



TREND IN CLIMATE CHANGE-INDUCED MIGRATION: A BIBLIOMETRIC ANALYSIS

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**Abstract**

Literature argues that numerous climatic factors contribute to migration decisions. To understand the complex interplay between climate change impacts and migration-decision, we need to analyse how the factors affect the said decision. This bibliometric review aims to analyse the climate change and migration literature and assess future research opportunities for exploring climate-induced migration. This review considers 4658 documents extracted from Scopus by performing a search with the words 'migration', 'climate change', 'climatic hazard' and 'coastal region' covering journal articles, review papers, book chapters, books, and conference papers from 2011 to 2020. This study applied VOSViewer for analysis. Results reveal that climate change is a dominant driver of migration, and the literature is deeply rooted in the United States and the United Kingdom. The lexical network shows that the developed countries which are less vulnerable to climatic hazards produce more co-authored documents. Furthermore, in the migration discourse, the co-authors from developed countries have strong ties exhibiting migration and climate change research, mainly concentrated among the collaborative framework of developed countries' researchers. Therefore, more research on migration and climate change issues in collaboration with the global south and north is highly demanding, providing further insights into the existing research arena.

**Keywords:** Migration; Climate Change; Environmental Hazard; Coastal Region; Lexical Network; VOSViewer

**Introduction**

Because of its dynamism, migration discourses are significantly rising, which are also complex in nature (Black et al., 2011). In migration discourses, climate change issues appear predominantly because people often choose migration as an adaptation strategy (McAdam, 2012; Farbotko & Lazrus, 2012; Bettini, 2013; Black et al., 2011). Researchers around the globe are contributing with their knowledge, expertise, skills, and experiences to produce scientific papers on climate change and migration. The international communities, including policymakers and researchers, are now tossing light on the migration and climate change nexus to make more effective policies; however, the knowledge is still fragmented (Piguët et al., 2011). The literature argues that climate change effects such as sea-level rise often produce climate refugees (Farbotko & Lazrus, 2012; Hauer, 2017; McLeman, 2014). Migration-induced human resettlement may happen due to climate change which is often treated as a push factor (Piguët et al., 2011). In contrast, migration contributes to adaption from climatic vulnerabilities and enhances social networking through the transfer of knowledge, technology, remittances, and so on (Scheffran et al., 2014). However, the maximum migration fluxes are caused by climate change combined with socio-political governance issues (Black et al., 2011). Nevertheless, migration decisions or relocation planning are also intertwined with multidimensional vulnerabilities, including climate change, which increases social costs (Marino, 2012). However, due to climatic hazards, migration decision is usually preferred by the male person from the household (Djoudi & Brockhaus, 2011). In some studies, climate change effects are treated as environmental stressors. Hence, to increase resilience, households undertake migration decisions as an adaptive strategy (Lu et al., 2016; Kartiki, 2011).

The least-developed countries (LDCs), such as Bangladesh, Bhutan, Nepal, and Cambodia are the worst victims of climatic hazards (Miyan, 2015; Hassani-Mahmooei & Parris, 2012). The literature argues that in Bangladesh, climate change-induced migration mainly occurs from the areas which are environmentally more stressed (Lu et al., 2016). It is predicted that in the subsequent 40 years, due to climatic hazards like droughts, cyclones, and floods, around three to forty million people will migrate from the vulnerable climatic zones of Bangladesh (Hassani-Mahmooei & Parris, 2012). To avoid adverse climatic shocks, the households of Bangladesh often choose migration as a non-farming

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adaptation strategy (Alam et al., 2017). Likewise, as an adaptation strategy, people from other extremely climatic vulnerable countries such as Sudan and Guinea also choose rural-urban migration (Dumenu & Obeng, 2016).

The literature on migration and climate change dynamics focuses on multidimensional issues where researchers collaboratively share their knowledge and expertise. While exploring the literature, it is found that there exist numerous review papers either on climate change or on migration still, there remains a dearth of Bibliometric analysis that deals with the nexus between climate change and migration. Considering the research gap, this paper aims to analyse the literature on migration and climate change and examine how climate change effects are connected with migration decisions. In addition, this paper aims to assess future research options for exploring climate change issues in migration.

