Perspective

Broadening climate migration research across impacts, adaptation and mitigation

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Current climate migration literature focuses on establishing links between climate drivers and migration. However, it often overlooks the broader role that migration plays within the context of climate impacts, adaptation and the connection with mitigation. This Perspective highlights four key research gaps: (1) the effectiveness of migration as an adaptation strategy, (2) how migration interacts with in situ adaptation efforts, (3) migration's impacts on origin and destination communities and (4) feedback between climate mitigation policies and migration. To address these gaps, we propose solutions grounded in strengthening conceptual frameworks, expanded and harmonized data, and advancing methodological innovation. Together, these efforts can inform policy-making to better protect vulnerable populations, allocate resources more effectively and strengthen resilience and justice.

Over recent decades, substantial attention has been focused on how climate factors influence different forms of migration—internal and international, permanent and temporary, voluntary and forced. Much of this empirical literature has examined whether, how and to what extent climate drivers—such as rising temperatures, shifting precipitation patterns, desertification and sea-level rise—shape migration decisions of individuals, families or entire communities[1,2]. These studies acknowledge both the direct and indirect effects of environmental pressures on migration, which are often mediated by socioeconomic factors such as health, income and food security[3–5]. However, the dominant focus on quantifying and establishing the relationship between climate drivers and migration overlooks the broader role that migration plays in the context of climate impacts and adaptation—including its effectiveness as an adaptation strategy, its interaction with in situ adaptation efforts, its impacts on communities and its feedback with climate mitigation policies. This Perspective contributes by identifying key gaps in the literature of recent decades and proposing concrete solutions to address them (Table 1). Addressing these gaps will enable better resource allocation, more targeted support for migrants, tailored socioeconomic policies for origin and destination areas, and more coherent strategies for advancing resilience, equity and a just green transition.

Effectiveness of migration as climate adaptation

The concept of 'migration as adaptation' rests on the assumption that people on the move enhance their well-being and climate resilience

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Table 1 | Proposed solutions for each of the four gaps

Research gap	Solutions		
	Strengthening conceptual frameworks	Enhancing data availability	Advancing methodological innovation
Lack of empirical assessment of migration's effectiveness as an adaptation strategy	Improve the conceptualization of migration–climate linkages by incorporating environmental risks	Longitudinal tracking, harmonized household surveys across countries, data on migration intentions, digital trace data, Earth observation (EO) data	Combining qualitative and quantitative approaches; integration across disciplines
Insufficient analysis of how migration interacts with in situ adaptation efforts	Revisit conceptualizations of climate-related migration by integrating sociocultural dimensions—such as identity, belonging, aspirations—and embedding principles of the Right to Stay and self-determination	Harmonized household surveys across countries, data on identity, belonging, aspirations, remittances, EO and geospatial data on local adaptation, digital trace data	Agent-based modelling for adaptation–migration trade-offs, linking surveys with EO; large language models
Lack of attention to migration's impacts on origin and destination communities	Develop an analytical approach to distinguish migration shaped by climatic factors from other types of mobility and characterize differences across groups	Data to distinguish climate-driven migrants, data on their resilience, labour market participation and integration trajectories, host-city capacity data	Needs-based models, migration models based on demographic stratification, overlapping generations models
Underexplored feedback between climate mitigation policies and migration	Apply migration theories to mitigation contexts to examine how policies influence mobility and immobility	Less data heavy, but EO and socioeconomic data could still help understand land-use change and mobility effects of mitigation efforts	Applying migration models to mitigation scenarios

through migration. While this idea has been advanced in conceptual papers[6,7], it has yet to receive robust empirical assessment and validation. For instance, some evidence suggests that low-income and socially excluded migrants end up clustering in high-density areas prone to flooding and landslides[8]. In addition, more research is needed to unpack the extent to which climatic conditions at destinations are factored into migration decisions. Poor migrants can inadvertently settle in climate-risky areas if, for example, they seek to take advantage of declining property values, reflecting these high risks. Understanding what happens at the destination once migration has occurred, how the migrants' climate exposure changes and to what extent they can cope with climate change and other stresses at the destination is extremely important for climate risk assessment and policy-making.

