

# Climate change, slow onset events and human mobility: reviewing the evidence

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This article synthesizes recent empirical literature on human mobility linked to slow-onset impacts of climate change. Through a review of the CLIMIG database from 2015 to 2020, it assesses the state of knowledge on human mobility related to slow onset events by distilling peer-reviewed articles across world regions, with particular attention given to developing country contexts. On top of providing an anatomy of the field including a geography of current studies, the methods employed, and the types of migration addressed, it explores findings as they converge and diverge across the sample relating migration as an adaptation strategy. It demonstrates the importance of context and the difficulty of presenting a singular narrative or global conclusions regarding the impact of slow onset events on human mobility dynamics, before submitting recommendations for future research.

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## Introduction

The mounting scholarship on the impact of climate change on human mobility shows a relationship that is complex and contextual: a constellation of factors and local features affect the mobility decision, its trajectory, and its consequences, as does the hazard itself [1,2]. The type of hazard and the speed with which it occurs shape human mobility responses in terms of agency, temporality, and space. Typically, hazards are divided into two broad categories according to the speed with which they occur: sudden or rapid onset events (such as floods or

storms) and more gradual changes or slow onset events (such as coastal erosion or drought).

In 2009, Lazcko and Azargham noted an imbalance in knowledge on climate change and human mobility, calling for a greater focus on slow-onset changes. Still today, rapid-onset events capture the majority of public attention, accompanied by staggering figures: in 2019 alone, nearly 25 million people were forced to flee floods, storms and other natural catastrophes [3].<sup>1</sup> While incredibly powerful, such figures do not account for slower, more gradual changes, which may, in fact, have a much greater impact on the movement of people but receive less attention [2,4,5].

Following previous studies that have reviewed the field of climate and migration at large up to 2016 [6<sup>\*</sup>], in specific regions [7,8], or the use of certain concepts [9], the present article reviews recent empirical literature on slow onset events and human mobility. Assessing the evidence since 2015 to reflect the most recent findings, it provides a brief anatomy of the field in terms of current research geographies, methodological approaches, temporal and spatial patterns of movement, and the character of those movements. The following section describes the methodological approach of the study, before presenting trends found across 101 empirical studies. Subsequently, it highlights spatio-temporal mobility dynamics, using diverse but salient examples of consensus and debate in the field. Finally, it explores the migration-as-adaptation discourse, its evidential strengths and weaknesses. Based on the findings, it concludes by identifying critical gaps and directions for future research.

## Methods

The study relies on a rapid review assessment. Systematic reviews are a useful tool to synthesize evidence, but they are time consuming owing to the high level of methodological rigor, human resources and skill required [10,11]. Rapid reviews present a viable alternative, streamlining traditional systematic review methods and have been successfully deployed in migration studies [8,12]. The evidentiary base comes from the CLIMIG portal,<sup>2</sup> a comprehensive bibliographic database specifically dedicated to compiling peer-reviewed scientific publications connecting migration, environment, and climate change.

<sup>1</sup> It should be noted that IDMC has begun including some drought displacement statistics in their annual GRID report.

<sup>2</sup> <https://climig.com/>.

Helmed by the University of Neuchâtel, it systematically tracks new publications in scientific journals, books, and reports according to a set of strict guidelines (see Ref. [6\*] for a detailed description of the scope of the database as well as search and maintenance methods).<sup>3</sup> The database now holds some 1412 publications<sup>4</sup> related to environmental change and human mobility.

The methodological process started by asking, ‘How do slow onset events affect human mobility?’ CLIMIG tags articles using six hazard keywords that include two broad categories of slow onset events: Sea Level Rise (SLR) and Drought. However, this study expands slow-onset types to include all those identified by the UN Framework Convention for Climate Change (UNFCCC).<sup>5</sup> Accordingly, I combed CLIMIG using my own larger series of truncated keywords<sup>6</sup> related to slow onset events such as sea level rise, drought and desertification, biodiversity loss, glacial retreat, land and forest degradation, and climate variability. Results were then filtered to only include English-language publications and to include publications since 2015. I excluded studies not of an empirical nature (e.g. literature reviews and conceptual pieces). Only peer-reviewed journal articles were kept for feasibility and were checked for quality, although CLIMIG follows IPCC guidelines. After the screening process, 101 empirical case study articles were identified and analyzed related to slow onset events and human mobility between 2015 and 2020 (see Figure 1).<sup>7</sup> Each entry’s abstract, keywords, and main text were then individually reviewed. I manually coded entries regarding hazard type (s), methods, study area, type of migration (temporal, geographical, geopolitical), key concepts, and findings (see appendix for a summary table).

## Anatomy of the field

### Methods deployed

In order to have a better picture of recent scholarship on slow onset events as they relate to human mobility, one

<sup>3</sup> Its robustness, confirmed by tests made in comparison with searches on SCOPUS and the ISI Web of Science, and focus on the nexus of climate change and migration makes it an ideal database to examine the most recent evolutions in the field [6\*,7].

<sup>4</sup> As of March 2020.

<sup>5</sup> <https://unfccc.int/process/bodies/constituted-bodies/executive-committee-of-the-warsaw-international-mechanism-for-loss-and-damage-wim-excom/areas-of-work/slow-onset-events>.

<sup>6</sup> The CLIMIG database codes for two broad categories of slow-onset: Sea Level Rise (SLR) and Drought. Each of these codes encompasses an array of hazards, for example, coastal erosion, salinisation and rainfall within SLR and temperature, desertification and heat waves within drought. I additionally searched CLIMIG for other related hazard and impact types associated with slow onset events including biodiversity loss (biodiv\*), glacial retreat (glaci\*), erosion (erosi\*), land and forest degradation (degrad\*, deforest\*), salinisation (salin\*), and climate variability (variabil\*), rainfall (rainfall, precipit\*), temperature\*, permafrost thaw (permaf\*), ocean acidification (acidi\*).

<sup>7</sup> Endnote, Zotero, and spreadsheet software were used for compilation and analysis.

should understand *how* data is being generated and analysed. First, I discern between quantitative studies, qualitative studies, and mixed method studies. If we consider that publications may use more than one type of method, 74 papers used quantitative methods, compared to 46 papers using qualitative methods.<sup>8</sup> Answering the need for more mixed-methods approaches, 24 studies used both quantitative and qualitative methods, or nearly 24% [13].

