Data & Policy (2025), 7: e70
doi:10.1017/dap.2025.10034

EDITORIAL

Anticipating human mobility: Methods, data, and policy in forecasting and foresight

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Received: 05 September 2025; **Revised:** 05 September 2025; **Accepted:** 05 September 2025

Keywords: anticipation; forecasting; foresight; migration

Abstract

The escalating complexity of global migration patterns renders evident the limitation of traditional reactive governance approaches and the urgent need for anticipatory and forward-thinking strategies. This Special Collection, "Anticipatory Methods in Migration Policy: Forecasting, Foresight, and Other Forward-Looking Methods in Migration Policymaking," groups scholarly works and practitioners' contributions dedicated to the state-of-the-art of anticipatory approaches. It showcases significant methodological evolutions, highlighting innovations from advanced quantitative forecasting using Machine Learning to predict displacement, irregular border crossings, and asylum trends, to rich, in-depth insights generated through qualitative foresight, participatory scenario building, and hybrid methodologies that integrate diverse knowledge forms. The contributions collectively emphasize the power of methodological pluralism, address a spectrum of migration drivers, including conflict and climate change, and critically examine the opportunities, ethical imperatives, and governance challenges associated with novel data sources, such as mobile phone data. By focusing on translating predictive insights and foresight into actionable policies and humanitarian action, this collection aims to advance both academic discourse and provide tangible guidance for policymakers and practitioners. It underscores the importance of navigating inherent uncertainties and strengthening ethical frameworks to ensure that innovations in anticipatory migration policy enhance preparedness, resource allocation, and uphold human dignity in an era of increasing global migration.

Impact statement

This Special Issue aims to inform migration policy and practice by demonstrating how new anticipatory methods can shift governance from reactive to proactive. It provides policymakers, humanitarian organizations, and researchers with actionable insights and tools—from Artificial Intelligence-driven forecasting to participatory foresight—for improved early warning, optimized resource allocation, and the development of more adaptive, evidence-based, and ethically sound migration strategies. By bridging the gap between innovative research and real-world applications, this collection seeks to enhance preparedness for diverse migration scenarios, ultimately fostering more effective and humane outcomes for both migrant and host communities globally in an era of complex human mobility.

1. Introduction: The need for anticipation in migration governance

Migration is a complex and diverse phenomenon, caused and influenced by various factors. Across the world, it has become an increasingly important issue that could yield significant opportunities and challenges for countries of origin, transit, and destination. Without pretending to perfectly forecast the future, the anticipatory methods provide a new and promising way of addressing the field's uncertainty for various policy-related purposes. Anticipatory methods include techniques such as early warning systems, nowcasting, forecasting, horizon scanning, Delphi methods, backcasting, and others. Increasingly, they prove promising for researchers, policymakers, and practitioners to address the challenges of migration and inform forward-looking policy actions.

Driven by the interplay of economic factors, political instability, conflict, social dynamics, and the escalating impacts of climate change, human mobility challenges policymakers worldwide to develop responses that are not only effective but also humane and forward-thinking. Traditional, reactive approaches to migration governance are increasingly proving insufficient in the face of such dynamic and often sudden and disruptive phenomena. This Special Issue, "Anticipatory Methods in Migration Policy: Forecasting, Foresight, and Other Forward-Looking Methods in Migration Policymaking," convenes a diverse collection of scholarly works dedicated to exploring the variety of anticipatory strategies.

This special collection seeks to understand how new data sources, technologies, and anticipatory techniques can help signal emerging migration trends. We aim to understand how decision-makers can leverage anticipatory techniques and implement necessary legal and regulatory considerations to protect the human and data rights of migrants on the way.

The contributions describe the rapidly evolving landscape of tools and methodologies designed to enhance our capacity to look ahead. They move beyond simply acknowledging future uncertainties, offering concrete examples of how forecasting, foresight, and other innovative methods can help anticipate migration trends, assess potential impacts, enhance preparedness, and formulate proactive policies. From the granular predictions generated by Machine Learning (ML) algorithms to the rich, contextual insights generated through participatory foresight and scenario planning, this issue aims to provide a comprehensive overview of the state-of-the-art, its current applications, inherent challenges, and promising future directions. We hope that this collection will not only advance academic discourse but also provide tangible guidance for policymakers, humanitarian organizations, and all stakeholders committed to navigating the future of migration with greater preparedness, effectiveness, and ethical responsibility.

