



Synthesis

Migration in West Africa: a visual analysis of motivation, causes, and routes

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ABSTRACT. Migration in West Africa has been taking place for centuries for different reasons. Many dimensions of migration remain insufficiently documented and poorly understood. In particular, factors of migration in destination areas and areas of origin are still lacking comprehensive analysis. In this paper, we bring a new perspective to the model of push and pull factors of migration in West Africa by reviewing and analyzing interview-based case studies of migration related to Ghana, Burkina Faso, and Nigeria, as well as to the associated migration routes. The overall aim of this study was to determine the areas that individuals historically chose as destinations for migration and what they perceived to be the distinctive conditions in those areas. Hence, characteristic features about destination areas and areas of origin were identified and located in maps, whereas interrelationships among push and pull factors were illustrated by means of Sankey diagrams. With these tools, we provide a novel combination for visualizing the reasons for migration. The literature review emphasizes the complex relationships between different drivers of migration, with environmental and economic factors emerging as the most important drivers of migration in the focus countries. Moreover, the identified and mapped migration patterns suggest that individuals migrate mainly from the northern part of a particular country to its center or southern regions. This scientific approach shows that the spatial allocation of migratory movements can facilitate assessments on how to meet specific Sustainable Development Goals and to improve regional policies.

Key Words: *area of origin; causes; destination area; drivers of migration; map; migration flows; migration patterns; push–pull model; Sankey diagrams; Sustainable Development Goals; review*

INTRODUCTION

The first objective of the UN's Sustainable Development Goals (SDG), namely to end poverty in all its forms everywhere, is merely one of many SDGs indirectly or directly related to forced and voluntary migration (UN 2015, IOM 2018). Although the goal is formulated globally, it is notably relevant to West Africa. In fact, this region is particularly vulnerable to multiple pressures such as climate change, low soil fertility, conflicts, and limited access to economic resources, all of which can lead to poverty and food insecurity (Mertz et al. 2011, Sissoko et al. 2011, Hollinger and Staatz 2015, Partey et al. 2018, Adaawen et al. 2019). Globally, migration has been a strategy for escaping poverty, food insecurity, or other adverse circumstances for centuries (Black et al. 2011b, Adger et al. 2018, Wiederkehr et al. 2018, Kumasi et al. 2019). Hence, migration can be seen as an adaptation strategy that assists households to diversify their income and decrease their exposure to climate change impacts, contributing indirectly to the achievement of SDG 13 (climate action; ODI 2018). However, voluntary migration can also entail insecure living conditions and accelerate vulnerability for migrants and their dependents (Warner and Afifi 2014, Vinke et al. 2020). Collecting data on migration-related issues corresponding to SDG 17.18, such as migration status or migration movements to and from rural areas, is essential for decision makers to create local, migration-sensitive policies (IOM 2018).

According to the United Nations Department of Economic and Social Affairs (UNDESA), an estimated 7.5 million migrants originated from West African countries in the year 2020. Approximately 89% of international migrants from West Africa stay in other West African countries (author calculations based on UNDESA 2020), indicating internal and cross-border migration patterns as the predominant phenomenon and

characterizing the region as a hot spot for migration movements. The population in West Africa, consisting of a variety of ethnic groups, has migrated for many generations (Zachariah and Conde 1980, Bassett and Turner 2007). Ethnic groups like Fulani (Tonah 2002, Bassett and Turner 2007, Bukari et al. 2020), and Mossi (Skinner 1960, Henry et al. 2004, Kress 2006) are observed to be highly mobile throughout West Africa. When referring to human mobility in this region, it is important to differentiate various types of migration. Forced migration or displacement driven by severe droughts, conflicts, or terrorist attacks must be distinguished from seasonal (labor) migration (Adaawen et al. 2019). Other types of migration are outlined in the literature as long-term, short-term, and permanent migration (Guilmoto 1998, Bilsborrow and Henry 2012). As reported by the International Organization for Migration (IOM 2019), seasonal migration refers to migrant workers who depend on certain seasonal conditions and migrate for only a specific part of the year. Short-term migrants migrate for more than three months but less than 12 months, detached from seasonal conditions. Migrants who change their residence but intend to return after a limited period of time are termed as temporary migration. Long-term migration (also referred to as permanent migration in certain studies) is described as a change of residence of more than one year. Migration patterns in West Africa are sensitive to changing conditions (Dick and Schraven 2021), and usually occur in corridors from the more arid north to the more humid south of West Africa (Flahaux and de Haas 2016, van der Land et al. 2018).

The theoretical model of five drivers of migration, which include environmental, economic, demographic, political, and social forces (Black et al. 2011a), is used in a variety of literature (Parnell and Walawege 2011, Neumann et al. 2015, Neumann and

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Hermans 2017, de Longueville et al. 2020). Food security is considered as a sixth driver of migration in this study because it has been cited as an important factor of migration in a large number of studies that deal with migration in West Africa (Doevenspeck 2011, Pearson and Niaufre 2013, Sow et al. 2014, Neumann et al. 2015, van der Land et al. 2018, Morales-Muñoz et al. 2020). Moreover, given that food security is mostly a combination of several (negative) factors, such as armed conflict, low agricultural production, poor infrastructure, etc., assigning food security to one of the five drivers does not adequately and sufficiently address its importance.

The scientific discourse in recent years has focused on the influence of environmental change on migration patterns on account of the climate change debate (Brown 2008, Black et al. 2011c, McLeman 2013, Gautier et al. 2016, de Longueville et al. 2019, de Longueville et al. 2020, Rigaud et al. 2021). However, environmental factors must be integrated into a complex network of factors and processes and cannot be seen as a stand-alone determinant of migration (Bilsborrow and Henry 2012, Cattaneo and Massetti 2019, Adger et al. 2021). In particular, recent literature highlights the combination and interplay of several factors that influence the decision to migrate (Ackah and Medvedev 2010, Black et al. 2011a, Abu et al. 2014, Neumann et al. 2015, Sanfo et al. 2017, van Hear et al. 2018, Bukari et al. 2020). Economic and social factors play an important role when it comes to deciding whether to migrate or not (Carr 2005, Bassett and Turner 2007, Doevenspeck 2011, Sow et al. 2014). However, beyond a combination of factors that would be conducive to migration, the process also requires financial means. In other words, households that do not have the necessary resources may send only one household member or none to migrate, and thus remain trapped in their situation (Foresight 2011, Black et al. 2013, Cattaneo and Massetti 2019).

To further specify the reasons for migration, the model of push and pull factors (based on Lee 1966) is an approach that has been widely discussed in the literature (de Haas 2011, Parnell and Walawege 2011, Flahaux and de Haas 2016, Castelli 2018). Push and pull factors are seen as determinants of migration, with push factors being forces that pressure individuals to leave their place of origin, whereas pull factors induce people to move to a specific new place (Ackah and Medvedev 2010, Black et al. 2011c, Garcia et al. 2015, Sanfo et al. 2017, FAO et al. 2018). In this study the model of push and pull factors was used to retrieve information on destination areas and areas of origin, as these are essential for understanding migration patterns. Studies agree that migration in the region occurs mainly within the country or to neighboring countries (Adepoju 2003, Mercandalli and Losch 2017, van der Land et al. 2018, Adaawen et al. 2019). Ghana, Burkina Faso, and Nigeria were selected as focus regions in this study because they are of central importance for West African and North—South migration patterns (UNDESA 2019). Considering only international migration routes, according to estimations made by UNDESA, the main destination countries in 2019 for migrants from Burkina Faso were Côte d’Ivoire, Ghana, and Mali. Migrants from Ghana moved mainly to Nigeria, Côte d’Ivoire, or Togo, and individuals from Nigeria especially migrated to Niger, Benin, or Ghana (UNDESA 2019). Although broad interregional and international migration corridors have been characterized in the literature (Mercandalli and Losch 2017, UNCTAD 2018,

McAuliffe et al. 2019), the exact locations affected by out-migration or in-migration, especially in terms of within-country migration, still lack in-depth documentation.

Although several literature reviews or meta-analyses exist on the environmental influence on human mobility in West Africa (Jónsson 2010, Obokata et al. 2014, Gautier et al. 2016, Thober et al. 2018, Borderon et al. 2019), to date there is no scientific literature that specifically address reasons for migration in destination areas and areas of origins, nor scientific reviews that include a spatially explicit analysis of all possible driving forces in West Africa. In the studies published so far, the reasons for migration have mostly been presented in the form of text, tables, or bar charts (Ango et al. 2014, Olaniyan and Okeke-Uzodike 2015, Sanfo et al. 2016, Goldbach 2017, Neumann and Hermans 2017). The majority of studies have illustrated migration routes separately from the underlying factors (Henry et al. 2003, Rademacher-Schulz et al. 2014, Warner and Afifi 2014, Goldbach 2017). Paone and Richmond (2017) visualize both routes and reasons of migration, but focus exclusively on environmental factors.