The initial coding of methods by quantitative and qualitative types and specific methods (e.g. interviews, surveys) was then cross-referenced and broken down according to the keywords of the CLIMIG database.<sup>9</sup> CLIMIG follows a six-part typology of methods, presented in Table 1 [14].

Using the CLIMIG codes for methodological types, in Figure 2,<sup>10</sup> the most frequently used methods were qualitative case studies, small scale questionnaires, and large-scale surveys. Surveys are nearly equal to qualitative case studies, reflecting a growing trend compared to previous research [6\*,14].

### Geography of case studies

According to recent literature, where are slow onset events most affecting human mobility? To be clear, it is not possible to determine if *more* migration or displacement is occurring in one continent or country than in others. It is only able to show where these links are currently being studied. Reflective of the trends in general and before 2015 [6\*], empirical studies have overwhelmingly been conducted in developing countries in the Global South ( $n = 83$ ), or 82% of the sample. Studies on international migration from countries in the Global South to countries in the Global North are a distant second ( $n = 11$ ), followed by those focused exclusively on the Global North ( $n = 4$ ), and lastly macro studies that examined global datasets without regard for a specific country of origin or destination ( $n = 3$ ). The geographical representation overwhelmingly favors Asia, with 56 studies (Figure 3).<sup>11</sup> The number one sub-region was South

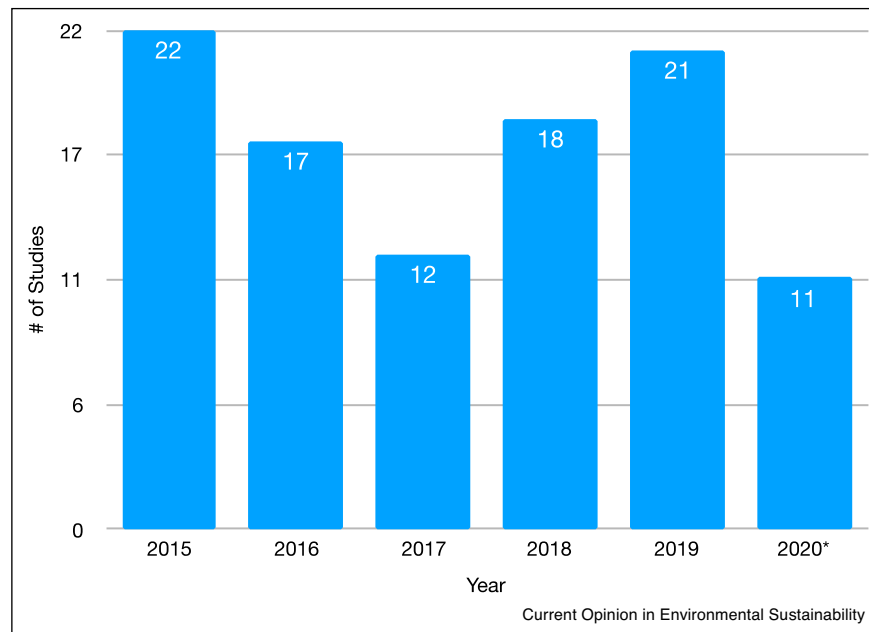
<sup>8</sup> Piguet *et al.* [6] reviewed all case studies in the Climig database until the end of 2016 and found that 32% of their sample included qualitative methods.

<sup>9</sup> However, in the process of analysis, we noted 19 entries deemed empirical studies by the author that were not assigned Type keywords in CLIMIG. These were doublechecked, and assigned a code according to the six-part typology or removed. For these studies and the studies for which Types assigned by author and Types assigned by CLIMIG differed, the author discussed with the developers of the database.

<sup>10</sup> Ten studies were assigned multiple Types in the CLIMIG database by its developers or by the author. Our methodological keywords included more mixed methods studies owing to our consideration of small-scale surveys and interviews as different methods, for example.

<sup>11</sup> As several studies included multiple origin points, either in multi-case or comparative studies, case study location figures are greater than the number of articles.

Figure 1



Number of empirical case studies by year, 2015–2020.  
Source: Author's elaboration.

Table 1

## Method keywords in CLIMIG database

|        |   |
|--------|---|
| Type 1 | Ecological models based on area characteristics (spatial analysis)                              |
| Type 2 | Multilevel analysis based on area and individual characteristics                                |
| Type 3 | Analysis of individual data based on large sample surveys (>100)                                |
| Type 4 | Historical analogues  |
| Type 5 | Indexes of vulnerability, hotspots identification, scenarios, regional case studies, and so on. |
| Type 6 | Qualitative field case studies using ethnographic methods and small sample questionnaires       |

Asia ( $n = 32$ ). Top countries of empirical research were Bangladesh ( $n = 17$ ), followed by India (9).

In the second position, 28 empirical case studies were published on African countries since 2015.<sup>12</sup> North American studies followed ( $n = 11$ ), then South and Central America ( $n = 6$ ).<sup>13</sup> However, as only English language studies were included, a wider linguistic scope could to some extent alter this distribution.

<sup>12</sup> For more information, see the systematic review of environmental migration studies in Africa up to May 2017 conducted by Borderon *et al.* [7].

<sup>13</sup> Australia only appeared as a destination site and ( $n = 1$ ) and, therefore, does not appear in the continental breakdown

## Hazard type

This study concentrates on slow onset events, but without dismissing their collision with rapid onset events in multi-risk scenarios (e.g. SLR and cyclones in Bangladesh), and the impacts of slow onset events (e.g. coastal flooding caused by sea-level rise). To this end, I included those studies that captured both slow and sudden changes.