## Materials and Methods

### *Data*

The bibliometric analysis considers databases from different sources, including PubMed, Scopus, WoS, and Google Scholar (Biswas et al., 2021). However, due to the inaccessibility to the database, this paper does not explore the WoS database, therefore, it only considers the Scopus database. A total of 5846 documents were initially retrieved using advanced search queries from the online source Scopus. After cleaning up the duplicate documents (1188), the final database covers 4658 documents. For excluding the duplicate copies of documents, manual screening and excluding methods were adopted using Excel. The database was retrieved from the source on December 21, 2021, considering the period 2011-2020. For inclusion, only journal articles, books, book chapters, review papers, and conference papers are considered from the social science subject area. Among all the documents, book chapters and review papers hold the second and third highest positions in terms of citation count, respectively. The advanced search includes words such as 'migration' and 'climate change' in the keywords, title, abstract and main body. While including the keywords, some other keywords, such as climatic hazard, coastal region, and environmental hazards, are also considered. Because migration may also happen due to environmental and climatic hazards. Moreover, the coastal zone is highly prone to climatic and environmental hazards, pushing people to migrate. All published documents written in English are the only language criteria for inclusion. For extracting data from the online resource Scopus, the advanced search query using the Boolean approach is adopted in this study. The search query includes the keywords migration, reason, decision, climate change, climatic hazard, environmental hazard, and coastal region.

### *Data processing and analytical tools*

This bibliometric analysis uses Excel for temporal network analysis, for example, the number of documents, citations *per* author, citations *per* document, and graphical analysis. In addition, for spatial and lexical network analysis, VOSViewer software (Version 1.6.17) is adopted in this study. In general, bibliometric research combines both quantitative and statistical analyses to analyse journal articles and count citations (Della Corte et al., 2019). Researchers are now also adopting the R package for quantitative data analysis in bibliometric analysis (Priovashini & Mallick, 2021, Zhang et al., 2019; Maretti et al., 2019). Bibliometric analysis is an effective tool to visualize the connections between authors and countries, keywords, and so on (Priovashini & Mallick, 2021). This analysis provides a detailed statistical overview, visualizes the networks, and provides a detailed description of the existing scientific database. VOSViewer software is applied in this study to portray spatial network analysis and lexical network analysis. Using Microsoft excel, descriptive statistics have been produced. In this study, the annual production of documents *per* year (Figure 1) in the social science subject area is considered for temporal analysis. In the second stage, the source network is constructed using the most cited papers on climate change and migration (Table 2). Likewise, the prominent top sources of documents ( $\geq 21$  documents) have been sorted out, which is indicated in Table 3. After that, a list of top contributing authors who commonly research climate change and migration issues (Table 4) has been identified based on the number of documents produced. Later, a spatial network analysis using a graphical presentation (Figure 2) was carried out considering co-authorship of the country ( $\geq 11$  documents per country). In addition, the lexical network analysis of this study consists of co-occurrences of all keywords ( $\geq 20$  co-occurrences) represented in Figure 3. This paper also focuses on Bangladesh as a keyword in climate change and migration research (Figure 4).

## Results and Discussion

### *Summary statistics*

The descriptive analysis (Table 1) suggests that in the last decade, a growing number of documents (4658) has been produced, which consists of journal articles (3569), books (174), book chapters (547), review papers (243) and

conference papers (125). If the average citation *per* year is considered, then the documents received around 5,632 citations, whereas, *per* document, the average citation is around 12. Besides, the average document number of citations each year is around 1.21. There were 20 subject areas where climate change and migration issues were analysed; however, this study includes only social science as a subject area. A total of 14,872 keywords were used in the existing literature, where 3,989 are the author's keywords, i.e., authors who specially worked in the field of migration and climate change. Among 4,658 documents, single-authored and multiple-authored documents are 2,004 and 2,654, respectively. In terms of document production, each of the authors contributed around 1.17 documents. In contrast, the authors *per* document are around 0.86. In migration and climate change issues, 160 organizations sponsored the researchers to explore knowledge. The authors contributing to climate change and migration research are affiliated with a total of 152 universities or organizations and the contribution of those organizations is enormous.