In view of the above, our objectives in this paper are as follows:

- to ascertain and spatially allocate reasons for migration by analyzing survey-based case studies in the context of the previously described six drivers;
- to characterize destination areas and areas of origin by assigning respective push and pull factors in order to supplement the traditional push–pull model;
- to locate migration routes based on the conducted literature review; and
- to visualize the outcomes of the aforementioned objectives for a better understanding of migration patterns in the West African countries Ghana, Burkina Faso, and Nigeria

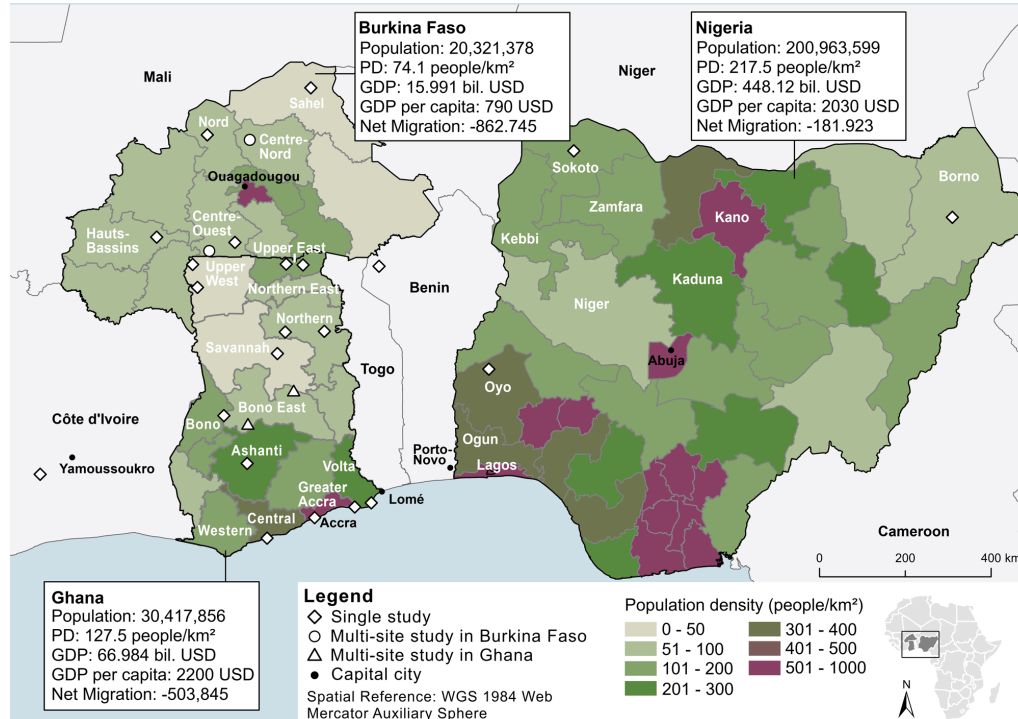
The results of this study will serve as groundwork for further research addressing the complex patterns of migration in West Africa and will facilitate the development of recommendations for regional policies.

METHODS

Study area

This study focuses on the three West African countries Ghana, Burkina Faso, and Nigeria (hereafter “focus countries”) as important countries of an international collaboration to tackle challenges related to climate change and poverty (see West African Science Service Centre on Climate Change and Adapted Land Use [WASCAL], <https://wascal.org/>). For this study, emphasis is placed on English-speaking countries where UNDESA (2019) reports high migration rates (Sierra Leone, Liberia, and the Gambia report rather lower migration numbers). The selected countries are amongst the five most densely populated countries in West Africa (World Bank 2021). Given the substantial migration flows between Ghana and Burkina Faso and the availability of extensive literature on migration patterns in Burkina Faso, we have additionally included this country in our analysis. In addition, studies related to migration routes to or from the focus countries, such as Benin or Côte d’Ivoire, were analyzed. These countries differ not only in their economic situation, but

Fig. 1. The focus countries Ghana, Burkina Faso, and Nigeria with relevant socio-economic information, the districts of interest for this study, population density per district, and the location of the selected case studies. The data shown refer to the year 2019. Sources: UNDESA 2019, World Bank 2021; Humanitarian Data Exchange, <https://data.humdata.org/>; WorldPop, <https://www.worldpop.org/project/categories?id=18>.



also in their migration rates and population density, as illustrated in Figure 1. Nigeria and Ghana are anglophone countries and are similar in their gross domestic product (GDP) per capita, but total GDP in Nigeria is considerably higher (World Bank 2021). Although francophone Burkina Faso is the least densely populated country among the focus countries, it experiences the highest rate of out-migration (World Bank 2021; WorldPop, <https://www.worldpop.org/project/categories?id=18>). The focus countries cover several bioclimatic regions, ranging from the arid Sahel subregion in northern Burkina Faso to the humid Guinea-Congo subregion in southern Nigeria (Herrmann et al. 2020). The three focus countries are analyzed separately because of their different geopolitical and socio-economic backgrounds, but cross-border migration among them is analyzed together.

Selection of literature and location of case studies

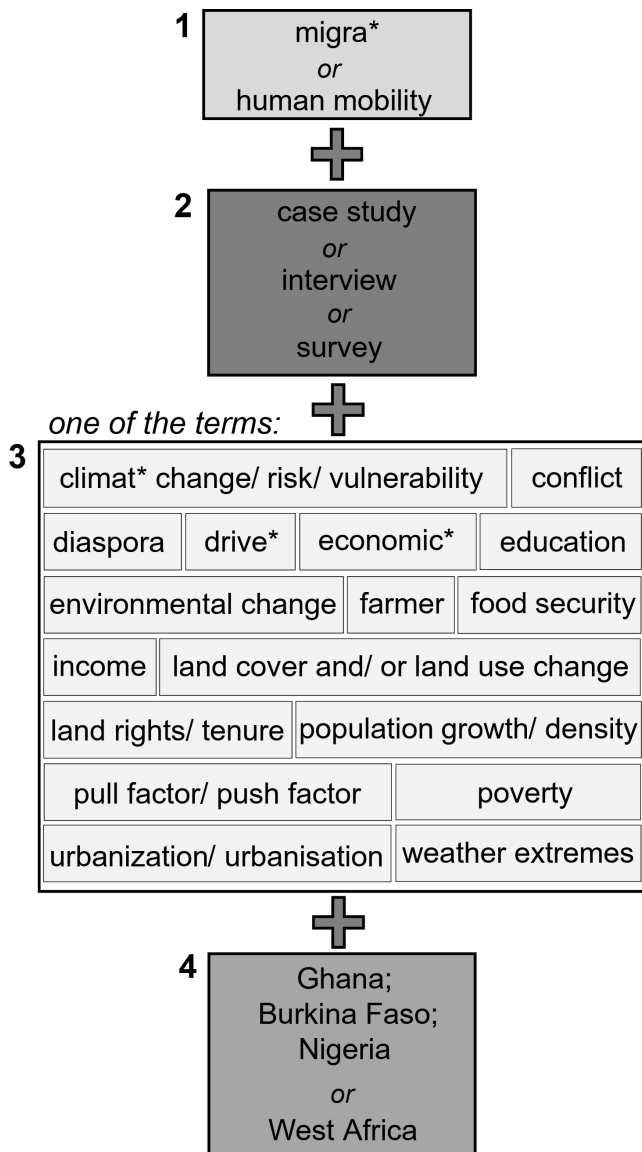
With the aim of a comprehensive literature research, multiple keywords were selected, which are indicated in Figure 2. We used the search terms “migra*” or “human mobility” in combination with a keyword from the second and third box together with the respective country name or the term “West Africa.” The definition of keywords is based on a previous literature review on the topic of migration in West Africa. Therefore, only keywords that have been identified in numerous studies as being associated with the term “migration” were applied. The search was conducted between March 2021 and June 2021 using the search engines Web of Science (<https://apps.webofknowledge.com>) and Google Scholar (<https://scholar.google.com>).

We additionally formulated several criteria for the selection of case studies in order to maintain quality standards and achieve our research objectives. To be included, a study had to fulfill the following criteria:

- qualitative or quantitative surveys carried out by the authors of the case studies (literature reviews or studies that only processed census data were excluded);
- published in a journal with peer-review process;
- published in the English language;
- published in the last 20 years;
- defined destination areas and areas of origin of migrants; and
- defined push and pull factors.

The terms “push” or “pull” did not necessarily have to be used in the studies but rather the reasons related to the destination area or area of origin had to be mentioned. In the end, 24 scientific papers were included. Of these, 14 pertain to Ghana, six to Burkina Faso, and four to Nigeria. In two of the studies, multiple sites were evaluated. These were counted separately because all the above-mentioned criteria apply, resulting in a total of 26 case studies for the analysis. Certain studies that did not meet all criteria have been excluded from the analysis but serve as supporting literature for the discussion. An overview of all case

Fig. 2. Overview of keywords for case study selection.



studies is provided in Appendix 1 (Table A1.1). The respective location of case studies in West Africa can be found in Figure 1. Table A2.1 in Appendix 2 lists the references that were found on Web of Science prior to applying the criteria for case study selection, but were not included in the underlying analysis.

Analysis of literature according to push and pull factors of migration

For the most part, factors were included in the analysis that were reported in the methods or results section of the respective study, in other words, factors that were mentioned by the respondents. Some of the factors, however, came from third sources, but were supported by statements from the respondents. We analyzed the literature according to environmental, economic, demographic, social, and political drivers (based on Black et al. 2011a), as well

as in terms of food security, which has been described as a driver of migration in arid regions (Neumann and Hermans 2017). The drivers of migration were divided into push and pull factors to retrieve information on the characteristics of destination areas or areas of origin and to address the question regarding which factors are perceived to make a region attractive and which are considered repulsive. The respective factors are shown in Figure 3. For the exact wording of the factors, we refer to Appendix 3 (Table A3.1 and Table A3.2).

A classification of the factors to the drivers is complex because certain factors can be associated with several drivers. However, for our analysis or the visualization of the results, one driver had to be selected. Currently, no standard classification of factors is reported in the literature, thus a classification based on the relevant references was designed in this study. The assignment of environmental factors is based on Black et al. (2011a), describing that weather conditions and land productivity are related to the environment. Black et al. (2011a) and Neumann et al. (2015) described employment opportunities as an economic driver. Lack of available land or access to land are assigned to the category of economic drivers, in line with Parrish et al. (2020), whereas “scarcity of land” is also considered a demographic push factor when it is linked to population pressure. The category of social drivers is subdivided into “social conflicts” (Parrish et al. 2020) as a push factor; we refer to Neumann and Hermans (2017) who describe “escape from family problems” and “escape from assault and violence” as social drivers. “Social network” as well as “educational opportunities” are defined as social pull factors as described in Black et al. (2011a). Political push factors are “political conflicts”, including ethnic conflicts, (Black et al. 2011a, Neumann et al. 2015) and “poor infrastructure” (Parrish et al. 2020), whereas “better infrastructure” and “safety” are defined as political pull factors. Economic and political drivers are closely interrelated, as Neumann et al. (2015) emphasize. The factor “infrastructure” needs to be disentangled to differentiate economic infrastructure and infrastructure in the context of political aspects. For this reason, we classify “access to market” as an economic driver (Deen-Swarray et al. 2014). In case studies where “infrastructure” refers to the development of infrastructure, roads and transportation, or access to certain facilities, we consider “infrastructure” as a political factor that depends on regional development policies (Czaika and Reinprecht 2020). Food security as a driver of migration is divided into “food insecurity” as a push factor and “food security” as a pull factor (Neumann et al. 2015). Multiple citations of a factor in the same study were only counted once. However, it was not possible to weight the factors, given that in most case studies quantitative information was missing.