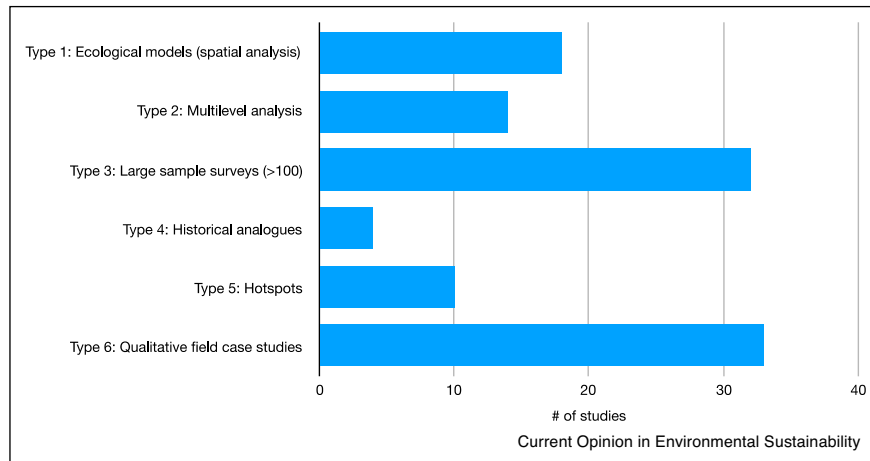
In Figure 4, hazards are grouped into six types<sup>14</sup> climate variability (including variations in temperature and rainfall), drought and desertification, sea level rise (including coastal erosion and soil salinization), riverbank erosion, biodiversity loss, and permafrost thaw.<sup>15</sup>

The most referenced type of hazard was climate variability, followed by drought and desertification, and sea level rise. Climate variability studies tend to examine spatio-temporal variability in temperature and precipitation

<sup>14</sup> Figure 4 includes all slow-onset hazards found in the sample, but owing to the relationships between events and multiple hazards faced by the same population, the total number of hazards exceeds the total number reviewed. For example, 27 publications covered both climate variability and drought.

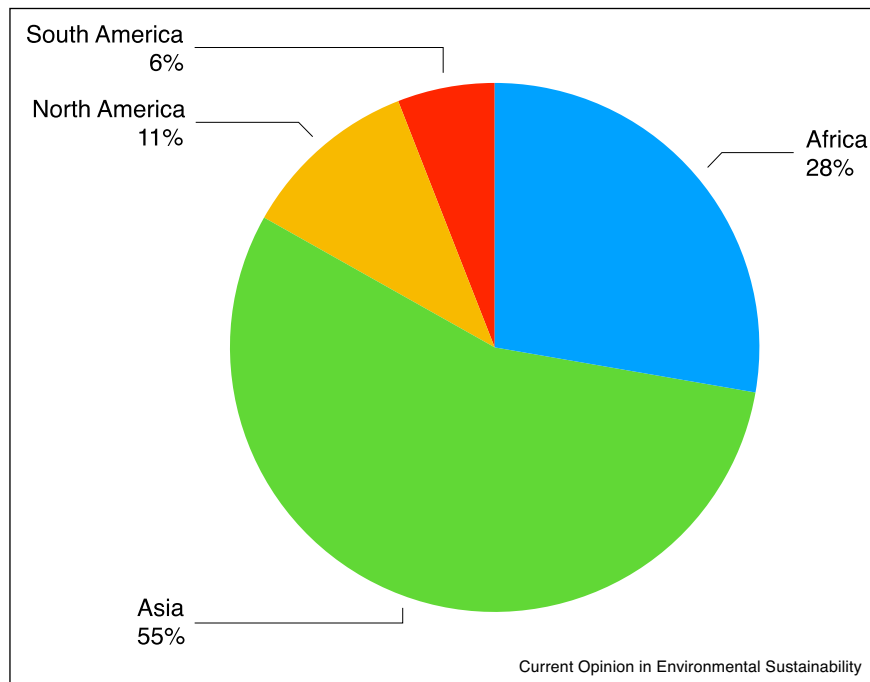
<sup>15</sup> The UNFCCC designates 8 categories of slow onset hazards: sea level rise, increasing temperatures, ocean acidification, glacial retreat, salinization, land and forest degradation, loss of biodiversity and desertification. However, the present analysis departs from these types because these categories did not easily map onto the CLIMIG database nor the content of empirical research. Glacial retreat and ocean acidification yielded no results for the time period

Figure 2



Case studies by CLIMIG Method Type.

Figure 3

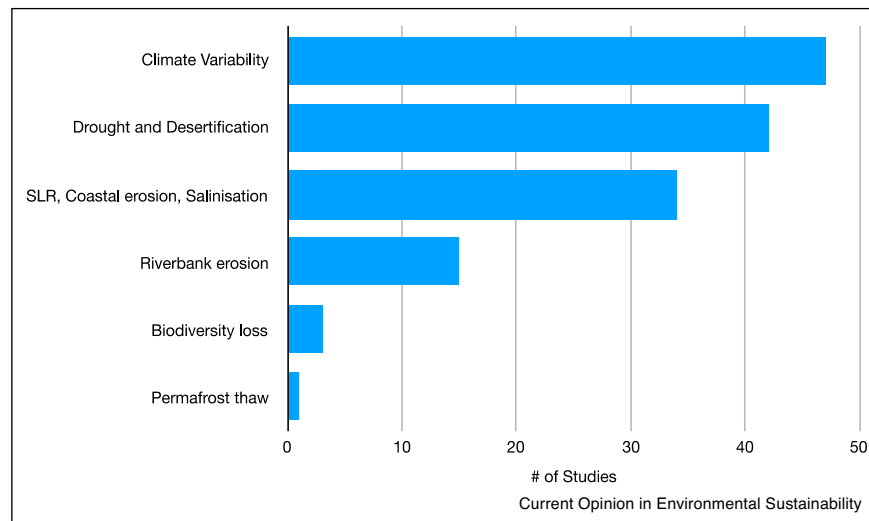


Breakdown of empirical case studies by continent.

using national or sub-national datasets with monthly, yearly or multi-year intervals [15,16]. An alternative strategy is to use local perceptions of climate variability when appropriate data is lacking at the community level [17] or to examine mobility decisions based on what the population perceives to be happening rather than externally observed data, which may not align [18\*]. Riverbank erosion also had a lesser, but still relatively strong presence in the sample. Even though riverbank erosion is

gradual in its onset, this hazard often forces populations to relocate their homes away from danger or move permanently elsewhere [19]. Despite the importance of biodiversity loss for fishing communities, only three studies explicitly connected it to human mobility. However, owing to different indicators and local contexts, these categories are not mutually exclusive. For instance, Panda [17] examined climate variability in combination with drought at the community level.