Table 1. Summary statistics of the concerned documents (Scopus database, timespan: 2011-2020)

Description	Data	Description	Data
Timespan	2011-2020	Subject area	20
Documents	4,658	Indexed keywords	6,684
Journal articles	3,569	Total keywords	14,872
Book chapter	547	Authors	3,989
Review papers	243	Single authored documents	2,004
Book	174	Multiple authored documents	2,654
Conference paper	125	Documents per author	1.17
Yearly average citation	5,632	Authors per document	0.86
Per document average citations	12.08	Funding sponsor organization	160
Per document average citations each year	1.21	Affiliated University/organization	152

**Temporal network analysis - Trend of annual document production**

Considering the yearly production of scientific documents using the time period 2011-2020, it is observed that there is an increasing trend of document production starting from 2011 to 2017 (Figure 1).

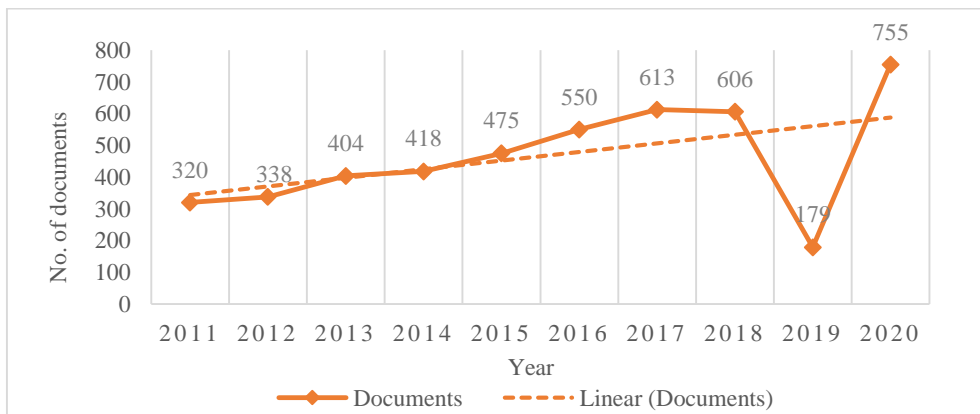


Figure 1. Trend of document production (Scopus database, timespan: 2011-2020)

The declining trend of document production started in 2018 when the annual production of scientific papers declined by seven documents compared to 2017. However, in 2019, the annual production of scientific documents dropped significantly by 427. It might happen due to congestion in the review process which means the reviewers might not give feedback in due time. It is found that the most contributing sources, such as International Migration, Journal of Ethnic and Migration Studies, Population, Space and Place, and Quaternary Science Reviews produced very

few pieces of documents in that specific year. During this year, the focus of the journals might be on keywords other than migration and climate change issues. Surprisingly, in 2020, the production of documents regained its increasing tendency, and this year, 755 scientific papers were added to the existing literature. Researchers are currently working more within the collaborative framework than before hence, the blending of ideas and knowledge across and within the countries is contributing more to document production.

**Source Network analysis**

**Top 12 papers with the authors, source, and document type**

In this analysis, the papers on climate change and migration cited at least 200 times, are considered (Table 2). The top 10 cited papers were produced within the timeframe of 2011 and 2016. Table 2 demonstrates that the author of the most cited paper is contributed by Black et al. (2011), cited 485 times and published by the Global Environmental Change journal. The paper mainly explored human migration due to environmental change. The second and third most cited papers are contributed by Moreton-Robinson (2015) and Lapola et al. (2014), respectively. A paper on climate refugees (Farbotko & Lazrus, 2012) also attracts the researchers' attraction, therefore, cited 281 times. The top 10 most cited papers that have more than 200 citations were the first three documents combined with articles, books and review papers. It indicates that in migration and climate change issues, different documents like articles, books, and review papers have an almost similar level of contribution to scientific paper production.

Table 2. Top 10 papers based on citation (citations ≥ 200) on climate change and migration (Scopus database, timespan: 2011-2020)