For each study, we determined which pull factors and which push factors were mentioned to better understand the meaning and characteristics of the destination areas and areas of origin. With this information, a matrix was created for each focus country, which served as the basis for the Sankey diagram visualization. The Sankey diagram reflects a specific flow by the width of the lines between two connections and is commonly used to analyze energy or material flows (Schmidt 2008). In this study, the number in the boxes on the outgoing flow of the Sankey diagram show how many pull factors are named in the context of the respective push factors (see Fig. 4). The number on the box of the incoming

Fig. 3. Overview of the assigned push and pull factors. Push factors are illustrated with a solid line, pull factors with a dashed line.

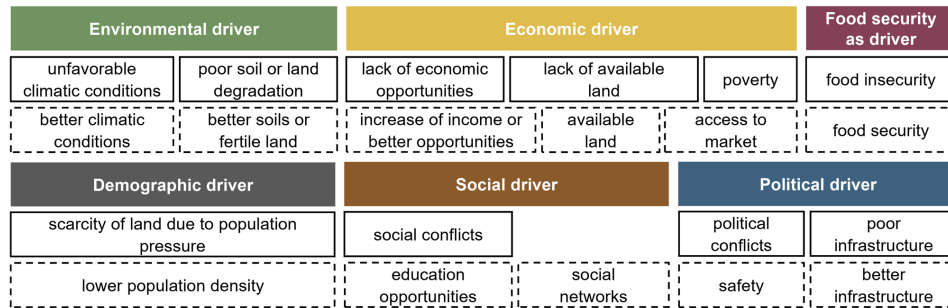
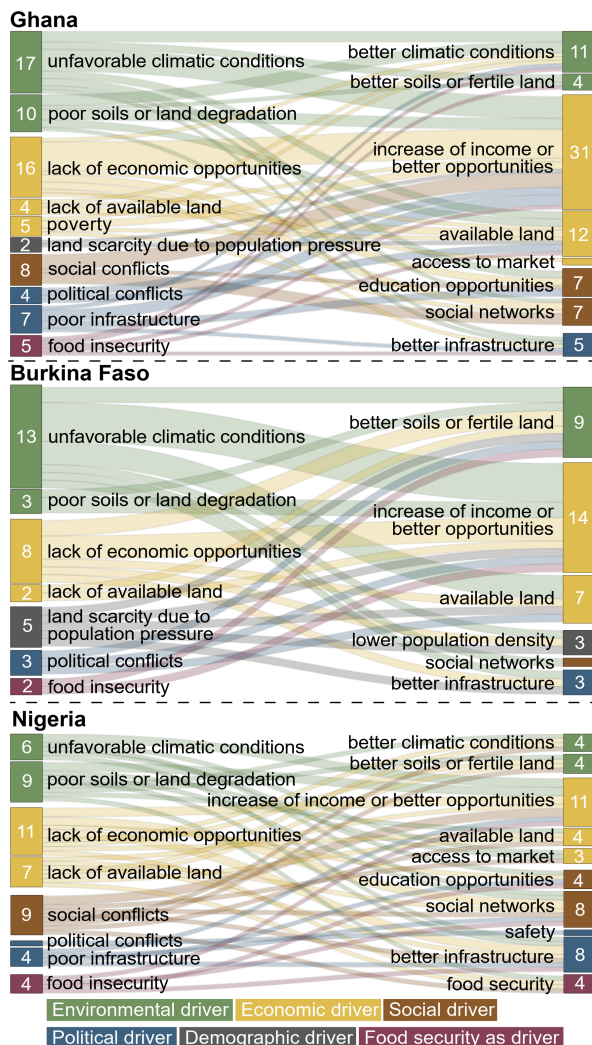


Fig. 4. Sankey diagram showing the interconnections of push and pull factors for Ghana, Burkina Faso and Nigeria. Numbers in the left-sided boxes reflect how many pull factors are named in the context of the respective push factors. Numbers on the right-hand side reflect the number of push factors that are named in the context of the respective pull factors. Colors of the boxes show the same driver categories. Colors of the lines reflect the category of push factors.



flow indicates how many push factors are mentioned in the context of the respective pull factors. The width of lines was determined by how frequently a push factor was cited (counting only once per case study) in combination with a pull factor (multiple counting possible). For a detailed methodological overview of Sankey diagram preprocessing, please refer to Appendix 4 (Fig. A4.1). To generate the diagrams, the Sankey Diagram Generator provided by Acquire Procurement Services was used (<http://sankey-diagram-generator.acquireprocure.com/>) and subsequently adapted by the authors for better readability.

Migration routes and characterization of destination areas and areas of origin

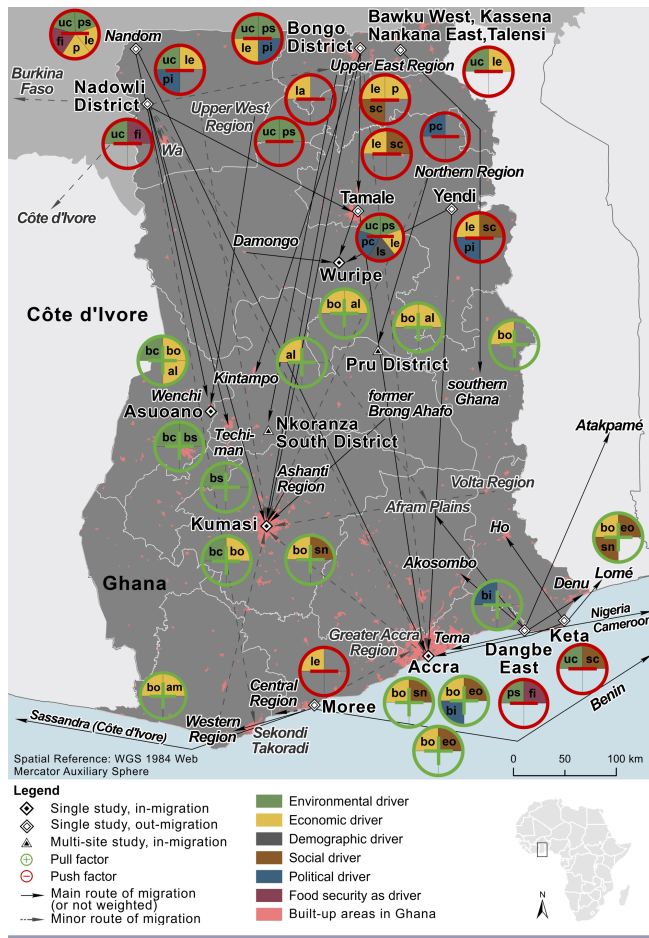
Migration routes were identified by means of reported destination areas and respective areas of origin. Weighting of the arrows was included in our maps when respective information was provided. Dashed arrows were used for minor migration routes. The reported and categorized push and pull factors of migration were spatially assigned to the mentioned destination and areas of origin (see Fig. 5 and Fig. 6). For the spatial representation, ArcGIS Pro version 2.4.1 was used. Furthermore, infographics in the respective map show the push factors in red circles and pull factors in green circles.

RESULTS

Overview of case studies

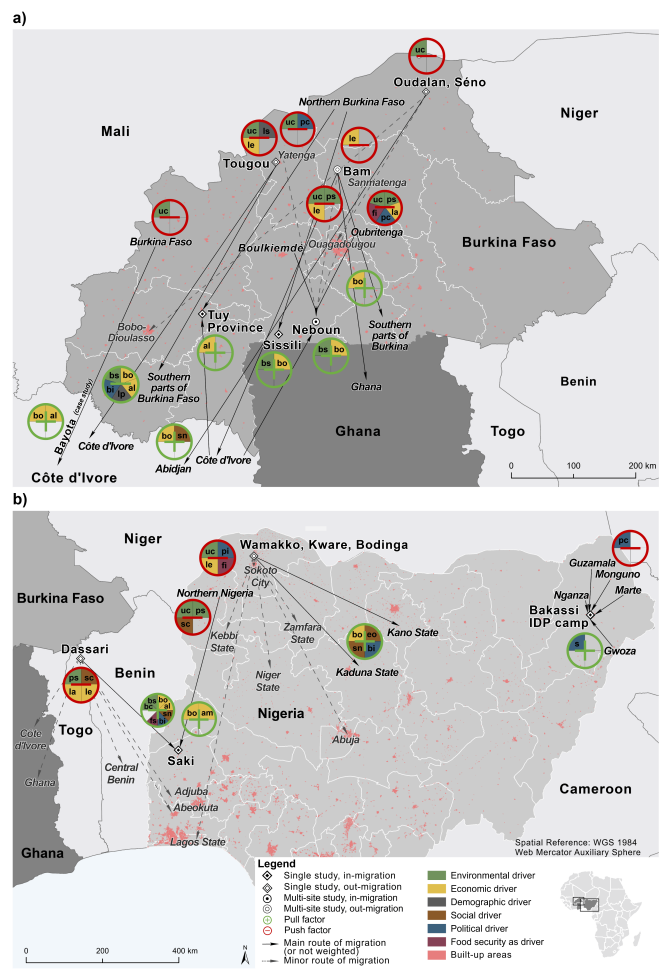
As mentioned, all selected studies included in-situ surveys. However, the number of respondents and the type of interview or focus group discussion vary, ranging from 20 respondents (West and Nèbié 2019) to 8834 (Hampshire 2002). In six studies, the questions focused directly on climate or environmental issues. The remaining studies asked about land use practices or reasons for migration in general, among other topics. In all studies, the migration movement had already taken place. Although most studies related to Burkina Faso link reported migration movements to the main migration waves associated with the droughts of the 1970s and 1980s (Ruf et al. 2015, Jahel et al. 2018), migration patterns in Ghana were affiliated with other events or lacked a temporal classification. Migration patterns after the 1990s to 2000s were mentioned for example in Braimoh (2004), whereas migration during the 2010s was reported in Rademacher-Schulz et al. (2014) and in Owusu-Ansah and Addai (2014). Migration patterns in northeastern Nigeria are mostly linked to the presence of the Islamist group Boko Haram starting in 2009 (Kamta et al. 2020). In Olaniyan and Okeke-Uzodike (2015),