Figure 4



Empirical case studies by hazard type.

Combining geography with hazard, over 70% of case studies on sea level rise were conducted in or about Asian-Pacific countries, with Bangladesh ( $n = 9$ ) and Fiji ( $n = 5$ ) dominating. Drought was most studied in African countries ( $n = 20$ ).<sup>16</sup> The combination of drought, desertification, and climate variability impacts the livelihoods of millions on a continent where the majority of the population relies on agriculture. While these figures reflect major impacts of slow onset events geographically, they also point to potential blind spots. Despite the fragility of African highly populated coastal cities such as Lagos and Dakar as well as agricultural production such as rice paddies and fisheries located on coastal plains, the impact of sea level rise on human mobility was only studied in three African cases: Ghana [20], Nigeria [21] and Senegal [22].

### Migration patterns and dynamics

To date, research tends focus on causality of mobility decision-making, and – to a lesser extent – the consequences of that decision [23<sup>\*</sup>]. Few studies specifically seek to understand, rather than reference in passing, the spatio-temporal features of mobility as a response to environmental change. For this reason, I expanded upon the categories within the CLIMIG database and analyzed in previous studies [6<sup>\*</sup>] by coding for migration trajectory (origin, destination) and duration (temporary, permanent).

<sup>16</sup> This supports the findings Piguet *et al.* [6<sup>\*</sup>], who found that up to 2016, 62% of drought case studies were performed in Africa

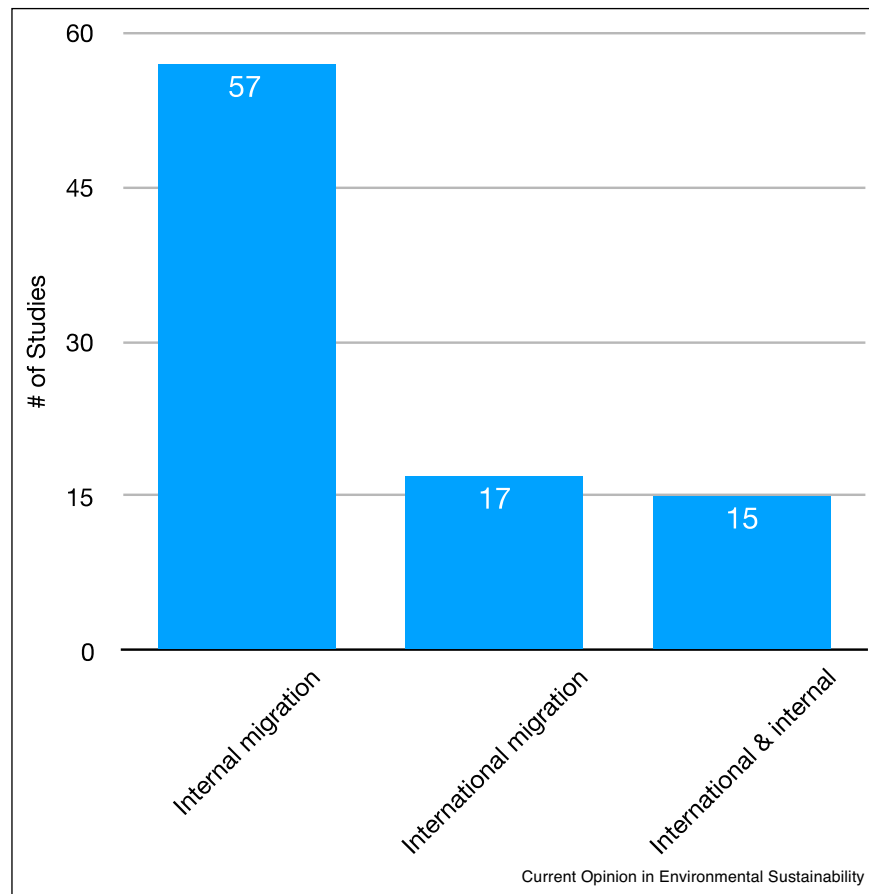
### Mobility in space

It is often said that environmental migration largely takes place within national boundaries [24]. Our findings confirm that for slow onset events: of the 89 studies that referred to one or more destinations, 64% studies referred only to internal migration, 19% looked at international movements, and 17% referred to both international and internal migration (see Figure 5).

Most case studies look at rural sending points, reflecting the vulnerability of rural, natural resource-dependent livelihoods, but a smaller body did address the importance of urban mobility [25–27]. Rural-to-urban migration is the most commonly studied pattern, but rural-to-rural migration also occurs. In northern Latin America and the Caribbean, Baez *et al.* [28] linked individual-level information from censuses for eight countries with natural disaster indicators to measure the impact of droughts and hurricanes on internal mobility. In doing so, it found that when confronted with drought, younger individuals favored traveling short distances by relocating to nearby rural and small towns, motivated possibly by nearby off-farm employment opportunities and lower moving costs. Makondo and Thomas [29] also found that drought and land degradation led to rural-to-rural migration away from southern Zambia.

Studies on international migration revealed differing findings, underlining the importance of context and methodology. For example, Wesselbaum [30<sup>\*</sup>] examines migration flows from 198 countries to Australia showing that temperature does not have a robust, significant effect on migration flows, while weather-related disasters do

Figure 5



Type of migration studied, Internal versus International.

significantly affect flows to Australia. In Bangladesh, Chen and Mueller [31] found that migration to neighboring countries declines with short-term, adverse weather but increases with soil salinity.

