.
- Maldonado, J. K., Shearer, C., Bronen, R., Peterson, K., & Lazrus, H. (2013). The impact of climate change on tribal communities in the US: displacement, relocation, and human rights. *Climatic Change*, 120(3), 601–614.
- Malkki, L. H. (1995). Refugees and exile: from “refugee studies” to the national order of things. *Annual Review of Anthropology*, 25, 495–523.
- Marino, E. (2012). The long history of environmental migration: assessing vulnerability construction and obstacles to successful relocation in Shishmaref, Alaska. *Global environmental change*, 22(2), 374–381.

- Maurel, M., & Tuccio, M. (2016). Climate instability, urbanisation and international migration. *J Dev Stud*, 52(5), 735–752.
- McAdam, J. (2013). Conceptualizing crisis migration. *University of New South Wales Faculty of Law Research Series 2013. Working Paper*(20).
- McAdam, J. (2014). Creating new norms on climate change, natural disasters and displacement: international developments 2010–2013. *Refuge*, 29(2), 11–26.
- McDowell, C. (2011). Climate change adaptation and mitigation: implications for land acquisition and population relocation. *Development Policy Review*, 31(6), 677–695.
- McGregor, J. A. (1993). Refugees and the environment. In R. Black & V. Robinson (Eds.), *Geography and refugees: Patterns and processes of change* (pp. 157–170). London: Belhaven.
- McLeman, R., Mayo, D., Strebeck, E., & Smit, B. (2008). Drought adaptation in rural eastern Oklahoma in the 1930s: lessons for climate change adaptation research. *Mitig Adapt Strateg Glob Chang*, 13(4), 379–400.
- McLeman, R., Herold, S., Reljic, Z., Sawada, M., & McKenney, D. (2010). GIS-based modeling of drought and historical population change on the Canadian prairies. *J Hist Geogr*, 36(1), 43–56. <https://doi.org/10.1016/j.jhg.2009.04.003>.
- McNamara, K. E. (2007). Conceptualizing discourses on environmental refugees at the United Nations. *Population and Environment* 29(1), 12–24.
- Methmann, C., & Oels, A. (2015). From ‘fearing’ to ‘empowering’ climate refugees: governing climate-induced migration in the name of resilience. *Security Dialogue*, 46(1), 51–68. <https://doi.org/10.1177/0967010614552548>.
- Milan, A., Gioli, G., & Afifi, T. (2014). Migration and global environmental change: methodological lessons from mountain areas of the global south. *Earth Syst Dynam Discuss*, 5(2), 1711–1749. <https://doi.org/10.5194/esdd-5-1711-2014>.
- Mortimore, M. (2010). Adapting to drought in the Sahel: lessons for climate change. *Wiley Interdiscip Rev Clim Chang*, 1(1), 134–143.
- Mulligan, M., Burke, S. M., & Douglas, C. (2014). Environmental change and migration between Europe and its neighbours. In E. Piguet & F. Laczo (Eds.), *People on the move in a changing climate: The regional impact of environmental change on migration* (pp. 49–79): Springer Netherlands.
- Munster, R. v. (2012). Securitization. Oxford Bibliographies doi:<https://doi.org/10.1093/OBO/9780199743292-0091>.
- Murphy, D. W. A. (2014). Theorizing climate change, (im)mobility and socio-ecological systems resilience in low-elevation coastal zones. *Climate and Development*, 1–18. <https://doi.org/10.1080/17565529.2014.953904>.
- Myers, N. (1997). Environmental refugees. *Popul Environ*, 19(2), 167–182.
- Myers, N. (2002). Environmental refugees: a growing phenomenon of the 21st century. *Philosophical Transactions: Biological Sciences*, 357(1420), 609–613.
- Nawrotzki, R. J., Hunter, L. M., Runfola, D. M., & Riosmena, F. (2015). Climate change as a migration driver from rural to urban Mexico. *Environmental Research Letters*, 10(11), 114023.
- Neumann, K., & Hilderink, H. (2015). Opportunities and challenges for investigating the environment-migration nexus. *Hum Ecol*, 43(2), 309–322. <https://doi.org/10.1007/s10745-015-9733-5>.