Fig. 5. Migration flows and drivers in Ghana with allocated push and pull factors; author illustration based on literature review. Source of built-up area: CIESIN et al. 2020b. Explanation of codes: push factors (red circles): fi = food insecurity, la = lack of available land, le = lack of economic opportunities, ls = land scarcity, p = poverty, pc = political conflicts, pi = poor infrastructure, ps = poor soil or land degradation, sc = social conflicts, uc = unfavorable climatic conditions; pull factors (green circles): al = available land, am = access to market, bc = better climatic conditions, bi = better infrastructure, bo = increase of income or better opportunities, bs = better soils or fertile land, eo = education opportunities, sn = social network.



migration in Nigeria was described in the context of the 1960s and from 1990 onward. In 12 studies, a quantification of drivers was provided (Dreier and Sow 2015, Goldbach 2017) and in six studies, the number of migrants was specified (Hampshire 2002, Ango et al. 2014). The majority of studies (16) deal with rural to rural migration, although 13 studies address rural to urban migration and one study addresses urban to rural migration. Migration types cited in the case studies are long-term and permanent migration (21), seasonal migration (seven), short-term migration (four), and temporary migration (one). More than half of the selected case studies (17) focused only on internal migration

Fig. 6. Migration flows and drivers in (a) Burkina Faso and (b) Nigeria with allocated push and pull factors; author illustration based on literature review. Source of built-up area: CIESIN et al. 2020a, 2020c. Explanation of codes used in the map (sorted alphabetically, categorized by push and pull factors): push factors (red circles): fi = food insecurity, la = lack of available land, le = lack of economic opportunities, ls = land scarcity due to population growth, pi = poor infrastructure, pc = political conflicts, ps = poor soil or land degradation, sc = social conflicts, uc = unfavorable climatic conditions; pull factors (green circle): am = access to market, al = available land, bc = better climatic conditions, bi = better infrastructure, bo = increase in income & better opportunities, bs = better soils, eo = education opportunities, fs = food security, lp = lower population density, s = safety, sn = social network.



(Ouedraogo et al. 2009, van der Geest 2011, Sward 2017). Fulani and Mossi as migrants were the most frequently cited ethnic groups (Barbier et al. 2009, Olaniyan and Okeke-Uzodike 2015, West and Nébîé 2019).

Frequency of push and pull factors

A first overview indicated that economic drivers featured in 22 studies, environmental drivers in 18 studies, political drivers in 12

studies, social drivers in nine studies, food security as a driver in six studies, and demographic drivers in two studies. In total, 10 sub-categories for push factors and eleven sub-categories for pull factors were defined. Figure A5.1 in Appendix 5 shows the summarized push and pull factors by number of case studies, categorized by drivers of migration and by country. Overall, we identified 124 individual factors, of which 66 are counted as push factors and 58 as pull factors (see Appendix 3, Table A3.1 and Table A3.2). The majority of the push factors are associated with the environmental category (25). In contrast, the pull factors are mainly of economic character (30). Most factors are identified for Ghana (38 push and 29 pull factors), whereas for Burkina Faso (16 push and 15 pull factors) and Nigeria (12 push and 13 pull factors), fewer factors were specified, reflecting the smaller number of studies.

Interconnection of drivers

In 19 studies, a combination of at least two push factors was counted, with the same number applying to pull factors. The interrelation between push and pull factors becomes visible in the Sankey diagrams provided for each focus country (Fig. 4).

In Ghana, economic pull factors were found to play the most important role, as each push factor was reported in combination with an economic pull factor. The second most frequently cited pull factor “available land” was named in combination with push factors from all driver categories. “Better climatic conditions” is mostly cited together with environmental or economic pull factors. It is notable that each pull factor was named together with push factors from multiple driver categories. This observation also applies to the majority of pull factors in the other focus countries.

As in Ghana, the most frequently cited push factors in Burkina Faso include environmental drivers, but economic drivers are dominant for pull factors. Although “food insecurity” occurs together with “better soils or fertile land” or “increase of income or better opportunities,” food security was not reported as a pull factor in Burkina Faso. Moreover, the pull factors “access to market” and “better climatic conditions” were not quoted. “Available land” and “better soils or fertile land” were cited alongside “unfavorable climatic conditions” and “land scarcity due to population pressure.”

Although Nigeria was only represented in four cases, a similar trend can be observed. In fact, environmental and economic push and pull factors seem to be the most important factors here as well. The most frequently reported push factor, as in the other focus countries, is “lack of economic opportunities.” The pull factor “safety” was only cited in the context of Nigeria, alongside the push factor “political conflicts.”

Migration flows identified in studies

Given that the selected case studies report on areas of destination and origin, we were able to depict migration paths, directions and allocate the respective push and pull factors, as illustrated in Figures 5 and 6 for Ghana, Burkina Faso, and Nigeria. In northern Ghana, areas of out-migration were situated in the Upper West Region (Nadowli District and Nandom), in the Upper East Region (Bongo District as well as Bawku West, Kassenana Nankana East, and Talensi) and the Northern Region (Tamale, Yendi), where unfavorable climatic conditions like

insufficient rainfall or droughts as well as poor soil fertility, food insecurity, and the lack of employment opportunities were named as push factors (van der Geest 2011, Rademacher-Schulz et al. 2014, Adamtey et al. 2015, Tufuor and Sato 2017, Aniah et al. 2019, Antwi-Agyei and Nyantakyi-Frimpong 2021). Migrants from these regions mainly migrate to southern parts of Ghana such as Kumasi, Techiman, or Accra in order to find work or more fertile land.

Out-migration from the Greater Accra Region (Dangbe East), Volta Region (Keta), and Central Region (Moree) occurred for multiple reasons such as poor economic situations, the destruction of landing sites for canoes, or the impact of storms (Marquette et al. 2002, Codjoe et al. 2017, Goldbach 2017). In the respective destination areas, migrants wanted to find better educational opportunities, better markets, or safe landing sites (Marquette et al. 2002, Codjoe et al. 2017, Goldbach 2017). In-migration took place in Savannah Region (Wuripe), Bono Region (Asuoano), Bono East Region (Pru District, Nkoranza South Municipal District), Ashanti Region (Kumasi), and Accra. These regions attracted individuals primarily on account of improved economic conditions and access to farmland (Adjei-Nsiah et al. 2004, Braimoh 2004, Owusu-Ansah and Addai 2014, Sward 2017). Migrants left their home regions, located particularly in the northern regions of Ghana, because of scarcity of land, erratic precipitation, or the desire to find better jobs (Adjei-Nsiah et al. 2004, Braimoh 2004, Owusu-Ansah and Addai 2014, Sward 2017).

The literature review identified three case studies in northern Burkina Faso (namely in the districts Nord, Centre-Nord, and Sahel), where out-migration occurred (Fig. 6a; Hampshire 2002, Barbier et al. 2009, West and Nébié 2019). People migrated from these regions to southern Burkina Faso, to Ghana, or to Côte d’Ivoire. Environmental factors like frequent droughts, saturation of land, or lack of drinking water for animals, as well as economic factors such as limited off-farm income opportunities, were the main reasons for migration (Hampshire 2002, Barbier et al. 2009, West and Nébié 2019). Three case studies involved in-migration to locations in Burkina Faso (Ouedraogo et al. 2009, Jahel et al. 2018, West and Nébié 2019) in the districts Centre-Ouest (Neboun and Sissili) and Hauts-Bassins (Tuy Province). Fertile lands or the opportunity to make a better income were pull factors (Ouedraogo et al. 2009, Jahel et al. 2018, West and Nébié 2019). In-migration from Burkina Faso to Bayota in Côte d’Ivoire was reported in Ruf et al. (2015). According to this study, migrants were looking for land for cocoa plantations and better future opportunities given that they were affected by climate change in their areas of origin.

Out-migration in Nigeria took place in Sokoto State (Fig. 6b), from which migrants temporarily moved to Kano State or Kaduna State in search of better economic opportunities and educational facilities (Ango et al. 2014). Migrants left Sokoto State, especially the Local Government Areas Wamakko, Kware, and Bodinga, because of lack of social facilities and poor employment opportunities. In Benin (Dreier and Sow 2015), out-migration to the cities Saki, Adjuba, and Abeokuta (Oyo and Ogun State) in Nigeria was reported. The main reasons for migration were limited land and food insecurity (Dreier and Sow 2015). Migrants from Benin, who stay for a short or for a long

time, stated they came for better access to land and to find better soil quality in the mentioned locations. Because of the Islamist group Boko Haram and the resulting conflicts, people in northeastern Nigeria had to move to the Bakassi internally displaced people's (IDP) camp in Maiduguri, where they sought refuge (Kamta et al. 2020). In-migration was reported in a case study in Saki (Olaniyan and Okeke-Uzodike 2015), where migrants came from northern Nigeria because of erratic rainfall or decreasing grazing opportunities. They stated they moved to Saki because of climate-related and economic issues.