2. The evolving methodological frontier: From prediction to holistic understanding

The field of migration studies is experiencing significant methodological evolution, driven by technological advancements, the availability of new data sources, and a growing recognition of the limitations of singular approaches. This Special Issue seeks to capture this transformation, with a selection of articles that showcase a move toward more integrated, nuanced, and context-aware anticipatory methods.

2.1. Harnessing data and algorithms: The rise of advanced forecasting

A significant portion of this issue is dedicated to the innovative use of **quantitative forecasting and predictive analytics**, with a particular emphasis on ML and Artificial Intelligence (AI). Kjærum and Madsen (2025), for instance, delve into "Pushing the boundaries of anticipatory action using machine learning," detailing their work with the Danish Refugee Council's Anticipatory Humanitarian Action for Displacement model. This model leverages ML to forecast displacement in volatile regions such as the Sahel (Burkina Faso, Mali, and Niger) and South Sudan, using data on conflict, food insecurity, and vegetation health to translate predictions into concrete humanitarian interventions, despite acknowledging the inherent difficulties in forecasting sudden displacement surges. Bosco and coauthors contributed "A Machine Learning architecture to forecast Irregular Border Crossings and Asylum requests for policy

https://doi.org/10.1017/dap.2025.10034 Published online by Cambridge University Press

support in Europe," presenting an ensemble modeling approach that combines different ML methods to predict flows on the Central Mediterranean Route and asylum applications in Italy in the short- and medium-term, achieving high explained variance and underscoring the utility of such tools for timely policy support (Bosco et al., 2024). The development and application of such tools are further explored in Casagran and Stavropoulos (2024) in "Developing AI predictive migration tools to enhance humanitarian support: The case of EUMigraTool." They describe a platform designed specifically for Non-Governmental Organisations (NGOs), offering short and mid-term predictions of asylum seeker arrivals in the European Union (EU) by processing public information from sources like the GDELT Project, Eurostat, and news data, while navigating the complexities of validation and ethically sound deployment. Addressing the challenge of predicting individual intentions, Ruhnke and Rischke, in "Predicting mobility aspirations in Lebanon and Turkey: a data-driven exploration using ML," employ Random Forest models on unique survey data. Their work highlights that while factors like social cohesion and political representation are important predictors for Syrian migrants and host populations, commonly cited drivers like gender are less prominent in their model specification, and overall predictive accuracy for aspirations remains a significant challenge (Ruhnke and Rischke, 2024). Barker and coauthors, in "Mixed-frequency VAR: a new approach to forecasting migration in Europe using macroeconomic data," tackle data heterogeneity by employing a more econometric approach, using panel Vector Autoregressive (VAR) models. Their research demonstrates reasonable short-term forecast performance for migration flows in 26 European countries using macroeconomic drivers, while also noting the high uncertainty in long-term predictions, suggesting that such models may be valuable for coherent scenario development (Barker and Bijak, 2025).

2.2. The double-edged sword: Big data and novel data sources

The proliferation of **big data and novel data sources** offers transformative potential for migration studies, yet it comes with its own set of caveats. "Augmentation or replication? Assessing big data's role in migration studies" provides a critical appraisal of this data explosion. It questions the extent to which sources like mobile phone records and social media genuinely augment traditional insights or merely replicate them, emphasizing the need for rigorous methodological frameworks, ethical stewardship, and validation against established data to truly harness their epistemic value (Bircan, 2024. Aydogdu et al., instead, offer a deep dive into a specific type of big data in "Mobile phone data for anticipating displacements: practices, opportunities, and challenges." They review the life cycle of MPD—from Call Detail Records (CDRs) and GPS traces to newer forms like xDR and airtime top-ups—in the context of forced displacement. Their work highlights MDP capacity for ex-ante analysis in response to natural disasters and conflicts, while meticulously outlining the challenges of data access, anonymization, bias mitigation, and ethical data sharing, advocating for robust data collaboratives (Aydoğdu et al., 2025).