Rank	Author (year)	Title	Document type	Source	*TC
1.	Black et al. (2011)	The effect of environmental change on human migration	Article	Global Environmental Change	485
2.	Moreton-Robinson (2015)	The white possessive: property, power, and indigenous sovereignty	Book	University of Minnesota Press	389
3.	Lapola et al. (2014)	Pervasive transition of the Brazilian land-use system	Review	Nature Climate Change	318
4.	Farbotko and Lazrus (2012)	The first climate refugees? Contesting global narratives of climate change in Tuvalu	Article	Global Environmental Change	281
5.	Hazen et al. (2013)	Predicted habitat shifts of Pacific top predators in a changing climate	Article	Nature Climate Change	279
6.	Li et al. (2014)	Community-based rural residential land consolidation and allocation can help to revitalize hollowed villages in traditional agricultural areas of China: Evidence from Dancheng County, Henan Province	Article	Land Use Policy	220
7.	Gray and Mueller (2012)	Drought and Population Mobility in Rural Ethiopia	Article	World Development	215
8.	Giles-Corti et al. (2013)	The influence of urban design on neighbourhood walking following residential relocation: Longitudinal results from the RESIDE study	Article	Social Science and Medicine	208
9.	Hauer et al. (2016)	Millions projected to be at risk from sea-level rise in the continental United States	Article	Nature Climate Change	206
10.	Weiner (2015)	Sons of the soil: Migration and ethnic conflict in India	Book	Princeton University Press	202

\*TC indicates total citations

These documents cover human migration, climate change, environmental change, climate refugees, ethnic conflict, and so on. In the top-cited papers, divergent countries are concerned notably, Brazil (Lapola et al., 2014), China (Li et al., 2014), and India (Weiner, 2015). If the contribution of the journals is in producing top-cited papers, the journal Global Environmental Change contributes two most cited papers (total citations: 485 and 281, respectively). Also, Nature Climate Change has produced five top-cited papers (total citations: 318, 279, and 206, respectively).

**Prominent Sources of documents**

Table 3 demonstrates the prominent sources of documents, i.e., the top 10 journals which have produced at least 29 scientific papers. Considering the total production of documents, the top journal that appears on the list is international migration (91 documents). In migration research, climate change is a dominant keyword (Figure 3), which may produce more documents in international migration journals. With the highest number of documents, the journal could not secure the top position in the citation count (citations: 1316; citation *per* paper: 14.46). In contrast, with a comparatively smaller number of documents, the Global Environmental Change (IF: 9.523) journal ranks top position in the list in terms of citation count (2435) where citations *per* paper are 62.436. Similarly, the World Development journal produced 32 scientific papers, yet the citation score is 2254 (citations *per* paper: 70.438, IF: 5.278). One of the notable journals in this list is Quaternary Science Reviews which produced 51 scientific papers (citations: 1630; citations *per* paper: 31.961).

Table 3. Prominent sources of documents (journals which have produced documents  $\geq 29$ ) (Scopus database, timespan: 2011-2020)

Rank	Name of Journal	*TP	**TC	Citations/paper	IF** (2020)
1.	International Migration	91	1,316	14.46	1.95
2.	Journal of Ethnic and Migration Studies	79	1,606	20.33	1.51
3.	Population, Space and Place	79	1,835	23.23	3.81
4.	Quaternary Science Reviews	51	1,630	31.96	3.96
5.	Population and Environment	43	924	21.49	2.85
6.	Global Environmental Change	39	2,435	62.47	9.53
7.	Journal of International Migration and Integration	38	254	6.68	1.31
8.	World Development	32	2,254	70.44	5.28
9.	Social Science and Medicine	30	1,267	42.23	4.64
10.	Geoforum	29	667	23	3.91

Note: \*TP implies Total production; \*\*TC indicates total citation; \*\*IF implies impact factor

**Authors who commonly work on climate change and migration issues**

Table 4 demonstrates ten dominant authors who produced at least eight papers on the issues of climate change and migration in the corresponding decade. Some authors prefer to produce single-authored papers, whereas other authors prefer to work jointly with different intuitions, universities, and countries. As an author and co-author, Liu appears 16 times (single-authored paper is 1, and 15 are collaborative). Shen commonly worked with Liu (4 papers) among the co-authors. The authors' papers are cited 649 times until accessing the database from Scopus online source. The next top author is Kelman, who has produced 12 scientific papers (single-authored: 4; multiple-authored: 8) and got 191 citations. However, the author produced the articles and chapters with divergent research groups. In contrast, Baldwin (Durham University, UK) contributed 10 ten articles, books, and book chapters. The database provides interesting information about the working nature of the author. The author contributed mainly as a single author (7 papers). Likewise, Warner (United Nations University Institute for Environment and Human Security) has produced nine scientific papers (single-authored papers 4). In contrast, some of the top authors preferably work only within the collaborative framework, such as Black, Gray, Hunter, and Mckenzie.