DISCUSSION

Interrelation of push and pull factors

When the reported reasons for migration are depicted in Sankey diagrams, it becomes apparent that the presence of factors that attract people to an area do not imply that these factors are absent on the sending side. Thus, our findings indicate that the counterpart of a pull factor is not necessarily identified as the push factor. For example, the push factor “unfavorable climatic conditions” is not inevitably accompanied by “favorable climatic conditions” as a pull factor. In this regard, it becomes clear that there is an interplay of different drivers of migration. This is highlighted in the overview maps as a result of the categorization and symbolization of the reasons for migration according to the respective drivers. The review of studies underscores that environmental factors are important in the context of migration in West Africa. Nevertheless, it also emerged that particularly economic, followed by social and political factors, have a significant impact in respect of migration decisions. This observation is in line with van der Land et al. (2018), who conclude that environmental drivers are strongly linked to additional factors, such as the economic or social situation of each individual, but also structural or political conditions. This finding is further supported by the Sankey diagrams which show that the majority of pull factors were cited in combination with push factors of multiple driver categories. Moreover, this result suggests that the decision to migrate depends on the concurrence of multiple unfavorable determinants.

Although unfavorable environmental conditions appear to be a pushing factor in Ghana and Nigeria, economic drivers have an equal importance. With regard to Ghana, better economic conditions and the availability of fertile land in the destination region are more likely to be the reasons for migration than unfavorable climatic conditions for agriculture in the place of origin (van der Geest 2011, van der Land et al. 2018). Given this set of observations, the relationship between environmental and economic drivers appears to be particularly complex within the context of migration research. Another result worth highlighting is the relevance of social factors in Ghana and Nigeria. Family ties in the destination area and the desire for better educational opportunities seem to pull individuals. In other words, individual characteristics of migrants substantially influence migration decisions (van der Land et al. 2018).

It becomes evident that in Burkina Faso environmental factors—especially droughts, erratic rainfall, or declining soil fertility—were frequently mentioned in combination with out-migration. Sanfo et al. (2016) confirmed this observation by arguing that dry spells and droughts are pushing people to migrate. However, the

Sankey diagram revealed that these factors are closely related to economic drivers such as available land or increase of income. This assumption was also confirmed by Henry et al. (2004), whose results indicate that individuals in Burkina Faso do not migrate only because of unfavorable climatic conditions. Although environmental conditions are related to migration behavior, they are linked in a rather complex way, also depending on the different types of migration, particularly short- or long-term migration (Henry et al. 2004). In Burkina Faso, it is noticeable that factors connected to population density were mentioned more frequently when compared with the case studies in Ghana and Nigeria, even though the population density per district is comparatively lower. This may be attributed to the relatively high rate of population growth in Burkina Faso, which has been approximately 2.9% since the late 1990s (World Bank 2021). Survey data published by Sanfo et al. (2017) confirm the assumption that population pressure results in land degradation and land tenure insecurity.

Political drivers are related to conflicts in Côte d'Ivoire (Ouedraogo et al. 2009, Jahel et al. 2018), conflicts due to the presence of Boko Haram in northeastern Nigeria (Kamta et al. 2020), or violent conflicts with Fulani herdsmen in Nigeria (Olaniyan and Okeke-Uzodike 2015). However, the latter is not included as a factor of migration in the analysis, as it was not stated as a cause of migration itself, but as a consequence of migration (Lenshie et al. 2020). Meaning, as Olaniyan and Okeke-Uzodike (2015) described, climate change-induced migration of Fulani pastoralists may result in conflicts with the local residents due to economic competition or reluctance to assimilate and identify with local cultural values.

Migration patterns

The case studies analyzed reveal a consistent picture, namely that northern regions of a country connect with its central or southern parts (see Fig. 5 and Fig. 6). This is true for all three focus countries and is also in line with other literature (Henry et al. 2003, Bassett and Turner 2007, Adaawen et al. 2019). Migration patterns are complex (Konseiga 2005), with some places serving as transit stations before migrants move on to their final destination (Owusu-Ansah and Addai 2014, Rademacher-Schulz et al. 2014).

The visual analysis indicates that the most common migration patterns within Ghana are from northern to southern regions, as discussed in several studies (van der Geest et al. 2010, Black et al. 2011c, Adaawen and Owusu 2013, Antwi-Bosiakoh et al. 2014), but also between coastal regions of different countries or to the central part of Ghana (Marquette et al. 2002, Codjoe et al. 2017, Goldbach 2017). Figure 5 clearly shows that destination areas, which are predominantly located in the middle belt of Ghana, appear to be characterized primarily by more favorable economic opportunities and higher earnings, as well as better access to land. The capital Accra is a major destination area given its educational and economic opportunities. In contrast, areas of origin are mainly affected by unfavorable climatic conditions or the absence of economic opportunities and are particularly located in the northern Regions.

We identified migration routes both from Côte d'Ivoire to Burkina Faso and vice versa, which is also consistent with current estimations by UNDESA (2019). This migration route corresponds to the largest corridor when looking at migration

patterns within Africa (UNCTAD 2018, McAuliffe et al. 2019). For internal migration, our study revealed that people in Burkina Faso mainly migrate from north to south, which is also supported by Adaawen et al. (2019) and Henry et al. (2003).

Internal migration movements in Nigeria do not appear to have been explored in depth in the existing literature. Likewise, given the criteria defined in the methods, pertinent literature may not have been part of this analysis, which of course cannot be all-encompassing. The fact that government and academic institutions have focused heavily on international migration in recent years (Oyeniyi 2013) may also explain why we found few case studies related to Nigeria compared to the other focus countries. Furthermore, we only found case studies describing internal and international in-migration or internal out-migration, whereas out-migration to other countries was not addressed.

When looking at the main corridors identified by UNDESA (2019), it is striking that this study did not identify Mali and Niger as destinations for migrants from Burkina Faso and Nigeria, respectively, although these countries are popular destinations. Also noticeable is the fact that migrants are willing to travel long distances. For example, migrants from the villages Séno and Oudalan in Burkina Faso travel a distance of 1200 km to their destination Abidjan in Côte d'Ivoire (Hampshire 2002). Likewise, migrants from Tougou or other regions in northern Burkina Faso travel long distances to Côte d'Ivoire (Barbier et al. 2009). In Ghana, this applies to migrants from Nandom, who migrate to Accra, a distance of about 800 km (Antwi Bosiakoh et al. 2014). This observation could indicate that migration is mainly performed by individuals who possess certain financial resources to travel these distances.

The identified studies of individuals either out-migrating because of lack of access to land or in-migrating for available land (Braimoh 2004, Barbier et al. 2009, Ouedraogo et al. 2009, Dreier and Sow 2015, Ruf et al. 2015, Sward 2017, Jahel et al. 2018) may contribute to more targeted use of land registration tools to strengthen land rights. Secure land rights are major development goals addressed in SDG 1 (no poverty), SDG 2 (zero hunger), SDG 5 (gender equality), SDG 11 (sustainable cities and communities), and SDG 15 (life on land), all of which directly affect migration issues (see the Land Portal SDG land tracker, <https://landportal.org/book/sdgs>). Our study could support the documentation and monitoring of the SDGs. In addition, the migration-related data obtained in this study, such as migration status, ethnicity, or geographic location, may support the fulfillment of SDG 17.18 (capacity-building for reliable data availability).

Methodological discussion

In our study, we were able to create an overview of reasons for migration and migration routes in West Africa analyzing studies from interdisciplinary social, economic, and natural sciences. We developed new approaches of visualization, tested new combinations of analysis and generated a new classification of migration. Destination areas and areas of origin can now be studied in a more targeted manner, and the individual indicators of migration defined in this literature review can be analyzed in more detail as they are already spatially allocated. Although similar trends of reasons for migration are evident in the three focus countries, the small number of case studies, the partly dated

migration patterns, and the restriction to Ghana, Burkina Faso, and Nigeria preclude a generalization of our findings. Although this statement also applies to migration routes, they generally reflect today's migration corridors, despite some of the data relating to past events. However, the reasons why people migrate along these routes may have changed over time.

The classic push–pull model can serve as a starting point for accumulating the reasons for migration and allocating factors to areas of destination and origin even though de Haas (2011), Castelli (2018), and Gemenne and McLeman (2018) perceive this model as too simplistic and deterministic. De Haas (2011) criticized this model for tending to characterize migrants as passive actors driven by macro-level drivers (i.e., environmental conditions or population growth) and not considering migration as a process. As this study only considers case studies in which the local population was interviewed, the individual motives for migration, i.e., the micro-level factors, are part of the analysis and thus represent the push and pull factors as direct perceptions of the respondents. Moreover, we argue that the model is intuitive and easy to visualize, allows the analysis of factors for migration in a structured way, and provides a first overview of causes, patterns, and interrelationships of migration (van Hear et al. 2018).

We agree with van Hear et al. (2018), Castelli (2018), and de Haas (2011) that the drivers have to be considered under different dimensions. Although we assigned the factors to the respective driver categories in accordance with the literature, there is a problem of clear distinctive assignment, especially for the factors “poor infrastructure” and “better infrastructure.” We assigned them as political drivers following Czaika and Reinprecht (2020) on account of the higher actuality of reference, but according to Deen-Swarray et al. 2014, assignment as an economic driver is feasible as well. Therefore, we have included a Sankey diagram with these changes in Appendix 6 (Fig. A6.1), which shows a predominance of economic factors. With the spatial assignment of push and pull factors as well as the assignability of ethnic groups, a temporal scale or migration types, multiple dimensions were addressed in our study, even if only superficially. These dimensions, along with others, are proposed by van Hear et al. (2018) as part of their push–pull-plus model, which could not be implemented in our analysis because of a lack of information in some of the case studies. Nevertheless, in this study we extended the classic push–pull model by a visual analysis component and applied it to characterize destination areas and areas of origin. The reasons for migration were not considered in isolation; rather, the interplay of factors influencing the decision to migrate was elaborated using this model.

The Sankey diagrams show at first sight the interaction between the push and pull factors and thus show that the majority of the coupled factors do not belong to the same driver. However, these results depend directly on the research questions and objectives addressed in the individual studies. Given that the studies have a wide spread in the topics of the questionnaires, the results can be assumed to have a low level of bias. A limitation of Sankey diagrams could be the number of linkages to ensure traceability. Moreover, a higher number of connections between push and pull factors may not reflect that one factor is more relevant than another, but rather that the literature focuses on a particular group

of factors (e.g., environmental factors of migration). Besides, we were unable to disaggregate the data by gender, which would be important to account for all dimensions of migration, because independent female migration patterns have become increasingly important as strategies for coping with poverty and social pressure in recent years (Adepoju 2003, Tufuor and Sato 2017, Lattof et al. 2018, Onyeneke et al. 2019).

