



OPEN ACCESS

EDITED AND REVIEWED BY
Matthew Collins,
University of Exeter, United Kingdom

*CORRESPONDENCE
Gabriele Standardi
✉ gabriele.standardi@unimi.it

RECEIVED 12 September 2025
ACCEPTED 23 September 2025
PUBLISHED 06 October 2025

CITATION
Milan A and Standardi G (2025) Editorial:
Climate mobility modeling: methodological
advances and future prospects.
Front. Clim. 7:1704343.
doi: 10.3389/fclim.2025.1704343

COPYRIGHT
© 2025 Milan and Standardi. This is an
open-access article distributed under the
terms of the [Creative Commons Attribution
License \(CC BY\)](#). The use, distribution or
reproduction in other forums is permitted,
provided the original author(s) and the
copyright owner(s) are credited and that the
original publication in this journal is cited, in
accordance with accepted academic practice.
No use, distribution or reproduction is
permitted which does not comply with these
terms.

Editorial: Climate mobility modeling: methodological advances and future prospects

Andrea Milan¹ and Gabriele Standardi^{2,3*}

¹Global Centre for Climate Mobility (GCCM), Bonn, Germany, ²Department of Environmental Science and Policy, University of Milan, Milan, Italy, ³Euro-Mediterranean Center on Climate Change (CMCC), Venice, Italy

KEYWORDS

climate impacts, migration, methodological approaches, modeling, climate (im)mobility

Editorial on the Research Topic

Climate mobility modeling: methodological advances and future prospects

This Research Topic was launched on October 19, 2022. It was inspired by the session “Scenario-based Approaches to Modeling Migration Futures,” organized at the International Institute for Applied Systems Analysis (IIASA) as part of the Scenario Forum (June 20–22, 2022, Laxenburg, Austria).

The objective of this Research Topic was to provide an overview of the most recent methodologies used to study the complex relationship between climate change and human (im)mobility, and to highlight promising avenues for future research to improve our understanding of this relationship. This effort has resulted in a Research Topic of seven papers, which, in our view, successfully address the original aims of the Research Topic.

Among these seven contributions, three can be classified as Methodological Articles (Beyer, Miranda Espinosa et al.; Rossi et al.; Cottier), as they each adopt a specific methodological approach. Cottier presents a novel method for parameterizing a gravity model of migration using Bayesian hierarchical models with random intercepts. Rossi et al. introduce an enhanced probabilistic methodology for assessing flood displacement risk. Beyer, Miranda Espinosa et al. apply an event attribution approach that combines observational and counterfactual climate data on precipitation and wind speed with global internal displacement records.

Three papers are Review Articles that address different aspects of climate mobility (Turner et al.; Schewe and Beyer; Schewel et al.). Notably, Schewel et al. identify nine main modeling approaches: exposure models, agent-based models, gravity models, radiation models, statistical extrapolation models, systems dynamics models, Computable General Equilibrium (CGE) models, Integrated Assessment Models (IAMs), and machine learning models.

The final contribution is a Perspective Article, which outlines directions for future research (Beyer, Schewe et al.).

These papers could also be classified along several other dimensions. For example:

- Geographical scope, which ranges from global to continental, national, or mixed studies.
- Type of migration, distinguishing between internal vs. international and voluntary vs. involuntary (displacement).

- Climatic triggers, differentiating between slow-onset and sudden-onset events.
- Interconnections with other key issues, such as economic inequality and welfare, gender, conflict, legal protection of migrants, markets, and institutions.

In terms of geographical focus, four papers have a global/continental scope (Beyer, Miranda Espinosa et al.; Turner et al.; Schewe and Beyer; Cottier), with three focusing specifically on Africa (Cottier; Turner et al.; Schewe and Beyer), highlighting the continent's centrality to the topic. Two studies combine global and national analyses (Schewel et al.; Beyer, Schewe et al.), while one focuses on national case studies in the Pacific Island countries of Fiji and Vanuatu (Rossi et al.).

The type of migration is also a critical dimension. Two papers explicitly address displacement caused by extreme events (Rossi et al.; Beyer, Miranda Espinosa et al.). However, in their review Schewel et al. point out that many studies do not clearly distinguish between voluntary and involuntary migration. Beyer, Schewe et al. further caution against over-interpreting model results, noting that while some models of annual net migration consider all movement into and out of an area, others analyzing acute displacement often fail to specify whether displaced individuals eventually return. Turner et al. emphasize the complexity of migration decisions and warn against “decontextualized” studies that rely on simplistic weather–migration correlations, risking spurious conclusions. Unpacking the causal mechanisms is essential not only to understand migration, but also immobility. In this regard, Cottier suggests that adverse climate conditions may, paradoxically, increase the size of immobile populations through a reduced income effect.