- Neumayer, E., Plümper, T., & Barthel, F. (2014). The political economy of natural disaster damage. *Glob Environ Chang*, 24, 8–19. <https://doi.org/10.1016/j.gloenvcha.2013.03.011>.
- Obokata, R., Veronis, L., & McLeman, R. (2014). Empirical research on international environmental migration: a systematic review. *Popul Environ*, 36(1), 111–135. <https://doi.org/10.1007/s11111-014-0210-7>.
- Pascucci, E. (2016). The humanitarian infrastructure and the question of over-research: reflections on fieldwork in the refugee crises in the Middle East and North Africa. *Area*, <https://doi.org/10.1111/area.12312>.
- Pasgaard, M., & Strange, N. (2013). A quantitative analysis of the causes of the global climate change research distribution. *Glob Environ Chang*, 23(6), 1684–1693. <https://doi.org/10.1016/j.gloenvcha.2013.08.013>.
- Pasgaard, M., Dalsgaard, B., Maruyama, P. K., Sandel, B., & Strange, N. (2015). Geographical imbalances and divides in the scientific production of climate change knowledge. *Glob Environ Chang*, 35, 279–288. <https://doi.org/10.1016/j.gloenvcha.2015.09.018>.
- Pasgaard, M., Van Hecken, G., Ehammer, A., & Strange, N. (2017). Unfolding scientific expertise and security in the changing governance of ecosystem services. *Geoforum*, 84, 354–367. <https://doi.org/10.1016/j.geoforum.2017.02.001>.
- Pedersen, J. (1995). Drought, migration and population growth in the Sahel: the case of the Malian Gourma: 1900–1991. *Popul Stud*, 49, 111–126.
- Petersen, W. (1958). A general typology of migration. *Am Sociol Rev*, 23(3), 256–266.

- Piguët, E. (2008). Climate change and forced migration. *New Issues in Refugee Research - United Nations High Commissioner for Refugees Research Paper* (153).
- Piguët, E. (2010). Linking climate change, environmental degradation and migration: a methodological overview. *Wiley Interdiscip Rev Clim Chang*, 1(4), 517–524.
- Piguët, E. (2013). From “primitive migration” to “climate refugees”: the curious fate of the natural environment in migration studies. *Ann Assoc Am Geogr*, 103(1), 148–162.
- Piguët, E., & Laczko, F. (Eds.). (2014). *People on the move in a changing climate: The regional impact of environmental change on migration*. Springer Netherlands.
- Pullin, A. S., & Stewart, G. B. (2006). Guidelines for systematic review in conservation and environmental management. *Conserv Biol*, 20(6), 1647–1656. <https://doi.org/10.1111/j.1523-1739.2006.00485.x>.
- Reuveny, R., & Moore, W. H. (2009). Does environmental degradation influence migration? Emigration to developed countries in the late 1980s and 1990s. *Soc Sci Q*, 90, 461–479. <https://doi.org/10.1111/j.1540-6237.2009.00569.x>.
- Ronan, C. (1983). *The Cambridge illustrated history of the world's science*. Cambridge: Cambridge University Press.
- Ross, L. R. (2010). Climate change and immigration: Warnings for America's southern border. Retrieved from Washington DC: <http://americansecurityproject.org/featured-items/2010/climate-change-and-immigration-warnings-for-americas-southern-border/>.
- Sakdapolrak, P., Promburom, P., & Reif, A. (2013). Why successful in situ adaptation with environmental stress does not prevent people from migrating? Empirical evidence from northern Thailand. *Climate and Development*, 6(1), 38–45. <https://doi.org/10.1080/17565529.2013.826129>.
- Sall, M., Tall, S., Tandian, A., & Assane Samb, A. (2011). *Climate change, adaptations strategies and mobility: Evidence from four settlements in Senegal*. International Institute for Environment and Development (IIED). Human Settlements Working Paper (33).
- Scheffran, J., Marmar, E., & Sow, P. (2012). Migration as a contribution to resilience and innovation in climate adaptation: social networks and co-development in Northwest Africa. *Appl Geogr*, 33(0), 119–127. <https://doi.org/10.1016/j.apgeog.2011.10.002>.