For a holistic picture of migration patterns in West Africa, future studies should include francophone literature as well as gray literature (e.g., from the UN or World Bank), which were only considered as background information in this study. Moreover, comparing the occurrence of the factors over time is challenging, as only a few studies clearly document the implementation date of the surveys or the addressed migration movements. Surveys were often conducted with people who migrated at some point in the past. Consequently, our maps do not reflect current migration trends. Nevertheless, the findings allow us to draw conclusions about current migration patterns and serve as a basis for defining migration hot spots in the focus countries. Follow-up research of our analysis could focus on a finer distinction of drivers of individual migration factors (Fig. 3) by assigning a gradual weight to each relevant driver of the respective factor. The approach of ranking and weighting the most relevant drivers per factor could be combined with interviews and surveys with migration experts. Furthermore, by a Delphi approach with experts (Okoli and Pawlowski 2004), the relation between past, present, and future drivers of migration could identify how the circumstances or motives related to migration have changed or might change over time. In addition, documentation of the success of migration and how it has changed livelihoods would be of research interest. This would allow for inferences on how living conditions of individuals affect migration processes. Long-term information on migration patterns can thus contribute to the achievement of specific SDGs that address poverty alleviation (SDG 1), improved health and well-being (SDG 3), or combating and adapting to the impacts of climate change (SDG 13).

CONCLUSION

The purpose of this paper was to review and analyze survey-based case studies and migration routes, as well as the factors that drive migration, and to visualize their interplay. The evaluation of 26 case studies confirmed that environmental and economic drivers were the main forces affecting migration in the focus countries Ghana, Burkina Faso, and Nigeria. Although environmental factors were among the most frequently cited reasons for out-migration, economic factors appeared to be the most powerful factor attracting people to particular regions. Our visual analysis demonstrates that push and pull factors of the relevant drivers are closely interrelated, but that the counterpart of a push factor is not necessarily identified as the pull factor. The compilation of available information underlines the assumption that the decision to migrate depends on the coincidence of several unfavorable factors, based on the fact that in about 75% of the cases more than one push factor was mentioned. By means of the push–pull model, it was possible to spatially allocate and characterize destination areas and areas of origin with factors influencing migration and to illustrate these results in overview maps. In addition, Sankey diagrams appeared to be a useful tool to emphasize the outcomes of the overview maps, in particular with regard to disproving the assumption that a destination area is

characterized by the very factors that are not present in the area of origin. This approach resulted in a novel enhancement of the classical push–pull model that can be easily adapted to other study areas. By identifying factors that motivate people to migrate and allocate them to locations where out- or in-migration took place, policy and decision makers can use these insights for the compliance and achievement of certain SDGs or the targeted registration of land.

Responses to this article can be read online at:
<https://www.ecologyandsociety.org/issues/responses.php/13489>

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Data Availability:

All data used to create figures and tables are from the reviewed articles which can be found in Appendix 1 (Table A1.1). Thus, the data used in this manuscript is freely accessible to everybody referring to the published articles.

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Appendix 1

Table A1.1 Studies included in the systematic literature review.

Country	Study	Method	Main focus of interviews	Area of origin	Destination area	Migration data based on the year	Ethnic group of migrants	Migration type
Ghana	Adamtey et al. 2015	Survey (699 respondents)	reasons for migration, socio-economic well being	Yendi Municipality	Agbogbloshie (Accra)	not specified	Dagomba, Konkomba	rural to urban, internal, long-term
	Adjei-Nsiah et al. 2004	Survey (40 & 38 respondents), focus group discussion	soil fertility and land tenure issues	Upper West Region	Asuoano	not specified	Lobis, Walas and Dagabas	rural to rural, internal, permanent, annual
	Aniah et al. 2019	Survey (150 respondents), focus group discussion, key informant interviews	adaptation strategies to climate variability	Bongo District (Gowrie Kunkua and Soe Kabre)	southern Ghana (Tamale, Kumasi, Accra Kintampo)	not specified	not specified	rural to rural, rural to urban, internal, seasonal
	Antwi-Agyei and Nyantakyi-Frimpong 2021	Survey (555 respondents), stakeholder workshops, focus group discussion	socio-demographic characteristics, perceptions of climate change, access to climate information services, coping practices, migration perception and predisposition, migration impacts	Bawku West District, Kassena Nankana Municipal, Talensi District	southern Ghana	not specified	not specified	rural to rural, rural to urban, internal, seasonal, long-term
	Antwi Bosiakoh et al. 2014	Survey (96 respondents)	migration perception and predisposition, migration impacts	Nandom	Accra	not specified	not specified	rural to urban, internal, seasonal, long-term
Braimoh 2004	Survey (35 respondents), land use change analysis	socio-demographic characteristics, reasons for migration, farming technology, farm size	Tamale, Damongo, Yendi	Wuripe	1989 - 2001	not specified	rural to rural, urban to rural, internal, seasonal	

Table A1.1 (continued)

Country	Study	Method	Main focus of interviews	Area of origin	Destination area	Migration data based on the year	Ethnic group of migrants	Migration type
	Codjoe et al. 2017	Survey (350 respondents), focus group discussion	socio-demographic characteristics, experience of sea flooding in the household, migration status	Dangbe East District (Anyakpor, Ocanseykope, Ada-Foah)	Tema, Denu, Akosombo, Afram Plains, Atakpamé, international: Togo, Nigeria, Cameroon	not specified	not specified	rural to urban, internal, international, long-term
	Goldbach 2017	Survey (190 respondents)	socio-demographic characteristics, reasons for migration, migration intentions	Keta	Accra, Ho, Lomé	not specified	not specified	rural to urban, internal, international, long-term
	Marquette et al. 2002	Survey (120 respondents), focus group discussion	socio-demographic characteristics, fishing activity, fishery-related migration	Moree	Western Region, Central Region, Côte d'Ivoire (Sassandra), Benin	1990s	Fante	rural to rural, internal, international, seasonal, long-term, short-term
	Owusu-Ansah and Addai 2014	Survey (100 respondents)	socio-demographic characteristics, place of origin, motives for migration, length of stay	Regions: Upper East, Ashanti, Brong Ahafo, Upper West, Greater Accra, Western, Volta, Northern	Kumasi	2004-2014	Frafra and others	rural to urban, internal, long-term, short-term (transit)
	Rademacher-Schulz et al. 2014	Survey (158 respondents), participatory rural approaches, expert interviews	perception of rainfall variability, coping strategy to food insecurity	Nadowli District (Zupiri, Takpo, Mantari and Nanville)	Kumasi, Techiman, Tamale, Accra, Sekondi Takoradi, Afram Plains, Bolgatanga, Wa, Côte d'Ivoire, Burkina Faso	2011	not specified	rural to rural, rural to urban, internal, international seasonal

Table A1.1 (continued)

Country	Study	Method	Main focus of interviews	Area of origin	Destination area	Migration data based on the year	Ethnic group of migrants	Migration type
	Sward 2017a	Survey (60 respondents)	tenure norms and land use practices	Northern Region	Pru District	not specified	Gonja, Konkomba, Dagomba, Mamprusi, Chokossi	rural to rural, internal, long-term
	Sward 2017b	Survey (27 respondents), focus group discussion	tenure norms and land use practices	Upper East Region	Nkoranza South	after 1983 (- 2014)	Grusi, Frafra, Kusasi, Dagaba	rural to rural, internal, long-term
	Tufuor & Sato 2017	Survey (230 respondents), focus group discussion	circumstances of migrant women, motivations for migration	Tamale Metropolitan District, Savelugu-Nanton District, Tolon-Kumbungu District	Accra	not specified	Dagomba	rural to urban, internal, short-term, long-term
	van der Geest 2011	Survey (203 respondents)	reasons for migration	Nandom	Wenchi	2000	Dagara	rural to rural, internal, long-term
Burkina Faso	Barbier et al. 2009	Survey (205 respondents), focus group discussion	farmers' perceptions of climate variability and its impact	Tougou	southern part of Burkina Faso and Côte d'Ivoire	2004 / 2006, after the drought and 1970s/80s after the drought	Fulani and Mossi	rural to rural, internal, international, permanent
	Hampshire 2002	Survey (8834 respondents)	types of migration, migration motivation	Oudalan and Séno	Abidjan (Côte d'Ivoire), Ouagadougou, Bobo-Dioulasso	1994-1995	Fulani (and subgroups e.g. FulBe DjelgoBe, RiimaaiBe)	rural to urban, internal, international, seasonal

Table A1.1 (continued)

Country	Study	Method	Main focus of interviews	Area of origin	Destination area	Migration data based on the year	Ethnic group of migrants	Migration type
	Jahel et al. 2018	Survey (50 respondents), land use change analysis, population projections	development of farming and expansion strategy, annual development of the plot structure	Northern Burkina Faso, Côte d'Ivoire	Tuy Province	1970s and 80s (from Mossi Plateau), 2002-2010 from Côte d'Ivoire	not specified	rural to rural, internal, international, permanent
	West and Nébié 2019a	Survey (20 respondents), land use change analysis	land-use/land-cover change (LULCC) trends, changes in rainfall, land tenure, land-use practices, and migration	Bam	Côte d'Ivoire, Ghana, southern regions of Burkina Faso	main out-migration wave between 1975 -1996	Mossi	rural to rural, internal, international, long-term
	West and Nébié 2019b	Survey (20 respondents), land use change analysis	LULCC trends, changes in rainfall, land tenure, land-use practices, and migration	Northern parts of Burkina Faso	Sissili	main out-migration wave between 1975 -1996	Mossi, FulBe	rural to rural, internal, long-term
	Ouedraogo et al. 2009	Survey (175 respondents), land use change analysis	income generating activities from forest exploitation or agriculture, reasons for migration	Boulkiemdé, Oubritenga, Yatenga, Sanmatenga, Bam	Neboun	1976 - 2007	Mossi, Fulani	rural to rural, internal, long-term
	Ruf et al. 2015	Survey (60 respondents)	migration patterns and motivations, cocoa planting	Burkina Faso	Bayota (Côte d'Ivoire)	starting in 1970s	not specified	rural to rural, international, long-term