Several reasons could explain why people move within national boundaries in response to slow onset events: firstly, migration takes resources that are not available to all (and which climate change may erode), and international migration typically requires greater capital, financial, human, social, and political [32]. Secondly, place attachment may keep people from aspiring to move to other countries (or moving at all) [33]. Thirdly, whereas ‘mainstream’ migration studies by and large look at international flows and neglect internal mobility [34], the prevalence of work on internal movements may be similarly influenced by research bias. Especially when longitudinal data is missing, it is possible that studies only capture a piece of a longer migration journey, whereby an internal move may be just one of a series of ‘stepping stones’ along a stepwise, fragmented journey [35–37]. While some studies noted internal and international

migration [38], research on a continuum of movement within the same populations is rare and presents an opportunity for future research and a valuable insight for policy [39].

#### Mobility in time

Are slow onset events driving more permanent forms of migration than temporary? Slow onset events can make lands uninhabitable and irreversibly so, when coastal erosion and sea level rise ‘swallow’ coastal lands and small islands, for instance. The issue of temporality is an important one because — like spatial dimensions — it influences policy responses, and is also shaped by them. Unfortunately, most studies did not explicitly address discuss the duration of migration, whether it was temporary (including seasonal), or permanent — a persistent gap in scholarship. Of those that did ( $n = 37$ ), 22 noted permanent migration, the majority of which analysed planned relocation ( $n = 14$ ), largely in Asian countries and small-island states [40–42]. Planned relocation has the potential to facilitate migration in a way that maintains community and social structures, but relocation is

not always successful, especially when decision-making processes are not inclusive or transparent and long-term monitoring and evaluation is not undertaken. Comparative studies, while few and far between at present, would shed more light on this form of human mobility beyond a specific local context and help inform future programmes and policies [21].

Migration in response to slow onset events is not always, however, permanent. Fifteen studies observed temporary migration and seven studies observed both temporary and permanent migration flows. The duration of migration in response to drought, for example, differed depending on the study site. Several studies found that migration was seasonal, temporary, or circular: in their survey, Antwi-Agyei *et al.* [43] noted temporary labor migration to the south of Ghana during the farming off-season; whereas Makondo and Thomas [29] noted migration was largely permanent in rural Zambia. Temporal patterns differ even within countries, dependent on local contexts and infrastructure. In a study of two villages in India facing recurrent drought, Kattumuri *et al.* [44] found that in Gundlapalli, where farmers had greater access to irrigation, migration was less frequent and less permanent than in Saddapalli. Publications dealing with rising sea levels also observed temporary migration. In Bangladeshi coastal districts, Shamimul *et al.* [45] found that 88% of respondents engaged in temporary migration, underscoring the fact that not all movement related to SLR is permanent.

Yet, the vast majority of all empirical studies left the question of temporality unanswered. In part, this may be due to the uncertainty of when migration ‘ends’. Will migrant household members return? Or will the entire household eventually relocate to join the migrant? Longitudinal studies are few and far between, not just in the present sample, but reflecting a shortcoming in the field of environmental migration [13]. One must also question how the field is categorizing both temporal and spatial dynamics, and what we may be missing as a result. As noted by Safra de Campos *et al.* [23<sup>\*</sup>] in their study of subsistence households in semi-arid Northeast Brazil, the category of temporary migration, typically thought of to be seasonal or circular, may not be sufficient to capture daily, weekly, or occasional local mobility responses. Likewise, commuting practices or short-distance moves within communities do not easily fall under the heading of ‘migration’. One promising direction is to use mobilities approaches to unpack and illuminate more nuanced, everyday forms of mobility that escape traditional migration lenses [46<sup>\*</sup>].

### Migration as adaptation

Slow onset events can force people to leave, especially when their homelands become uninhabitable. One of the critical impacts of slow onset events evident in the

literature is the disruption of local livelihoods, particularly for those people dependent on natural resources.<sup>17</sup> These events may also decrease ecosystem services and overwhelm populations’ capacity to withstand both slow and rapid-onset events, reaching critical social tipping points at which the socio-ecological capacity to cope *in situ* is exceeded, leading to displacement [47]. Nonetheless, the vast majority of studies labeled mobility responses under the heading of migration rather than displacement ( $n = 12$ ).

Slow onset events are often perceived to contribute to more preemptive and proactive forms of migration because they provide more time for planning and preparing for movement, whereas sudden-onset events are seen to cause involuntary and reactive displacement leaving no time for careful decision-making or space for agency [48,49<sup>\*</sup>,50]. While recognizing the adverse conditions leading to migration, more than 30% of studies described migration as an adaptation strategy. Socio-economic differences can play a significant role in determining who goes and who stays. In some cases, it may be those who stay who are less reliant on natural resources or whose homes are less exposed; in others, people and households with more capital may be better placed to employ migration as an adaptation strategy [49<sup>\*</sup>,51].

Many of the empirical studies investigated migration as one amongst a host of potential adaptation options for rural, agricultural households. Heavily influenced by New Economics of Labor Migration (NELM) theory, migration is seen as a collective household choice, by which one family member moves, providing an insurance strategy and means of diversifying livelihoods [52]. This, in turn, helps shelter the household from the adverse impacts of climate change and contributes to increased resilience and/or adaptive capacity. In such scenarios, it may be those households without a migrant, whether they are unable or unwilling, who bear the greatest risks [1,32].

Although recent findings support the migration-as-adaptation discourse, that is not to say that the adaptation strategy always *works*. In rural areas of northern Ghana, seasonal migration also delivered maladaptive outcomes. When migrants failed to return home in time for the start of the farming season, it left the community of origin with a labor shortage that ultimately, local food security [43]. Additionally, the household-level of analysis common in the literature may be obscuring critical power dynamics and inequalities within the household, such as gendered divisions of labor. NELM has been long criticized in

<sup>17</sup> Agriculture, including farming, fishing, forestry, is by and large the most addressed economic sector and livelihood linking slow onset events to human mobility ( $n = 36$ ). Only four articles specifically examined the impacts on pastoralists (in Ethiopia, Kenya, Ghana and Mongolia). Fishing also received relatively little explicit focus compared to farming and farm-based livelihoods.

migration studies for its vision of the household as a harmonious, collective decision-making unit, a criticism that can also be levied in environmental migration [53\*]. How migration can be adaptive for some, but not for others, is mostly neglected in the wealth of studies focused on households. In a rare exception, Eastin [54] found that male out-migration increased familial burdens for women in developing countries, and that in addition to other inequalities, it diminished women's ability to achieve economic independence, and enhance their human and social capital relative to men. The lack of gendered and intersectional approaches in recent research remains a critical gap in the migration-as-adaptation discourse, and in the field more widely.