One of the key challenges is the lack of granular, location-specific data on both the origins and destinations of migrants, especially in cases of cross-border movement[9]. Although harmonized census microdata enable the modelling of migration flows between regions or countries, these data have limited temporal resolution, fail to capture short-term or circular mobility patterns, and typically lack information on the drivers of migration and related health and sociodemographic outcomes of the movers[10]. National household surveys can fill some of these gaps, as they often include demographic and general health indicators. However, they typically capture information only at the household's current location. Information on the mobility of individual members seldom extends to conditions at intended or actual destinations. Without comprehensive information at destinations, it is difficult to determine whether migrants improve their resilience after they move.

This raises the broader question of how people make migration decisions. So far, we have only a limited understanding of migrants' decision-making processes along the entire migration journey—encompassing the move to a new location, potential return, and repeated movements—and how these are shaped by climatic factors. Climate conditions not only affect whether individuals decide to stay or migrate[11] but can also disrupt planned trajectories, altering routes, destinations and forms of migration. Existing data often fail to clarify whether reported destinations correspond to migrants' original plans or instead reflect constraints encountered during the journey. Public attitude survey data, such as the Afrobarometer (www.afrobarometer.org) or Gallup World Polls (www.gallup.com) can provide information on intentions and aspirations to migrate, potentially enabling analysis

of the link between preferred destinations and their climate conditions. However, it is not clear whether and how intentions translate into actual behaviours. The correlation between intention and action is often assumed and not properly analysed[12]. Having data on both could help identify obstacles to realizing people's intentions. A better assessment of how migrants make decisions will help us understand the adaptive capacity of migrant populations.

A possible way to address this gap is to improve the conceptualization of migration–environment linkages by incorporating environmental risks as a metric for assessing migrants' well-being during the entire migration process. Conceptual frameworks such as the translocal social resilience approach[13] are particularly well suited to examining how migration is embedded in interconnected livelihood systems that span multiple places and produce diverse resilience outcomes. The translocal social resilience approach distinguishes between different forms of adaptation, helping to avoid overly simplistic interpretations of mobility as either positive or negative. In the same vein, the emerging concept of habitability in the climate-related migration literature draws attention to the ways in which places remain habitable through multiscalar connections, such as remittances, resource flows and social networks, which link migrants and non-migrants across space[14].

Improving conceptual frameworks to account for differential resilience outcomes is crucial for evaluating the adaptive capacity of movers, but without validation these advances risk remaining purely theoretical. Empirical analyses will only be possible through data improvements that allow researchers to track individual household members or entire families before, during and after migration, recording detailed indicators of changes in livelihood, climate exposures and well-being. Thus, longitudinal and location-specific household-level survey data are needed.

Suitable starting points are longitudinal datasets derived from surveys that capture shocks and adaptation strategies over time. These surveys typically include modules on livelihood shocks, as well as household coping strategies, providing valuable insight into adaptive behaviour over time. However, additional data collection efforts are needed to build on the strengths of existing surveys—particularly through longitudinal tracking of migrants, including across international borders. Such data would enable researchers to better understand migration routes, transitional experiences, circulatory and repeat migration patterns, and outcomes at destinations.

Traditional data sources have also seen some advancements in recent years. For example, the OECD Municipal Migration Database now offers harmonized data at the municipal level for 22 OECD countries, enabling researchers to study resilience after migration at a finer level. However, OECD countries are generally more resilient to climate stress than many other regions where migrants seek shelter. Expanding efforts to collect similar data in non-OECD countries, particularly those more vulnerable to climate impacts, is crucial for building a more comprehensive understanding of climate-related migration.