Table A1.1 (continued)

Country	Study	Method	Main focus of interviews	Area of origin	Destination area	Migration data based on the year	Ethnic group of migrants	Migration type
Nigeria	Ango et al. 2014	Survey (120 respondents)	socio-economic factors, reasons for migration, type of business engaged in, perceived income	Sokoto State (Wamakko, Kware, Bodinga)	Kaduna State, Kano State, Zamfara State, Niger State, Lagos State, Sokoto City, Abuja, Kebbi State	not specified	not specified	rural to urban, internal, temporary, permanent
	Dreier and Sow 2015	Survey (36 respondents), expert interviews	livelihood, their perception of climate and environmental change and personal migration experience	Northwest Benin (Dassari)	Nigeria (Saki, Abeokuta, Adjuba), Ghana, Central Benin, Côte d'Ivoire	2013	Biabala	rural to rural, internal, international, long-term, short-term
	Kamta et al. 2020	Survey (204 respondents), expert interviews	time people spent in conflict, gender, occupation, income, land ownership, access to water, previous water scarcity, previous migration	Guzamala, Gwoza, Marte, Monguno, Nganzei	Bakassi IDP Camp in Maiduguri	starting 2009	not specified	rural to urban (refugee camp), internal, type of migration is not clear
	Olaniyan and Okeke-Uzodike 2015	Survey (48 respondents)	relationship with the local host communities; and the causes of conflict; perceived consequences of the Fulani grazers' arrival in Saki	Northern Nigeria	Saki	1960s, 1990s onward	Fulani	rural to urban, internal, long-term

Appendix 2

Table A2.1 References found in ‘Web of Science’ using the terms listed in Fig. 2. prior to applying criteria for the selection of case studies. References highlighted in gray are cited in the manuscript as supporting literature.

Reference (first author, year of publication)	Title	DOI
Abu et al. 2014	Climate change and internal migration intentions in the forest-savannah transition zone of Ghana	https://doi.org/10.1007/s11111-013-0191-y
Adger et al. 2021	Perceived environmental risks and insecurity reduce future migration intentions in hazardous migration source areas	https://doi.org/10.1016/j.oneear.2020.12.009
Amare et al. 2021	Youth Migration Decisions in Sub-Saharan Africa: Satellite-Based Empirical Evidence from Nigeria	https://doi.org/10.1111/padr.12383
Antwi-Agyei et al. 2018	Adaptation opportunities and maladaptive outcomes in climate vulnerability hotspots of northern Ghana	https://doi.org/10.1016/j.crm.2017.11.003
Bassett & Turner 2007	Sudden Shift or Migratory Drift? FulBe Herd Movements to the Sudano-Guinean Region of West Africa	https://doi.org/10.1007/s10745-006-9067-4
Bukari et al. 2020	Diversity and Multiple Drivers of Pastoral Fulani Migration to Ghana	https://doi.org/10.3197/np.2020.240102
Cattaneo & Massetti 2019	Does harmful climate increase or decrease migration? Evidence from rural households in Nigeria	https://doi.org/10.1142/S2010007819500131
De Longueville et al. 2020	Comparing climate change perceptions and meteorological data in rural West Africa to improve the understanding of household decisions to migrate	https://doi.org/10.1007/s10584-020-02704-7
Guodaar et al. 2017	Using a mixed-method approach to explore the spatiality of adaptation practices of tomato farmers to climate variability in the Offinso North District, Ghana	https://doi.org/10.1080/23311886.2016.1273747
Gyimah 2006	Migration and Fertility Behavior in Sub-Saharan Africa: The Case of Ghana	not applicable
Henry et al. 2004	The Impact of Rainfall on the First Out-Migration: A Multilevel Event-History Analysis in Burkina Faso	https://doi.org/10.1023/B:POEN.0000036928.17696.e8

Table A2.1 (continued)

Reference (first author, year of publication)	Title	DOI
Ibrahim et al. 2021	Rural Migration and Relative Deprivation in Agro-Pastoral Communities Under the Threat of Cattle Rustling in Nigeria	https://doi.org/10.1177/2158244020988856
Igwe 2020	Climate Variation-Induced Migration, Land Conflicts, and Security Situation in Nigeria	https://doi.org/10.17561/tahrj.v14.5478
Kumasi et al. 2019	Small-holder farmers' climate change adaptation practices in the Upper East Region of Ghana	https://doi.org/10.1007/s10668-017-0062-2
Kwankye et al. 2009	Independent North-South Child Migration in Ghana: The Decision Making Process	not applicable
Laube et al. 2011	Smallholder adaptation to climate change: dynamics and limits in Northern Ghana	https://doi.org/10.1007/s10584-011-0199-1
Mikal et al. 2020	Domestic migration and mobile phones: A qualitative case study focused on recent migrants to Ouagadougou, Burkina Faso	https://doi.org/10.1371/journal.pone.0236248
Mukhtar et al. 2018	Boko Haram and the Geopolitics of Forced Migration in Nigeria	https://doi.org/10.32890/jis2018.14.4
Ofuoku et al. 2021	Impact of COVID-19-induced rural-rural migration on agricultural productivity in Delta State, Nigeria	http://dx.doi.org/10.17268/sci.agropecu.2021.006
Sanfo et al. 2016	Survey data on key climate and environmental drivers of farmers' migration in Burkina Faso, West Africa	https://doi.org/10.1016/j.dib.2016.11.001
Sanfo et al. 2017	Climate- and Environment-Induced Intervillage Migration in Southwestern Burkina Faso, West Africa	https://doi.org/10.1175/WCAS-D-16-0065.1
Warner et al. 2014	Where the rain falls: Evidence from 8 countries on how vulnerable households use migration to manage the risk of rainfall variability and food insecurity	https://doi.org/10.1080/17565529.2013.835707
Yendaw 2021	Cross-Border Migration of Itinerant Immigrant Retailers in Ghana	https://doi.org/10.1007/s12134-021-00839-9

Appendix 3

Table A3.1 Original wording of push factors given in respective studies;

G = Ghana, BF = Burkina Faso, N = Nigeria.

		factor	factor named in study	categorization based on	
Environmental driver	unfavorable climatic conditions	G unfavourable climatic [...] resources	Adjei-Nsiah et al. 2004	Black et al. 2011	
		recurrent droughts	Aniah et al. 2019		
		inadequate rainfall	Antwi-Agyei et al. 2021		
		harsh weather	Antwi Bosiakoh et al. 2014		
		irregular / unreliable rainfall	Braimoh 2004		
		storms	Goldbach 2017		
		high inter-annual rainfall variability	Rademacher-Schulz et al. 2014		
		poor rainfall pattern	van der Geest 2011		
		BF drought	Barbier et al. 2009		
	[...] during the dry season, [...], when rain-fed agriculture is not possible in the Sahel	Hampshire 2002			
	drought period, climatic risks	Jahel et al. 2018			
	frequent droughts	West and Nèbié 2019a			
	erratic rainfall	Ouedraogo et al. 2009			
	climate change and variability	Ruf et al. 2015			
	N change of environment	Ango et al. 2014			
	worsening weather condition; erratic rainfall	Olaniyan and Okeke-Uzodike 2015			
	poor soil & land degradation	G unfavourable [...] soil resources	Adjei-Nsiah et al. 2004		Neumann et al. 2015
		inherent poor soil fertility	Aniah et al. 2019		
declining soil fertility		Braimoh 2004			
destruction of landing sites for fishing boats as a result of inundation and high cliffs		Codjoe et al. 2017			
land infertility		van der Geest 2011			
BF saturation of land, land degradation		West and Nèbié 2019a	Black et al. 2011		
declining soil fertility		Ouedraogo et al. 2009	Neumann et al. 2015		
N dwindling grazing opportunity		Olaniyan and Okeke-Uzodike 2015	Black et al. 2011		
poor soil conditions		Dreier and Sow 2015	Neumann et al. 2015		
Economic driver	lack of economic opportunities	G lack of jobs	Adamtey et al. 2015	Black et al. 2011, Neumann et al. 2015	
		lack of jobs	Aniah et al. 2019		
		lack of employment opportunities	Antwi-Agyei et al. 2021		
		economic deprivation	Antwi Bosiakoh et al. 2014		
		changed employment to farming	Braimoh 2004		
		adverse economic conditions	Marquette et al. 2002		
		seeking jobs	Owusu-Ansah and Addai 2014		
		lack of local means to generate personal income	Tufuor & Sato 2017		

Table A3.1 (continued)

		factor	factor named in study	categorization based on	
		BF	lack of opportunities	Barbier et al. 2009	
			fewer off-farm income opportunities	West and Nébié 2019a	
			lack of economic opportunities	West and Nébié 2019b	
		N	lack of job opportunities	Ango et al. 2014	
			lack and costs of agricultural tools	Dreier and Sow 2015	
		poverty	G	poverty	Owusu-Ansah and Addai 2014
			poverty	van der Geest 2011	
		lack of available land	G	scarcity of land	Sward 2017b
			land scarcity	van der Geest 2011	
BF	scarcity of arable land		Ouedraogo et al. 2009		
		N	land in northwest Benin is very limited	Dreier and Sow 2015	
Demogr. driver	scarcity of land due to population pressure	G	scarcity of land at source of migration <i>(Author's note: due to population pressure)</i>	Braimoh 2004	
		BF	increasing land scarcity <i>(Author's note: due to population pressure)</i>	Barbier et al. 2009	
Social driver	social conflicts	G	escape outmoded cultural practices such as female genital mutilation and forced marriages	Adamtey et al. 2015	
			problems at home	Goldbach 2017	
			escaping from cultural practices	Owusu-Ansah and Addai 2014	
			divorce; widowhood; avoiding arranged marriage	Tufuor & Sato 2017	
		N	parry sorcery/ conflicts	Dreier and Sow 2015	
			natural inclination to migrate	Olaniyan and Okeke-Uzodike 2015	
Political driver	political conflicts	G	ethnic conflict	Braimoh 2004	
			disputes over customary land ownership	Sward 2017a	
		BF	conflicts (Ivory Coast)	Jahel et al. 2018	
		politico-economic unrest in the neighbouring Côte d'Ivoire	Ouedraogo et al. 2009		
			N	conflict	Kamta et al. 2020
		poor infra-structure	G	lack of education facilities	Adamtey et al. 2015
	low infrastructure development		Aniah et al. 2019		
	poor infrastructure		Antwi-Bosiakoh et al. 2014		
		N	lack of social infrastructure/facilities	Ango et al. 2014	
Food insecur.	food insecurity	G	dwindling fish harvests	Codjoe et al. 2017	
			food shortages	Rademacher-Schulz et al. 2014	
			hunger; food scarcity	van der Geest 2011	
		BF	need to produce more food	Ouedraogo et al. 2009	
		N	crop failure and famine	Ango et al. 2014	