2.3. Beyond numbers: The role of foresight, scenarios, and participation

While quantitative models strive for predictive accuracy, understanding the complex, often deeply human, drivers and implications of migration requires methodologies that embrace qualitative depth, scenario exploration, and direct engagement with affected populations. "Anticipating return migration to Ukraine: participatory foresight with Ukrainians displaced to Spain" compellingly demonstrates the value of such approaches. Through a rich participatory process involving workshops, online discussions, interviews, and an art exhibition, they co-developed four distinct future scenarios for Ukrainian return migration (Exhaustion Return, Energetic Return, Virtual Return, and Disconnection), underscoring how lived experiences and co-created narratives can profoundly inform more nuanced and responsive policymaking (Udovyk and M-Domènech, 2024).

Highlighting a pragmatic alternative to complex predictive models in acute crises (Krelinova 2025), present a case study on forecasting internal displacement in Ukraine. They detail how the International Organization for Migration (IOM) deployed a survey-based forecasting approach—the General

https://doi.org/10.1017/dap.2025.10034 Published online by Cambridge University Press

Population Survey—using telephone interviews to rapidly generate displacement figures, track mobility intentions, and anticipate pathways toward durable solutions (return or integration) in a highly volatile environment. Their work demonstrates that even without historical time-series data, a well-designed survey can provide accurate, near real-time, and actionable evidence for humanitarian planning and government policy, successfully predicting displacement scales and informing social protection caseloads.

"Migration scenarios for gender apartheid and asylum: when International Criminal Law and International Refugee Law Meet" employs a qualitative lens, using case study methods and legal-institutional analysis. This article explores the potential repercussions of codifying gender apartheid as a crime against humanity on asylum claims, particularly for women and girls from Afghanistan, by comparing policy responses in countries like Sweden, Finland, and Denmark with those in Germany and France, thereby delineating crucial migration scenarios at the intersection of international law and refugee protection (Golesorkhi, 2024). Martin et al., in "Anticipating climate change-related mobility in Karachi and Ho Chi Minh City: lessons from a hybrid foresight approach," describe a UNDP project that marries predictive analytics (modeling climate change impacts on internal migration) with participatory foresight workshops and systems mapping. This hybrid methodology allowed for the exploration of complex spatial patterns of population change under different climate scenarios, including Representative Concentration Pathways and the Shared Socioeconomic Pathways. It also covered an evaluation of potential impacts across various socioeconomic domains, offering valuable lessons on integrating diverse knowledge forms for anticipatory policy in the face of climate change (Martin et al., 2025).

Shifting the focus from predictive tools to the institutional processes that use them (Ashkapova 2025), provide a translational case study on North Macedonia's systematic effort to embed anticipatory governance into its national migration policy. The article details the country's multi-phase journey, which involves aligning foresight with its Migration Policy Resolution 2021–2025, extensive capacity-building through training and workshops for government and civil society stakeholders, and the collaborative development of a tailored governance model. By analyzing this process, the authors offer a real-world example of how a nation can move from reactive to proactive policy, while also candidly assessing the persistent challenges of securing government ownership, resources, and long-term sustainability.

2.4. Structuring the field: Conceptual frameworks and methodological reflections

To navigate this burgeoning field, conceptual clarity and overarching frameworks are essential. Marcucci, Verhulst, and Cervantes address this directly in "When forecasting and foresight meet data and innovation: toward a taxonomy of anticipatory methods for migration policy." They propose a novel taxonomy that organizes anticipatory methods into three core categories: Experience-based, Exploration-based, and Expertise-based. This framework aims to guide policymakers and researchers in selecting and integrating the most suitable methods for specific contexts, particularly given the trend toward blending quantitative and qualitative approaches and harnessing innovative tools and data sources (Marcucci et al., 2025). Their work provides a much-needed map for a domain characterized by rapid evolution and methodological diversity.