Existing surveys are also limited in geographic and temporal scope. To address this, harmonizing household surveys across countries would be particularly helpful, enabling the recording of migrants' experiences in both sending and receiving contexts and filling gaps left by national-level surveys. Moreover, regularly recording migration intentions alongside observed migration decisions can illuminate whether households' actions align with their plans—and, if not, identify the obstacles preventing them from following through. This can be achieved by leveraging innovative data sources such as anonymized mobile phone records, social media activity and online interactions. Establishing partnerships with technology firms that collect digital and mobile data could further enhance these efforts, provided that they adhere to strict ethical standards and robust privacy safeguards[15,16]. The advances in the use of large language models[17], employed on unstructured data from social media, official documents, reports and research papers, allow the transformation of qualitative insights into structured, actionable information on migration intentions, driving factors and patterns. This ability to conduct analyses at scale can support the shift towards migration solutions based on robust, factual data.

Complementing these surveys with digital trace and Earth observation data would allow researchers to link environmental stressors at origin and destination sites. Finally, the development of a centralized, cross-border platform for harmonizing and sharing data on migration would enable comprehensive analysis and informed policy-making[18].

Achieving this goal requires not only improved data but also methodological innovation[19,20]. One promising direction is the integration of quantitative and qualitative approaches[21,22]. Incorporating insights on risk perception and adaptation motives from interviews can help uncover the decision-making processes that shape migration outcomes. Moreover, migrant associations, local NGOs and municipalities can play a pivotal role in co-generating data on settlement conditions and resilience outcomes. At the same time, stronger integration across disciplines is needed to ensure that relocation occurs into safe, climate-resilient areas rather than risk-prone settlements, and to help balance investments between staying and moving. For instance, in line with ongoing efforts to integrate migration into urban development interventions[23], social scientists, economists, geographers and urban design experts would benefit from closer collaboration in planning future urban infrastructure to account for shifts in migration patterns induced by climate stress.

Together, these approaches would equip policy-makers with the evidence needed to design interventions that make migration a safer and more effective adaptation strategy, and ensure that research findings feed directly into national adaptation plans.

Climate migration and in situ adaptation

Another gap in the climate migration literature concerns the interaction between migration and in situ adaptation measures. The two strategies can be complementary if, for instance, remittances fund resilient farming techniques, enhancing household adaptation to climate shocks[24]. At the same time, the two strategies may act as substitutes, as successful in situ adaptation measures might reduce the need for relocation and vice versa[25–27]. At one extreme, in situ adaptation allows households to remain in place without migrating. At the other extreme, when in situ adaptation is no longer feasible, migration of the entire household or community becomes unavoidable. This is the case of planned relocation

and managed retreat[28]. Little research has explored the relationship between these two forms of private adaptation, particularly for cases that fall between these two extremes.

At the government level, this translates into understanding the relationship between different public policies for adaptation. Critical questions arise about prioritization and effectiveness—should resources be directed toward infrastructure development to protect communities in risk-prone areas, or should relocation policies be promoted, especially when protective measures are prohibitively expensive? Non-climate-focused public investments can also influence the extent to which households need to cope with climate shocks through migration. For example, the effect of heat shocks on migration is attenuated in areas with better infrastructure, where local transitions out of agricultural occupations are a viable alternative[29]. Such occupational transitions may be a first step towards later migration, creating dynamic complementarities that public policies could amplify.

The majority of existing conceptual frameworks portray climate migration as an inevitable outcome of environmental decline[30]. Such deterministic framings obscure the aspirations of many communities to remain in place and risk discouraging investments in local adaptation. Research should be guided by the principles of the Right to Stay and self-determination[31,32], ensuring that assessments of adaptation options and habitability are informed by the perspectives of those directly concerned. Advancing our understanding of climate-related migration would be possible by integrating sociocultural dimensions—such as place attachment, belonging, identity and aspirations to move or to stay—into the conceptualization of adaptation frameworks. Doing so can help reveal how agency, emotional ties and cultural values shape the trade-offs individuals and households make between in situ adaptation and migration, and how these choices evolve along different adaptation pathways.