## Conclusions

The breadth of recent studies linking slow onset events and human mobility is difficult to succinctly summarize, owing to the wide range of hazards, their impacts, their varied interactions with other drivers of population movement, and the specificity of local contexts. The quantity, diversity, and quality of recent literature is encouraging and acts as a valuable resource for more evidence-based policy. However, our review also found several persistent blind spots that need to be rectified. From a geographic perspective, more work should be done in understudied regions like Latin America [55]. Much more work on mobility responses to coastal threats in African countries is also required, including urban settings as origin points, not just destinations. Methodologically, longitudinal approaches would also allow us to better capture slow onset events as they unfold over time and across space, and to understand the long-term impacts of out-migration, such as potential feedback loops within socio-ecological systems. Mobilities approaches also offer a promising lens through which to advance knowledge on spatio-temporal dynamics of mobility, which remain largely overlooked. Climate mobilities should also be analysed from the perspective of populations rather than assuming people's perceptions of slow onset events and mobility strategies align with external assessments. Expanding the methodological toolbox could help address this gap, through Fuzzy Cognitive Mapping (FCM) techniques, for example [56]. Lastly, we need to investigate power dynamics and inequalities within communities and within households rather than assuming that the household acts collectively and harmoniously. Gendered, inter-generational, and intersectional approaches from the social sciences could help identify, analyse and mainstream social equity dimensions of the climate-migration nexus both within the context of slow onset events and in the field at large.

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## Conflict of interest statement

Nothing declared.

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## Appendix A. Supplementary data

Supplementary material related to this article can be found, in the online version, at doi:<https://doi.org/10.1016/j.cosust.2020.11.007>.

## References and recommended reading

Papers of particular interest, published within the period of review, have been highlighted as

- of special interest

1. Black R, Bennett SR, Thomas SM, Beddington JR: **Climate change: Migration as adaptation**. *Nature* 2011, **478**:447-449.
2. Warner K: **Environmental change and migration: methodological considerations from ground-breaking global survey**. *Popul Environ* 2011, **33**:3 <http://dx.doi.org/10.1007/s11111-011-0150-4>.
3. IDMC: *2020 Global Report on Internal Displacement*. Internal Displacement Monitoring Centre (IDMC); 2020 <https://www.internal-displacement.org/global-report/grid2020/>.
4. Nishimura L: *The Slow Onset Effects of Climate Change and Human Rights Protection For Cross-Border Migrants*. Office of the United Nations High Commissioner for Human Rights (OHCHR); Platform on Disaster Displacement (PDD); 2018.
5. Rigaud KK, de Sherbinin A, Jones B, Bergmann J, Clement V, Ober K, Schewe J, Adamo S, McCusker B, Heuser S, Midgley A: *Groundswell: Preparing for Internal Climate Migration*. World Bank; 2018. License: CC BY 3.0 IGO <https://openknowledge.worldbank.org/handle/10986/29461>.
6. Piguet E, Kaenzig R, Guélat J: **The uneven geography of research on "environmental migration"**. *Popul Environ* 2018, **39**:357-383 <http://dx.doi.org/10.1007/s11111-018-0296-4>.  
 Research on climate and migration have their own geographies which do not necessarily coincide. Results show that research on environmental migration is mainly done in countries of the Global South, whereas climate science research in general is focused on countries of the Global North. We contend that the peculiar geography of environmental migration cannot be explained solely by the uneven vulnerability of southern populations to the environment. It must also be understood through the lens of post-colonial and securitization studies as the result of a framing of 'environmental refugees' (and refugees in general) as an intrinsically 'southern problem' and as a security risk for the North.
7. Borderon, M., Sakdapolrak, P., Muttarak, R., Kebede, E., Pagogna, R., & Sporer, E. (2018, July 24). *A systematic review of empirical evidence on migration influenced by environmental change in Africa* [Monograph]. WP-18-003. <http://pure.iiasa.ac.at/id/eprint/15382/>.
8. Borderon Marion, Sakdapolrak P, Muttarak R, Kebede E, Pagogna R, Sporer E: **Migration influenced by environmental change in Africa: a systematic review of empirical evidence**. *Demogr Res* 2019, **41**:491-544.
9. Ayebe-Karlsson S, Smith CD, Kniveton D: **A discursive review of the textual use of 'trapped' in environmental migration**



- studies: the conceptual birth and troubled teenage years of trapped populations.** *Ambio* 2018, **47**:557-573 <http://dx.doi.org/10.1007/s13280-017-1007-6>.
10. Tricco AC, Antony J, Zarin W, Striffler L, Ghassemi M, Ivory J, Perrier L, Hutton B, Moher D, Straus SE: **A scoping review of rapid review methods.** *BMC Med* 2019, **13** <http://dx.doi.org/10.1186/s12916-015-0465-6>.
  11. Ganann R, Ciliska D, Thomas H: **Expediting systematic reviews: Methods and implications of rapid reviews.** *Implement Sci* 2010, **5** <http://dx.doi.org/10.1186/1748-5908-5-56>.
  12. Cummings C, Pacitto J, Lauro D, Foresti M: **Why People Move: Understanding the Drivers and Trends of Migration to Europe.** London: Overseas Development Institute; 2015.
  13. Gemenne F: **Qualitative research techniques: it's a case-studies world.** In *Routledge Handbook of Environmental Migration and Displacement*. Edited by McLeman R, Gemenne F. Routledge; 2018:117-134.
  14. Piguet E: **Linking climate change, environmental degradation, and migration: a methodological overview.** *WIREs Climate Change* 2010, **1**:517-524 <http://dx.doi.org/10.1002/wcc.54>.
  15. Mastrotrillo M, Licker R, Bohra-Mishra P, Fagiolo G, D. Estes L, Oppenheimer M: **The influence of climate variability on internal migration flows in South Africa.** *Global Environ Change* 2016, **39**:155-169 <http://dx.doi.org/10.1016/j.gloenvcha.2016.04.014>.
  16. Thiede B, Gray C, Mueller V: **Climate variability and inter-provincial migration in South America, 1970–2011.** *Global Environ Change* 2016, **41**:228-240 <http://dx.doi.org/10.1016/j.gloenvcha.2016.10.005>.
  17. Panda A: **Vulnerability to climate variability and drought among small and marginal farmers: a case study in Odisha, India.** *Clim Dev* 2017:1-13 <http://dx.doi.org/10.1080/17565529.2016.1184606>.
  18. De Longueville F, Ozer P, Gemenne F, Henry S, Mertz O, Nielsen J:
    - **Comparing climate change perceptions and meteorological data in rural West Africa to improve the understanding of household decisions to migrate.** *Clim Change* 2020 <http://dx.doi.org/10.1007/s10584-020-02704-7>.