Table 4. Authors who commonly research climate change and migration issues (Scopus database, timespan: 2011-2020)

Rank	Author's Name	TP*	Percentage (%)	SAP**	MAP***	TC****
1.	Liu, Y.	16	16.84	1	15	649
2.	Kelman, I.	12	12.63	4	8	191
3.	Baldwin, A.	10	10.53	7	3	215
4.	Warner, K.	9	9.47	4	5	363
5.	Black, R.	8	8.42	0	8	939
6.	Gray, C.	8	8.42	0	8	431
7.	Hunter, L.M.	8	8.42	0	8	369
8.	Mckenzie, D.	8	8.42	0	8	427
9.	Mcleman, R.	8	8.42	3	5	166
10	Mcnamara, K.E.	8	8.42	0	8	143
		<b>Total =95</b>	<b>100%</b>	<b>19</b>	<b>76</b>	<b>3,893</b>

Note: \*TP indicates Total publication; \*\*SAP designates Single Authored Paper; \*\*\*MAP means Multiple Authored Paper; and \*\*\*\*TC means Total Citations

### Spatial Network Analysis - Co-authorship network analysis

In this co-authorship network analysis of the countries, among 150 countries, 46 met the threshold level (documents  $\geq 20$  per country). The network visualization indicates the strongest collaboration with the United States, the United Kingdom, Germany, Australia, and Canada. The United States is also performing as a top scientific paper-producing country on environmental drivers (Priovashini & Mallick, 2020). Behind the leading position of the USA, different Universities, notably the University of Sussex (358), University of California (28), Arizona State University (24), Pennsylvania State University (20), and University of Florida (17), played a significant role in this respect. From Figure 2, it is observed that the climate change issue in migration research is concentrated mainly in the developed world, and there is a limited contribution from developing and undeveloped countries. For example, the link strength of the United States with the United Kingdom, Germany, and Canada are 51, 39, and 29, respectively. However, the strength of the links between the United States and Bangladesh is only 9. This collaboration may happen due to the existence of higher funding opportunities, institutional support, language efficiency, heightened knowledge level, and technical expertise of the authors. In contrast, these countries have limited experience in facing climatic vulnerabilities and shocks compared to the highly climatic vulnerable countries. The global north-north collaboration sometimes marginalized the least developed countries like Bangladesh, Nepal, Vietnam, Cambodia, and henceforth. In addition, researchers from the least developed countries usually get less access to resources, which may also be responsible for the lower productivity of scientific documents. Hence, for more effective and policy-oriented research, the heightened connection between climatically vulnerable countries and climatic well-off countries is highly recommended.

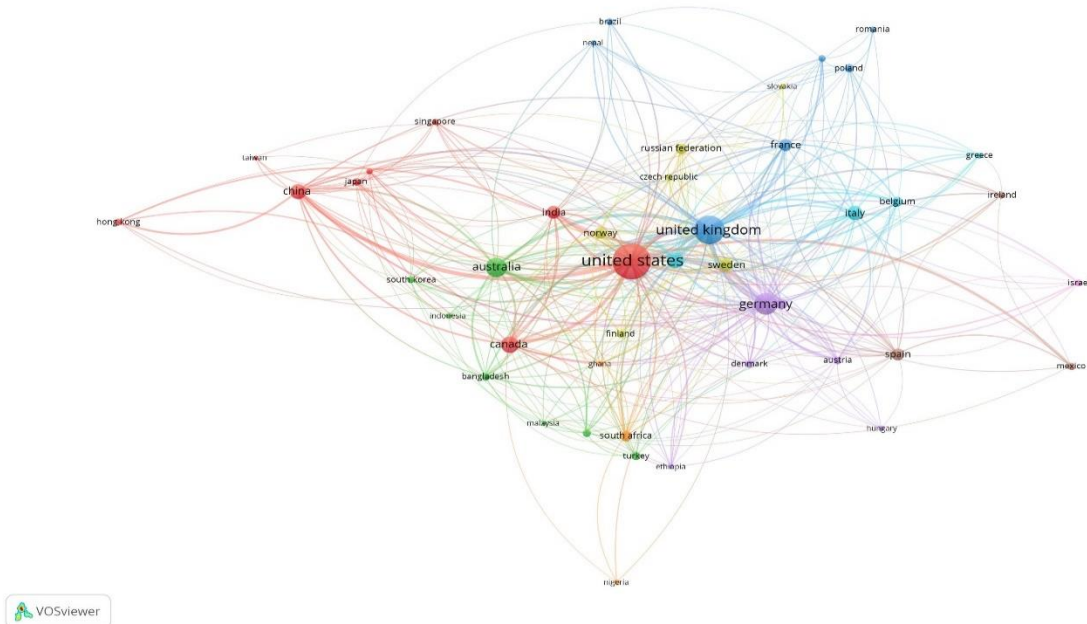


Figure 2. Co-authorship network of the countries (minimum  $\geq 20$  occurrences per country) (Scopus database, timespan: 2011-2020)