3. Synthesizing insights: Key contributions to anticipatory migration policy

The articles assembled in this Special Issue make several important contributions to the theory and practice of anticipatory methods in migration policy:

The collection vividly illustrates that the future of anticipatory migration policy lies not in a single "best" method, but in the thoughtful application and integration of a diverse toolkit. We see sophisticated ML models providing granular forecasts of displacement (Kjærum and Madsen, 2025), irregular border crossings (Bosco et al., 2024), and asylum applications (Casagran and Stavropoulos, 2024) (Bosco et al., 2024); advanced statistical techniques tackling complex data structures (Barker and Bijak, 2025); critical assessments of big data true value (Bircan, 2024); in-depth explorations of novel data like MPD (Aydoğdu et al., 2025); scenario-building grounded in legal and social analysis (Golesorkhi, 2024); and,

https://doi.org/10.1017/dap.2025.10034 Published online by Cambridge University Press

participatory and hybrid foresight methodologies that bring human experiences and complex systems thinking to the fore (Udovyk and M-Domènech, 2024; Martin et al., 2025). The explicit call for and demonstration of integrating quantitative predictions with qualitative, contextual understanding is a powerful recurring theme. The research spans a wide array of migration types and contexts, from conflict-induced displacement (Kjærum and Madsen, 2025) and disaster-related movements (Aydoğdu et al., 2025; Martin et al., 2025) to asylum seeking (Bosco et al. 2024; Casagran and Stavropoulos, 2024; Golesorkhi, 2024), labor and economic migration (Barker and Bijak, 2025), return migration dynamics (Udovyk and M-Domènech, 2024), and the foundational level of (im)mobility aspirations (Ruhnke and Rischke, 2024). This thematic richness ensures that the lessons learned have broad applicability across the diverse challenges confronting migration policymakers today. A clear-eyed view of data, its potential, and its pitfalls pervades the issue. Authors explore the utility of sources ranging from official statistics (Eurostat) and macroeconomic indicators (Casagran and Stavropoulos, 2024; Barker and Bijak, 2025) to cutting-edge big data like MPD (Aydoğdu et al., 2025), GDELT event data (Casagran and Stavropoulos, 2024), and rich qualitative data from direct human engagement (Udovyk and M-Domènech, 2024). Concurrently, they highlight persistent challenges: data access restrictions, the cost of acquisition, concerns about quality and representativeness (the "digital divide" [Bircan, 2024]), the need for robust validation techniques (Bircan, 2024; Casagran and Stavropoulos, 2024), and the critical importance of ethical frameworks. Issues of data privacy, potential for bias in algorithms, data colonialism, and the need for responsible data stewardship are explicitly addressed (Bircan, 2024; Casagran and Stavropoulos, 2024; Aydoğdu et al., 2025; Kjærum and Madsen, 2025). Every contribution is motivated by the ultimate goal of informing better, more effective, and more humane migration policies and humanitarian actions. Whether it is the Danish Refugee Council using forecasts to pre-position aid (Kjærum and Madsen, 2025), NGOs leveraging predictive tools for resource allocation (Casagran and Stavropoulos, 2024), or the potential of policymakers using scenarios to understand the implications of legal changes (Golesorkhi, 2024) or climate impacts (Martin et al., 2025), the practical application of anticipatory methods is paramount. This pragmatic focus is consistently coupled with a deep concern for ethical implications, advocating for approaches that respect human rights, ensure fairness, and empower, rather than marginalize, migrant and displaced populations. The call for participatory methods (Udovyk and M-Domènech, 2024; Martin et al., 2025) and human-centric design principles (Casagran and Stavropoulos, 2024) resonates strongly.

4. Navigating uncertainty: Cross-cutting challenges and future horizons

Despite the significant strides documented in this Special Issue, the path toward fully effective anticipatory migration policy is paved with ongoing challenges. The spectre of **uncertainty** looms large; as several authors note, the complex, dynamic, and often crisis-driven nature of migration makes precise prediction a very elusive goal (Ruhnke and Rischke, 2024; Barker and Bijak, 2025; Kjærum and Madsen, 2025), being a matter of predicting low-probability, extreme, and high-impact events. The so-called popularized by Nassim Taleb in his works. Acknowledging and quantifying this uncertainty, rather than striving for an illusion of certainty, is crucial for responsible forecasting and foresight. The limitations of models, including the intrinsic complexity of predicting "black swan" events or unprecedented surges in movement, must be transparently communicated (Kjærum and Madsen, 2025).