Provides an in-depth comparison between perceptions by rural dwellers of Burkina Faso and trends in meteorological data to discuss the importance of perceptions vis-à-vis climate trends in migration decision. Showing that perceptions do not always align with rainfall data.
  19. Etzold B, Mallick B: **Moving beyond the focus on environmental migration towards recognizing the normality of translocal lives: insights from Bangladesh.** In *Migration, Risk Management and Climate Change: Evidence and Policy Responses*. Edited by Milan A, Schraven B, Warner K, Cascone N. Springer International Publishing; 2016:105-128 [http://dx.doi.org/10.1007/978-3-319-42922-9\\_6](http://dx.doi.org/10.1007/978-3-319-42922-9_6).
  20. Codjoe S, Nyamedor F, Sward J, Dovie DB: **Environmental hazard and migration intentions in a coastal area in Ghana: a case of sea flooding.** *Popul Environ* 2017, **39**:128-146 <http://dx.doi.org/10.1007/s11111-017-0284-0>.
  21. Ajibade I: **Planned retreat in Global South megacities: disentangling policy, practice, and environmental justice.** *Clim Change* 2019:1-19 <http://dx.doi.org/10.1007/s10584-019-02535-1>.
  22. Zickgraf C: **Keeping people in place: political factors of (Im) mobility and climate change.** *Soc Sci* 2019, **8**:228 <http://dx.doi.org/10.3390/socsci8080228>.
  23. Safra de Campos R, Bell M, Charles-Edwards E: **Collecting and analysing data on climate-related local mobility: the MISTIC toolkit.** *Popul Space Place* 2016 <http://dx.doi.org/10.1002/psp.2037>. n/a-n/a.
- It is widely recognised that environmental events may trigger permanent and seasonal migration but less attention has been given to the way they shape the everyday mobility that shapes household livelihood strategies. This dearth of attention can be traced to a lack of statistical data, the difficulties of collecting information on local space-time trajectories and the absence of sound statistical measures by which to express them. We review prior work on the migration–environment nexus and trace the development of methods that aim to capture and measure temporary population movement. We identify nine discrete dimensions of mobility and introduce the Mobility in Space and Time among Individuals and Communities (MISTIC) toolkit that is designed to capture the spatio-temporal patterns of household everyday mobility using a flexible, participant centred approach that facilitates data recording and subsequent analysis.
24. McLeman R, Gemenne F: **Environmental migration research: evolution and current state of the science.** In *Routledge Handbook of Environmental Migration and Displacement*. Edited by McLeman R, Gemenne F. Routledge; 2018:3-16.
  25. Khavarian-Garmsir AR, Pourahmad A, Hataminejad H, Farhoodi R: **Climate change and environmental degradation and the drivers of migration in the context of shrinking cities: a case study of Khuzestan province, Iran.** *Sustain Cities Soc* 2019, **47** <http://dx.doi.org/10.1016/j.scs.2019.101480> 101480.
  26. Buchori I, Pramitasari A, Sugiri A, Maryono M, Basuki Y, Sejati AW: **Adaptation to coastal flooding and inundation: mitigations and migration pattern in Semarang City, Indonesia.** *Ocean Coast Manage* 2018, **163**:445-455 <http://dx.doi.org/10.1016/j.ocecoaman.2018.07.017>.
  27. Nawrotzki R, Hunter L, Runfola D, Riosmena F: **Climate change as a migration driver from rural and urban Mexico.** *Environ Res Lett* 2015, **10** 114023.
  28. Baez J, Caruso G, Mueller V, Niu C: **Droughts augment youth migration in Northern Latin America and the Caribbean.** *Clim Change* 2017, **140**:423-435 <http://dx.doi.org/10.1007/s10584-016-1863-2>.
  29. Makondo CC, Thomas DSG: **Environmental change and migration as adaptation in rural economies: evidence from Zambia's rural–rural migration.** *Migr Dev* 2019:1-29 <http://dx.doi.org/10.1080/21632324.2019.1646534>.
  30. Wesselbaum D: **The influence of climate on migration.** *Aust Econ Rev* 2019, **52**:363-372 <http://dx.doi.org/10.1111/1467-8462.12345>.
- Investigates the phenomenon of whether climatic factors, such as temperature and weather-related disasters, affect the decision to migrate internationally and examines migration flows from 198 countries to Australia for the time span from 1980 to 2015, showing that temperature does not have a robust, significant effect on migration flows, while weather-related disasters do significantly affect flows to Australia.
31. Chen J, Mueller V: **Coastal climate change, soil salinity and human migration in Bangladesh.** *Nat Clim Change* 2018, **8**:981-985.
  32. **Foresight: Foresight: Migration and Global Environmental Change Final Project Report.** The Government Office for Science; 2011.
  33. Adams H: **Why populations persist: mobility, place attachment and climate change.** *Popul Environ* 2016, **37**:429-448 <http://dx.doi.org/10.1007/s11111-015-0246-3>.
  34. King R, Skeldon R: **"Mind the Gap!" Integrating approaches to internal and international migration.** *J Ethnic Migr Stud* 2010, **36**:1619-1646 <http://dx.doi.org/10.1080/1369183x.2010.489380> aph.
  35. Collyer M: **In-between places: trans-Saharan transit migrants in morocco and the fragmented journey to Europe.** *Antipode* 2007, **39**:668-690 <http://dx.doi.org/10.1111/j.1467-8330.2007.00546.x>.
  36. Paul AM: **Stepwise international migration: a multistage migration pattern for the aspiring migrant.** *Am J Sociol* 2011, **116**:1842-1886 <http://dx.doi.org/10.1086/659641>.
  37. Paul AM: **Capital and mobility in the stepwise international migrations of Filipino migrant domestic workers.** *Migr Stud* 2015, **3**:438-459 <http://dx.doi.org/10.1093/migration/mnv014>.
  38. Sedova B, Kalkuhl M: **Who are the climate migrants and where do they go? Evidence from rural India.** *World Dev* 2020, **129** <http://dx.doi.org/10.1016/j.worlddev.2019.104848> 104848.
  39. Zickgraf Caroline: **"The fish migrate and so must we": The relationship between international and internal environmental mobility in a Senegalese fishing community.** *J Medzinarnodne Vztahy* 2018.