Table A3.2 Original wording of pull factors given in respective studies;
G = Ghana, BF = Burkina Faso, N = Nigeria.

		factor	factor named in study	categorization based on
Environmental driver	better climatic conditions	G where climatic [...] resources are more favourable	Adjei-Nsiah 2004	Black et al. 2011
		reduce the effects of climate and ecological change on their livelihood	Aniah et al. 2019	
		more attractive rainfall pattern	van der Geest 2011	
		N rain fall	Dreier and Sow 2015	
		G soil resources are more favourable for food production	Adjei-Nsiah et al. 2004	
	better soils or fertile land	more fertile lands	Rademacher-Schulz et al. 2014	Neumann et al. 2015
		BF pastures are still available	Barbier et al. 2009	
		fertile valley	West and Nébié 2019b	
		seek for pasture to graze their cattle	Ouedraogo et al. 2009	
		N soil productivity; good harvest	Dreier and Sow 2015	
Economic driver	increase of income or better opportunities	G seek employment; look for resources to expand or start up business	Adamtey et al. 2015	Black et al. 2011, Neumann et al. 2015
		to work on farms to earn income and accumulate food	Aniah et al. 2019	
		work to make a living; undertake different menial jobs	Antwi-Agyei et al. 2021	
		desire to be successful, desire to support family, desire to tap opportunities in receiving areas	Antwi Bosiakoh et al. 2014	
		to increase output/make more income	Braimoh 2004	
		work	Goldbach 2017	
		avoid poverty in the off-fishing season; to make lump sum savings; lower costs of living; petrol prices	Marquette et al. 2002	
		job opportunities in the city	Owusu-Ansah and Addai 2014	
		relatively good farming prospects	Sward 2017a	
		better life; economic advancement	Tufuor & Sato 2017	
		making money	van der Geest 2011	
		BF to Côte d'Ivoire where they mainly work in Cocoa plantations	Barbier et al. 2009	
		offering greater economic opportunities	Hampshire 2002	
		better opportunities	West and Nébié 2019a	
		non-farm income generating opportunities	West and Nébié 2019b	
		need to make income	Ouedraogo et al. 2009	
		pulled by perceived future opportunities [...] to improve their livelihoods	Ruf et al. 2015	
		N search for better employment; look for money through labor; to improve livelihood welfare; to learn trade	Ango et al. 2014	
		find paid work in the agrarian sector; accumulation of money; employment; agricultural work; prosperous economic activity; means for construction; available agricultural tools; commerce; bettering of life situation	Dreier and Sow 2015	
		to engage in crop farming	Olaniyan and Okeke-Uzodike 2015	

Table A3.2 (continued)

		factor	factor named in study	categorization based on	
	available land	G	more secure land tenure	Braimoh 2004	
			availability of farmland	Sward 2017a	
			attaining relatively fertile farmland	Sward 2017b	
			abundance and fertility of land	van der Geest 2011	Parrish et al. 2020
	BF	pastures are still available; where land is still available	Barbier et al. 2009		
		available lands	Jahel et al. 2018		
		new cocoa farm; access to forest plot	Ruf et al. 2015		
	access to market	N	available soils	Dreier and Sow 2015	
		G	better exchange rates and markets	Marquette et al. 2002	
		N	need for market	Olaniyan and Okeke-Uzodike 2015	Neumann et al. 2015
Demogr. d.	lower population density	BF	[...] where population density is lower	Barbier et al. 2009	Black et al. 2011
Social driver	social network	G	marriage	Goldbach 2017	Black et al. 2011
			family reunion	Owusu-Ansah and Addai 2014	
			escape from restrictive marriage; more freedom; adventure	Tufuor & Sato 2017	
	BF	kin networks	Hampshire 2002		
	N	join family members in the city	Ango et al. 2014		
		personal development, information, networks, adventure	Dreier and Sow 2015		
education opportunities	G	access to quality education	Adamtey et al. 2015		
		desire to get good quality education	Antwi Bosiakoh et al. 2014		
		education	Goldbach 2017		
	N	further education	Ango et al. 2014		
Political driver	better infrastructure	G	good quality health care; good roads and transport; telecommunication facilities	Antwi Bosiakoh et al. 2014	Czaika and Reinprecht 2020
			harbor or safe landing place [for canoes]	Codjoe et al. 2017	
	BF	where [...] <i>tse tse</i> fly is under control	Barbier et al. 2009	Authors' decision	
	N	better transportation in the urban areas; better housing in the city	Ango et al. 2014	Czaika and Reinprecht 2020	
	relatively low transportation costs	Dreier and Sow 2015			
	safety	N	safety and availability of humanitarian assistance	Kamta et al. 2020	Black et al. 2011, Parrish et al. 2020
Food sec.	food security	N	food security	Dreier and Sow 2015	Neumann et al. 2015

Appendix 4

Fig. A4.1 Methodical overview of generating Sankey diagrams.

- a) allocation of pull factors mentioned in the combination with push factors. The light blue box shows how a multiple counting of the pull factors occurs. In this example, within the case study Adjei-Nsiah et al. 2004, ‘better climatic conditions’ and ‘better soils or fertile land’ as pull factors were named together with ‘unfavorable climatic conditions’ as well as with ‘poor soil or land degradation’.
- b) Illustration of how the assignment of the pull factors results in the pivot table, which serves as basis for the Sankey diagram.

a) Allocation

Pull factors named in connection with the respective push

Case Study	push factor	pull factor		
Adjei-Nsiah et al. 2004	unfavorable climatic conditions	better climatic conditions	better soils or fertile land	
Aniah et al. 2019	unfavorable climatic conditions	better climatic conditions	increase of income or better opportunities	
Antwi-Agyei and Nyantakyi-Frimpong 2021	unfavorable climatic conditions	increase of income or better opportunities		
Antwi Bosiakoh et al. 2014	unfavorable climatic conditions	increase of income or better opportunities	education opportunities	better infrastructure
Braimoh 2004	unfavorable climatic conditions	increase of income or better opportunities	available land	
Goldbach 2017	unfavorable climatic conditions	increase of income or better opportunities	social networks	education opportunities
Rademacher-Schulz 2014	unfavorable climatic conditions	better soils or fertile land		
Adjei-Nsiah 2004	poor soil or land degradation	better climatic conditions	better soils or fertile land	
Braimoh, 2004	poor soil or land degradation	increase of income or better opportunities	available land	

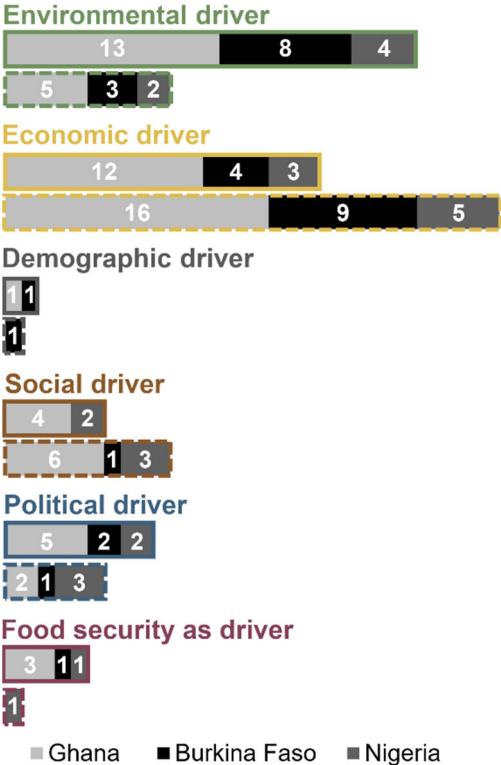
b) Matrix

Pivot table as basis for Sankey diagram

push factor	pull factor									sum = number in Sankey diagram
	better climatic conditions	better soils or fertile land	increase of income or better opportunities	available land	access to market	education opportunities	social networks	better infrastructure	food security	
unfavorable climatic conditions	3	2	6	2		2	1	1		17
poor soil or land degradation	3	1	3	2				1		10
lack of economic opportunities	1		8	1	1	2	2	1		16
lack of available land	1		1	2						4
poverty	1		2	1			1			5
land scarcity due to pop. pressure			1	1						2
social conflicts			4			1	3			8
political conflicts			2	2						4
poor infrastructure	1		3			2		1		7
food insecurity	1	1	1	1				1		5
sum = number in Sankey diagram	11	4	31	12	1	7	7	5	0	

Appendix 5

Fig. A5.1 Aggregated push and pull factors by number of studies, categorized by drivers of migration and by country. Solid frame indicates push factors, dashed frame indicates pull factors.



Appendix 6

Fig. A6.1 Alternative Sankey diagram showing the interconnections of push and pull factors for Ghana, Burkina Faso and Nigeria, with 'infrastructure' being classified as an economic driver.

Numbers in the left-sided boxes reflect how many pull factors are named in the context of the respective push factors. Numbers on the right-hand side reflect the number of push factors that are named in the context of the respective pull factors. Colors of the boxes show the same driver categories. Colors of the lines reflect the category of push factors.