### Lexical network analysis - Co-occurrences of all keywords

Keywords reflect the main themes and explain the contents, which help to get an overall idea of any research paper (Zhang et al., 2019; Lina et al., 2020). Hence, network analysis using visualizing software provides a synopsis of keywords used in the literature. Among all the keywords (14872), 655 meet the minimum threshold level (minimum co-occurrence number  $\geq 20$ ). The keywords with the maximum link are selected for graphical presentation. Each of the clusters represents different dimensions and determinants of migration. The networking graphic represents the co-occurrence of the keywords, makes links, and shows the strength of the links among the keywords (Biswas et al., 2021). The greater number of nodes demonstrates the greater the number of keywords available in the concerned field of interest (Lina et al., 2020; Biswas et al., 2021). The links between keywords indicate that the corresponding nodes are used jointly in an identical document (Biswas et al., 2021; Lina et al., 2020; Zhang et al., 2019). The terminology 'migration' is found strongly linked with the keywords such as climate change, vulnerabilities, China, adaption, and so on (Figure 3). From the co-occurrences of all the keywords, migration and climate change dimensions are found dominant. Keyword migration (1351) is strongly connection with the keywords such as climate change (662), international migration, labour migration, decision making, and so on, whereas, climate change is also connected with migration, international migration, population migration, human and henceforth. As a keyword, Bangladesh (77) remains far behind the United States (206), China (178), the United Kingdom (120), Australia (92), and India (91). However, as one of the most climate-vulnerable countries, the researchers on migration and climate change issues should focus more on Bangladesh and other climate-vulnerable countries. In this regard, collaboration with global north and developing countries can generate deeper insights and contribute to effective policy formulation. The co-occurrence of all keywords is concentrated between migration and climate change issues which are expected. This result is also aligned with the findings of Priovashini & Mallick (2020). These two keywords are treated as cause and effect (McAdam, 2012, Hauer & Mishra, 2016; Farbotko & Lazrus, 2012; Bettini, 2013). The literature argues that due to climate change, sea-level rise is a stressor that is also causing displacement of human settlement (Hauer & Mishra, 2016; Black et al., 2011). In Brazil, climate change from the local and international levels, greenhouse gas emissions, deforestation, and agriculture are highly connected. These linkages act as a push factor for rural-urban migration (Lapola et al., 2014). Similarly, Farbotko & Lazrus (2012) also identified sea-level rise as the effect of climate change



## Conclusion

Climate change issues are significantly dominating in migration research, especially sea-level rise, drought, and flood. The lexical network suggests that climate change predominantly affects human migration, and the authors from different backgrounds also focused on these two issues intensively. These research areas are given priority by the developed countries' authors and affiliated organizations. They are producing more scientific papers and hiking the total number of citations. In the decade (2011-2020), the United States and the United Kingdom produced many scientific papers where strong networks are predominantly exhibited among developed countries. The United States and the United Kingdom lead the document production hence, total citations are also higher for those countries. More collaboration is extremely demanding to lessen the gaps in scientific research among the developed and least developed countries. A blending of theoretical and imperial analysis from different countries' perspectives can also add value to the existing literature. If the leading countries collaborate with the climatically vulnerable countries, then ideas, thoughts, knowledge, skills, and expertise will be exchanged among the countries which will bring more effective outcomes at the policy level. In addition, the less paper-producing countries should focus on producing more scientific papers and increase their excellence in scientific research arenas. Moreover, researchers from developing countries usually get less/no access to extract databases, funding, and online resources. These may also act as barriers to document production. In this respect, access to different journals, funding and online sources can support the researchers of the global south. Further study options are available using content analysis to examine the drivers of migration, environmental stressors, and socio-economic and political determinants.

## Conflict of Interest

The authors declare no conflict of interest.

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