To better understand how migration interacts with local adaptation measures, advances are also needed in data collection. Household surveys remain a valuable source of information on coping strategies and can also capture sociocultural dimensions such as aspirations, identity and belonging. These data should be complemented with information on remittances[33]. For instance, evidence from banking and other financial data in remittance-receiving regions could reveal whether funds are channelled into adaptive investments, such as water-efficient irrigation or livelihood diversification, thereby indicating complementarity between migration and in situ adaptation.

As discussed above, harmonizing surveys across countries would be highly beneficial, enabling comparative analyses across contexts with differing agricultural systems, infrastructures and levels of external support, as these characteristics influence both migration and in situ adaptation. In addition, some ground features associated with human activities, such as irrigation, land cover and land reorganization, can be derived from Earth observation and geospatial data, providing indirect evidence of adaptation processes. When combined with socioeconomic or survey data, these observations can help identify regions where successful in situ adaptation may reduce migration pressures, and where out-migration is more likely once local coping strategies fail. Improvements in Earth observation data along the spatial and temporal resolution could provide useful information on the dynamics connected to human settlement in remote areas.

Improving data availability would not only expand the analytical toolkit but also enable the use of advanced methodologies such as artificial intelligence and machine learning. Digital trace data—for example, location histories, search histories[34] and interactions with large language models such as those built for agriculture[35]—could also help address this gap by providing detailed insights into migration and adaptation behaviours. Combined with these methodologies, such data have the potential to transform our understanding of the complex interactions between migration and adaptation[36].

Methodologically, agent-based simulations are particularly well suited to testing how policy choices—such as investing in protective infrastructure versus relocation programs—affect mobility patterns, especially when private in situ adaptation fails under intensifying climate pressures[27]. They can also help simulate decision-making under uncertainty, capturing the dynamic trade-offs that migrants face (for example, between affordability and exposure). From a modelling perspective, a unified framework could integrate migration as one among multiple adaptation strategies[37] and examine its interactions with broader adaptation policies. Such models would enable the exploration of the degree of substitutability and complementarity between adaptation options, informed by spatial socioeconomic data, infrastructure and service provision metrics and high-quality survey data on mobility and adaptation behaviours. Combined with estimates of future adaptation needs, costs and feasibility, they could ultimately improve the usability of projections of future climate-related migration for policy-relevant applications[38].

Consequences for origin and destination areas

Migration flows reshape both origin and destination areas, yet more inclusive research is needed to capture multiple perspectives—who the climate migrants are and how their movements affect the communities they leave and those they join. Only a limited number of studies have analysed the economic and social repercussions of migration flows linked to climate shocks, leaving an important gap in the climate-impact literature.

Climate change is expected to generate internal migration, particularly from rural to urban areas, as cities often offer more employment opportunities in climate-resilient sectors[39,40]. This may accelerate structural changes in affected economies, shifting from agriculture to manufacturing and services[41]. However, a mismatch between the skills of rural migrants and those needed in urban labour markets could exacerbate unemployment and inequality[42]. Destination cities may then need to absorb large numbers of rural migrants without developing competitive sectors to employ them, resulting in 'consumption cities'[43]. The profound societal and structural shifts can be further accelerated as extreme climate shocks can lead to depopulation of some areas and increased population agglomeration in others[44].

Another important consequence that has received little consideration is whether climate migrants are perceived as a distinct category compared with other migrants, and whether this perception affects attitudes in receiving countries[45]. The movements of climate migrants stem from global externalities, with impacts distributed unevenly across regions and generations, resulting in different shares of responsibility. This brings up equity and justice considerations. However, it is unclear whether these considerations can influence the attitudes of natives in receiving countries towards climate migrants. To our knowledge, the limited number of existing studies on this topic provide mixed conclusions[46,47].