The **ethical governance of data and algorithms** requires continuous vigilance. As Bircan (2024) and Aydoğdu et al. (2025) articulate the use of big data and MPD brings risks of surveillance, biased representation, and potential misuse. The principles of privacy-by-design, accountability, transparency (or at least interpretability for complex ML models), and fairness must be embedded in the development and deployment of these technologies, as emphasized in EUMigraTool design (Casagran and Stavropoulos, 2024).

Bridging the **gap between research insights and policy implementation** remains a persistent challenge. This involves more than producing accurate forecasts or compelling scenarios; it requires sustained dialogue, capacity building within policy institutions, and the development of clear pathways

https://doi.org/10.1017/dap.2025.10034 Published online by Cambridge University Press

for integrating anticipatory knowledge into decision-making cycles. The taxonomy proposed by Marcucci et al. (2025) offers a valuable step in this direction, providing a structured way to think about and apply a diverse range of methods. The practical experiences shared in Kjærum and Madsen (2025) in translating forecasts into on-the-ground humanitarian action also offer critical lessons.

Looking forward, several avenues for future research and practice emerge. The integration of quantitative and qualitative approaches, **advancing hybrid methodologies**, as exemplified by Martin et al. (2025) and implicitly by others who combine data analysis with contextual understanding, needs further systematic development and evaluation. Efforts to enhance the availability, quality, and accessibility of migration-relevant data—both traditional and non-traditional—are paramount. **Improving data ecosystems** includes fostering data collaboratives (Aydoğdu et al., 2025), promoting open data standards where appropriate, and investing in data literacy for all stakeholders.

Strengthening ethical frameworks is vital. As AI and big data become more powerful, so too does the need for robust, adaptable ethical guidelines and oversight mechanisms specifically tailored to the migration context. This includes addressing issues of algorithmic bias, group privacy, and data sovereignty. While global and regional trends are important, effective anticipation often requires understanding local drivers, vulnerabilities, and capacities. Methods that can be adapted to specific contexts and that incorporate local knowledge, including participatory approaches (Udovyk and M-Domènech, 2024), will be increasingly vital for **focusing on local and contextualized anticipation**. There is a pressing need for **longitudinal evaluation:** more longitudinal studies that assess the real-world accuracy, utility, and impact of different anticipatory methods over time. This will be key to refining techniques and demonstrating their value proposition.

5. Conclusion: Toward a more anticipatory and humane future

The contributions to this Special Issue reveal a rapidly evolving field—one marked by methodological innovation, interdisciplinary collaboration, and a shared commitment to more humane and forward-looking migration policies. Anticipating migration is no longer a speculative or academic endeavor; it has become an essential pillar of effective governance, responsible humanitarian response, and the broader effort to safeguard human dignity amid growing global mobility.

Equally vital is the cultivation of communities of practice, such as the Big Data for Migration Alliance, which can foster the exchange of lessons learned, ethical standards, and proven practices across institutions and geographies. These networks play a crucial role in building capacity, aligning norms, and scaling what works.

To truly enable anticipatory capacity, data must be made available in a more systematic, sustainable, and responsible manner. This includes ensuring interoperability, addressing biases and data asymmetries, and embedding safeguards to protect individuals and communities. It also requires designing governance frameworks that enable data sharing while respecting rights and trust.

Finally, there is a pressing need to deepen our understanding of the potential and limitations of AI in migration forecasting. While AI promises enhanced precision and timeliness, it also introduces risks—such as reinforcing discriminatory patterns or obscuring accountability. Ongoing research, ethical scrutiny, and participatory design will be critical to harnessing AI responsibly in this domain.

Regarding the use of AI with migration data, the EU AI Act represents a pioneering effort to introduce robust governance and uphold European values. By classifying many AI applications in the migration, asylum, and border management spheres as "high-risk," the Act mandates significant safeguards, including enhanced data quality, transparency in system use, and crucial human oversight.