The type of climatic trigger is another key factor. Two studies (Rossi et al.; Beyer, Miranda Espinosa et al.) focus on sudden-onset events such as floods and storms. Beyer, Schewe et al. also advocate for moving beyond basic temperature and precipitation metrics to include more direct climate impacts—such as droughts, wildfires, and crop yields—for which high-quality data are increasingly available. Cottier, for instance, focuses on crop yields and water availability. The three review papers examine a wide range of climatic triggers (Turner et al.; Schewe and Beyer; Schewel et al.).

The final dimension—interconnections with other domains—would have likely deserved deeper investigation. Climate mobility is closely linked to economic performance, inequality and poverty, food security, gender, conflict, and the legal status of climate migrants. Integrating these aspects into climate mobility frameworks is essential, especially in modeling efforts, as it helps reveal the often-hidden feedback loops between climate change, migration, and broader socio-economic and political variables.

In this vein, Benveniste et al. (2022) highlighted the role of economic constraints in shaping climate immobility under various Shared Socioeconomic Pathways (SSPs) using an Integrated Assessment Model. Standardi (2023) conducted a preliminary experiment assessing how climate impacts, higher labor–capital substitutability, and international trade scenarios interact to influence international labor reallocation, using a Computable General Equilibrium model.

Several reflections emerge from this Research Topic. First, the field of climate-related migration forecasting is still in its infancy,

and existing forecasting models lack reliability. Scenario-based approaches may be more practical for real-world planning, as they allow exploration of a wide range of “what-if” scenarios (Schewel et al.). This is supported by Schewe and Beyer, who show that existing international migration projections from African countries differ by two orders of magnitude, while projections for internal migration even differ in direction.

Given the topic's complexity, it is essential to understand and contextualize migration decisions rather than merely correlating migration rates with climatic variables. Social scientists and policymakers need to understand who migrates and why, including the full set of necessary and sufficient causal factors, to design effective and cost-efficient risk-reduction policies (Turner et al.). In this regard, the role of socio-economic variables must be carefully assessed to avoid climate-centric disaster narratives (Beyer, Miranda Espinosa et al.) or to prevent underestimating the endogenous links between climate change and economic activity when projecting future migration patterns (Cottier). In the case of Fiji and Vanuatu, Rossi et al. include loss of livelihood and access to essential services (e.g., schools, healthcare) as relevant drivers of displacement.

To conclude, while it is indisputable that climate change will significantly affect human mobility—by shifting the climate niche in which humans have lived for millennia (Xu et al., 2020)—much more work is needed in terms of both data collection and modeling innovation. Among key priorities, Beyer, Schewe et al. propose: leveraging non-linear machine learning approaches; focusing on relevant climate impacts beyond temperature and precipitation; and investigating spatial, temporal, demographic, and income-related heterogeneities.

Author contributions

AM: Writing – original draft, Writing – review & editing. GS: Writing – original draft, Writing – review & editing.

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

The author(s) declared that they were an editorial board member of Frontiers, at the time of submission. This had no impact on the peer review process and the final decision.

Generative AI statement

The author(s) declare that no Gen AI was used in the creation of this manuscript.

Any alternative text (alt text) provided alongside figures in this article has been generated by Frontiers with the support of artificial intelligence and reasonable efforts have been made to ensure accuracy, including review by the authors wherever possible. If you identify any issues, please contact us.

Publisher's note

All claims expressed in this article are solely those of the authors and do not necessarily represent those of their affiliated

organizations, or those of the publisher, the editors and the reviewers. Any product that may be evaluated in this article, or claim that may be made by its manufacturer, is not guaranteed or endorsed by the publisher.

References

Benveniste, H., Oppenheimer, M., and Fleurbaey, M. (2022). Climate change increases resource-constrained international immobility. *Nat. Clim. Change* 12, 634–641. doi: 10.1038/s41558-022-01401-w

Standardi, G. (2023). Exploring market-driven adaptation to climate change in a general equilibrium global trade model.

Mitig. Adapt. Strat. Glob. Change 28:11. doi: 10.1007/s11027-023-10049-6

Xu, C., Kohler, T.A., Lenton, T.M., Svenning, J.C., and Scheffer, M. (2020). Future of the human climate niche. *Proc. Natl. Acad. Sci. U. S. A.* 117, 11350–11355. doi: 10.1073/pnas.1910114117