Therefore, the first step in understanding and quantifying the implications of climate migration for origin and destination areas is to develop a conceptual approach that distinguishes migration influenced by climatic factors from migration driven by other causes and that identifies how climate-affected migrants differ across groups. Such an approach should account not only for the economic and financial motivations and constraints, but also for the demographic, socioeconomic and cultural characteristics that shape perceptions and beliefs about climate change among affected communities, prompting individuals to migrate or stay[9,10]. This approach would make it possible to assess whether a greater role of climate factors in migration decisions is associated with differences in resilience, labour-market participation and integration trajectories of migrants, and with the capacity of host cities to provide housing, healthcare, education and essential services.

In terms of methods, developing new models based on specific needs and characteristics of climate migrants can lead to a better understanding of the interaction between migrants and their hosting communities[48]. Furthermore, migration models based on demographic stratification can quantify the impact of climate-induced youth migration on demographic change and ageing trends in origin areas[49]. Finally, macroeconomic models such as overlapping generations models can provide a dynamic view of the broader consequences of climate migration on human capital and wage distribution in both sending and receiving economies[50].

Climate mitigation policies and migration

Climate change can shape migration not only directly through its physical impacts, but also indirectly through mitigation policies, which can have regressive distributional consequences[51–53]. Even if revenue redistribution can address the adverse distributional implications of climate policies such as a carbon tax, the green transition may widen economic disparities and amplify the incentive to move between countries. For example, policies such as the European Union's carbon border adjustment mechanism, while supporting the green transition, may disadvantage low-income countries with high emission profiles, which would then be subjected to higher tariffs, with possible ramifications for international migration. Little research exists on the implications of climate mitigation policies for international migration.

Within countries, the structural changes induced by the decarbonization of the national economy are likely to affect labour migration patterns. The transition is expected to induce a contraction of jobs in carbon-intensive economic activities and an expansion of 'green' jobs. How to achieve a just transition by reallocating workers from carbon-intensive sectors to greener occupations remains under-researched.

Another potential connection between climate mitigation and migration concerns the geographic concentration of critical materials needed for the green transition. Many countries rich in natural resources deal with weak governance and political instability. For example, the Democratic Republic of the Congo dominates the global cobalt production[54] and scores poorly on measures of institutional quality[55]. Like fossil fuel extraction, mineral extraction for green technologies in these areas can contribute to grievances, conflicts and human-rights abuses, leading to forced displacement[56]. On the other hand, extraction industries offer relatively climate-insensitive employment opportunities, which can lead to new in-migration patterns.

There are also contrasting hypotheses on whether and how migration affects climate mitigation. Some research has shown that migrants adopt more environmentally unsustainable lifestyles[57,58], especially in urban destination areas. Others argue that increasing migration and urbanization may benefit mitigation efforts[59,60]. Even if the outcome may ultimately depend on the level of development of the targeted destinations[61], cross-border migration effects on emissions and global warming are expected to be minimal[62].

To better understand the relationship between migration and mitigation, general migration theories can be applied to examine how large-scale climate mitigation policies—such as renewable energy infrastructure, land-use transformations or carbon taxes—interact with mobility or immobility[63,64]. This also requires considering the politics of habitability, recognizing that powerful actors—including states and private corporations—can actively shape which places are rendered habitable or uninhabitable through infrastructure development, resource extraction or border control[14].

In summary, broadening research on climate-related migration will improve our understanding of how climate change shapes migration decisions, routes and outcomes. The proposed solutions would enable the field to move forward along four key dimensions, facilitate robust empirical testing and modelling, and ultimately ensure the integration of the literature on climate-related migration into a broader research agenda on adaptation, climate impacts, and mitigation. Gaining a deeper understanding of migration as an adaptation strategy and its broader impacts would facilitate a better allocation of financial

resources in both origin and destination areas. It would help to identify destination areas that will probably need support, as well as to anticipate the types of resource required to accommodate those affected by climate impacts. Furthermore, it would ensure more targeted assistance for migrants throughout their journey, as well as supporting the provision of more effective in situ adaptation measures. Finally, understanding the possible link between climate mitigation measures and migration is important for designing appropriate policies to achieve the sustainable development goals, build resilience to climate change and ensure a just green transition.

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Author contributions

Competing interests

The authors declare no competing interests.

Additional information