The journey toward anticipatory migration governance is complex, but the rewards—more resilient institutions, more just outcomes, and more humane futures—are worth the efforts. We hope that the research presented here will inspire continued innovation, critical reflection, and concerted action to realize that vision.

https://doi.org/10.1017/dap.2025.10034 Published online by Cambridge University Press

Acknowledgments. The Guest Editors express their sincere gratitude to all the authors whose rigorous research and thoughtful contributions have made this Special Issue possible. We also extend our thanks to the many anonymous reviewers whose insightful feedback was invaluable in shaping these articles. Finally, we acknowledge the support of the editorial team at Data & Policy for their guidance throughout this process.

Author contribution. Conceptualization: M.F., M.B., A.R., and S.V. Investigation: M.F., M.B., and A.R. Fact checking: M.F., M.B., A.R., and S.V. Writing—original draft: M.F. Writing—review and editing: M.F., M.B., C.B., D.J., A.M.P., U.M., A.R., and S.V. All authors approved the final submitted draft.

Competing interests. The authors declare no competing interests.

Ethical standard. The research meets all ethical guidelines, including adherence to the legal requirements of the study country.

References

Ashkapova V and Zulfiu Alili M (2025) *"Embracing Foresight in Migration Policy: A Transformative Journey towards Anticipatory Governance in North Macedonia". In: Data & Policy.* Forthcoming.

Aydoğdu B, **Bilgili Ö**, **Güneş S and Salah AA** (2025) Mobile phone data for anticipating displacements: Practices, opportunities, and challenges. *Data & Policy 7*, e5. https://doi.org/10.1017/dap.2024.94.

Barker ER and Bijak J (2025) Mixed-frequency VAR: A new approach to forecasting migration in Europe using macroeconomic data. *Data & Policy 7*, e3. https://doi.org/10.1017/dap.2024.82.

Bircan T (2024) Augmentation or replication? Assessing big data's role in migration studies. *Data & Policy 6*, e51. https://doi.org/10.1017/dap.2024.57.

Bosco C, **Minora U**, **Rosińska A**, **Teobaldelli M and Belmonte M** (2024) A machine learning architecture to forecast irregular border crossings and asylum requests for policy support in Europe: A case study. *Data & Policy 6*, e81. https://doi.org/10.1017/dap.2024.48.

Casagran CB and Stavropoulos G (2024) Developing AI predictive migration tools to enhance humanitarian support: The case of EUMigraTool. *Data & Policy 7*, e64. https://doi.org/10.1017/dap.2024.76.

Golesorkhi LZ (2024) Migration scenarios for gender apartheid and asylum: When international criminal law and international refugee law meet. *Data & Policy 6*, e77. https://doi.org/10.1017/dap.2024.51.

Kjærum A and Madsen BS (2025) Pushing the boundaries of anticipatory action using machine learning. *Data & Policy 7*, e8. https://doi.org/10.1017/dap.2024.88.

Krelinova K, **Loktieva I** & **Jusselme D** (2025) Forecasting displacement and solutions for decision-making in volatile contexts: a case study from Ukraine. *Data & Policy*, 7. https://doi.org/10.1017/dap.2024.46.

Marcucci S, **Verhulst S and Cervantes ME** (2025) When forecasting and foresight meet data and innovation: Toward a taxonomy of anticipatory methods for migration policy. *Data & Policy 7*, e24. https://doi.org/10.1017/dap.2024.56.

Martin A, **Kistemaker B**, **Allen B and Jones B** (2025) Anticipating climate change-related mobility in Karachi and Ho Chi Minh City: Lessons from a hybrid foresight approach. *Data & Policy 7*, e13. https://doi.org/10.1017/dap.2025.2.

Ruhnke S and Rischke R (2024) Predicting mobility aspirations in Lebanon and Turkey: A data-driven exploration using machine learning. *Data & Policy 6*, e47. https://doi.org/10.1017/dap.2024.32.

Udovyk O and M-Domènech R (2024) Anticipating return migration to Ukraine: Participatory foresight with Ukrainians displaced to Spain. *Data & Policy 6*, e48. https://doi.org/10.1017/dap.2024.45.

Cite this article: Fontana M, Belmonte M, Bosco C, Jusselme D, Menocal Peters A, Minora U, Rosinska A and Verhulst S (2025). Anticipating human mobility: Methods, data, and policy in forecasting and foresight. *Data & Policy*, 7: e70. doi:10.1017/dap.2025.10034