- Sen, S. (2016). Gender, development-induced displacement, and resistance: women uprooted by river erosion in West Bengal and Bangladesh. *Refugee Watch: A South Asian Journal on Forced Migration* (47), 20–35.
- de Sherbinin, A., Castro, M., Gemenne, F., Cernea, M. M., Adamo, S., Fearnside, P. M., & Shi, G. (2011). Preparing for resettlement associated with climate change. *Science*, 334(6055), 456–457. <https://doi.org/10.1126/science.1208821>.
- Sly, D. F., & Tayman, J. (1977). Ecological approach to migration reexamined. *Am Sociol Rev*, 42(5), 783–795.
- Smith, C. (2014). Modelling migration futures: development and testing of the rainfalls agent-based migration model: Tanzania. *Climate and Development*, 6(1), 77–91. <https://doi.org/10.1080/17565529.2013.872593>.
- Stal, M. (2011). Flooding and relocation: the Zambezi River valley in Mozambique. *Int Migr*, 49, 125–145. <https://doi.org/10.1111/j.1468-2435.2010.00667.x>.
- Suhrke, A. (1994). Environmental degradation and population flows. *J Int Aff*, 47, 473–496.
- Swift, J. (1977). Sahelian pastoralists: underdevelopment, desertification, and famine. *Annu Rev Anthropol*, 6, 457–478. <https://doi.org/10.2307/2949340>.
- Tan, Y., Zuo, A., & Hugo, G. (2013). Environmental-related resettlement in China: a case study of the Ganzi Tibetan Autonomous Prefecture in Sichuan Province. *Asian and Pacific Migration Journal*, 22(1), 77–107.
- Tan, Y., Liu, X., & Hugo, G. (2015). Exploring relationship between social inequality and adaptations to climate change: evidence from urban household surveys in the Yangtze River delta, China. *Popul Environ*, 36(4), 400–428. <https://doi.org/10.1007/s11111-014-0223-2>.
- Taylor, T. G. (1949). *Environment, race, and migration: Fundamentals of human distribution*. Toronto: University of Toronto Press.
- Thiede, B., Gray, C., & Mueller, V. (2016). Climate variability and inter-provincial migration in South America, 1970–2011. *Glob Environ Chang*, 41, 228–240. <https://doi.org/10.1016/j.gloenvcha.2016.10.005>.
- Upadhyay, H., Kelman, I., Lingaraj, G. J., Mishra, A., Shreve, C. M., & Stojanov, R. (2015). Conceptualizing and contextualizing research and policy for links between climate change and migration. *International Journal of Climate Change Strategies and Management*, 7(3), 394–471.
- Waddell, E. (1975). How the Enga cope with frost: responses to climate perturbations in the Central Highlands of New Guinea. *Hum Ecol*, 3(4), 249–273.

- Walsh, S. J., Malanson, G. P., Entwisle, B., Rindfuss, R. R., Mucha, P. J., Heumann, B. W., & Ding, D. (2013). Design of an agent-based model to examine population–environment interactions in Nang Rong District, Thailand. *Applied Geogr*, 39, 183–198. <https://doi.org/10.1016/j.apgeog.2012.12.010>.
- Warner, K., Ehrhart, C., de Sherbinin, A., Adamo, S., & Chai-Onn, T. (2009). In search of shelter: Mapping the effects of climate change on human migration and displacement: CARE/CIESIN/UNHCR/UNU-EHS/World Bank.
- Warner, K., Kälín, W., Martin, S. F., Nassef, Y., Lee, S., Melde, S., Afifi, T. (2014). *Integrating human mobility issues within national adaptation plans*. Retrieved from Bonn: <https://environmentalmigration.iom.int/sites/default/files/publications/pdf/1800.pdf>
- White, G. (1945). Human adjustment to floods. University of Chicago - Dept. of Geography Research Paper
- Wolpert, J. (1966). Migration as an adjustment to environmental stress. *Journal of Social Issues*, 22, 92–102.