40. Mortreux C, Safra de Campos R, Adger WN, Ghosh T, Das S, Adams H, Hazra S: **Political economy of planned relocation: a model of action and inaction in government responses.** *Global Environ Change* 2018, **50**:123-132 <http://dx.doi.org/10.1016/j.gloenvcha.2018.03.008>.
41. Piggott-McKellar AE, McNamara KE, Nunn PD, Sekinini ST: **Moving people in a changing climate: lessons from two case studies in Fiji.** *Soc Sci* 2019, **8**:133.
42. Lindegaard LS: **Lessons from climate-related planned relocations: the case of Vietnam.** *Clim Dev* 2019:1-10 <http://dx.doi.org/10.1080/17565529.2019.1664973>.
43. Antwi-Agyei P, Dougill AJ, Stringer LC, Codjoe SNA: **Adaptation opportunities and maladaptive outcomes in climate vulnerability hotspots of northern Ghana.** *Clim Risk Manage* 2017 <http://dx.doi.org/10.1016/j.crm.2017.11.003>.
44. Kattumuri R, Ravindranath D, Esteves T: **Local adaptation strategies in semi-arid regions: Study of two villages in Karnataka, India.** *Clim Dev* 2017, **9**:36-49 <http://dx.doi.org/10.1080/17565529.2015.1067179>.
45. Shamimul I, Amzad H, Rafia Islam L: **Forced migration as a livelihood adaptation in response to climate change: an empirical study on Central South exposed Coast of Bangladesh.** *Soc Change* 2019, **13** In: <http://www.societyandchange.com/uploads/1569837147.pdf>.
46. Boas I, Farbotko C, Adams H, Sterly H, Bush S, van der Geest K, Wiegel H, Ashraf H, Baldwin A, Bettini G et al.: **Climate migration myths.** *Nat Clim Change* 2019, **9**:901-903 <http://dx.doi.org/10.1038/s41558-019-0633-3>.
- Misleading claims about mass migration induced by climate change continue to surface in both academia and policy. This requires a new research agenda on 'climate mobilities' that moves beyond simplistic assumptions and more accurately advances knowledge of the nexus between human mobility and climate change.
47. IDMC: **No Matter of Choice: Displacement in a Changing Climate.** Internal Displacement Monitoring Centre (IDMC); 2018 In: <https://www.internal-displacement.org/sites/default/files/publications/documents/20181213-slow-onset-intro.pdf>.
48. Kaczan D, Orgill-Meyer J: **The impact of climate change on migration: a synthesis of recent empirical insights.** *Clim Change* 2019:1-20.
49. Nawrotzki R, DeWaard J, Bakhtsiyarava M, Ha J: **Climate shocks and rural-urban migration in Mexico: exploring nonlinearities and thresholds.** *Clim Change* 2016:1-16 <http://dx.doi.org/10.1007/s10584-016-1849-0>.
- Evidence is increasing that climate change and variability may influence human migration patterns. This study tests whether climate change more strongly impacted international compared to domestic migration from rural Mexico during 1986–99. We employ eight temperature and precipitation-based climate change indices linked to detailed migration histories obtained from the Mexican Migration Project. Results from multilevel discrete-time event-history models challenge the assumption that climate-related migration will be predominantly short distance and domestic, but instead show that climate change more strongly impacted international moves from rural Mexico. The stronger climate impact on international migration may be explained by the self-insurance function of international migration, the presence of strong migrant networks, and climate-related changes in wage difference. While a warming in temperature increased international outmigration, higher levels of precipitation declined the odds of an international move.
50. Lazcko F, Aghazarm C (Eds): **Migration, Environment and Climate Change: Assessing the Evidence | Environmental Migration Portal.** International Organization for Migration (IOM); 2009 In: <https://environmentalmigration.iom.int/migration-environment-and-climate-change-assessing-evidence>.
51. Zickgraf C, Vigil Diaz Telenti S, De Longueville F, Ozer P, Gemenne F: **The Impact of Vulnerability and Resilience to Environmental Changes on Mobility Patterns in West Africa (KNOMAD Series).** World Bank Group; 2016.
52. Stark O, Bloom DE: **The new economics of labor migration.** *Am Econ Rev* 1985, **75**:173-178.
53. Gioli G, Milan A: **Gender, migration, and (Global) environmental change.** In *Routledge Handbook of Environmental Displacement and Migration*. Edited by McLeman R, Gemenne F. 2018:135-150. Provides a detailed review of the links between gender, migration, and environmental change.
54. Eastin J: **Climate change and gender equality in developing states.** *World Dev* 2018, **107**:289-305 <http://dx.doi.org/10.1016/j.worlddev.2018.02.021>.
55. Kaenzig R, Piguet E: **Migration and climate change in Latin America and the Caribbean.** *People Move Changing Clim* 2014, **2** [http://dx.doi.org/10.1007/978-94-007-6985-4\\_7](http://dx.doi.org/10.1007/978-94-007-6985-4_7).
56. Reckien D, Wildenberg M, Bachhofer M: **Subjective realities of climate change: how mental maps of impacts deliver socially sensible adaptation options.** *Sustain Sci* 2013, **8**:159-172 <http://dx.doi.org/10.1007/s11625-012-0179-z>.