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Time to travel: climate migration in the course of history

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ABSTRACT

This study examines climate migration as a historically embedded phenomenon and situates contemporary climate-induced mobility within a long-term perspective. It aims to demonstrate that migration driven by environmental change is not an unprecedented crisis, but a recurring adaptive strategy that has shaped human settlement patterns and social transformation across time. Methodologically, the article employs a historical-analytical approach based on an interdisciplinary literature review, integrating insights from environmental history, migration studies, archaeology, and climate science. Through comparative temporal analysis, it traces climate-related mobility from prehistoric periods to the present to identify structural continuities and contextual shifts. The findings indicate that climatic variability has consistently triggered significant population movements. Prehistoric migrations out of Africa were influenced by glacial cycles and desertification. In classical and medieval eras, prolonged droughts and cooling periods contributed to political instability and demographic change. During the early modern period, climate shocks intersected with colonial expansion and global trade. In the contemporary era, anthropogenic climate change has intensified displacement, compounded by border regimes, legal constraints, and socioeconomic inequalities. Theoretically, the study reframes climate migration as a long-standing adaptive response rather than solely a humanitarian crisis. Practically, it highlights the importance of historically informed and equity-based policy frameworks to govern climate-induced mobility more sustainably.

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Introduction

Human history is profoundly shaped by the rhythms of the natural environment, and climate has always been one of the most decisive forces in determining where and how people live (Covert & Medeiros, 2021; Codding et al., 2024; Santana et al., 2025). The movement of human populations, whether across continents or within regions, has often been catalyzed by climatic shifts that altered landscapes, disrupted ecosystems, and constrained resources (Raina et al., 2025). From the earliest dispersals of *Homo sapiens* out of Africa to the displacements caused by contemporary sea-level rise, climate-induced migration represents a recurring phenomenon that transcends time and geography (Nicholson et al., 2022; Atapattu, 2020). Understanding this relationship requires not only attention to present-day data but also a long historical perspective that situates modern experiences within a continuum of human environment interactions. Evidence from archaeology and paleoclimatology highlights that early human migrations were closely tied to major climatic events (Qin & Sun, 2023; Codding et al., 2024; Friesen et al., 2020; Rostain & Gregorio Da Souza, 2023; Schaebitz et al., 2021). Approximately 60,000–70,000 years ago, *Homo sapiens* began migrating out of Africa a process widely linked to changing climate conditions

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(Mohamed et al., 2025). The Sahara, which at times was a fertile and habitable region, underwent cycles of desertification that forced populations to move in search of water and grazing land (Larrasoña, 2021; Biagetti, 2023; Tandjaoui et al., 2025; Deng et al., 2024). Similarly, the end of the last Ice Age around 12,000 years ago saw massive shifts in human settlement patterns as retreating glaciers opened new territories in Europe and Asia while simultaneously submerging coastal plains (Bortolini et al., 2021; D. Li et al., 2025; Agatova & Nepop, 2025). The so-called '*Fertile Crescent*,' often celebrated as the cradle of agriculture, was itself the product of favorable climatic conditions that allowed early humans to transition from nomadic lifestyles to sedentary farming (Jaradat, 2017; Riehl, 2016). These examples underscore the fundamental role of climate in shaping the trajectory of human civilization.

The conceptualization of climate migration can be framed through migration theories that emphasize the interplay of 'push' and 'pull' factors (Newete et al., 2025; Halliru et al., 2024; Udoh et al., 2025; Bakaki, 2021; Majumder & Rahman, 2022; Mukherjee & Fransen, 2024). Push factors such as drought, famine, and resource scarcity create pressures that drive people away from their homelands (Cook & Comstock, 2022; Bukari et al., 2020; Raha & Gayen, 2021), while pull factors such as fertile land, safety, or economic opportunity attract them to new areas (Ochoa-Moreno et al., 2025; Madan & Dangi, 2023; Amar et al., 2020; Schouler-Ocak et al., 2025; Naval et al., 2025; Ghafoor et al., 2022; Hermans et al., 2023). Environmental determinism, though criticized for neglecting human agency, provides a lens to understand how ecological constraints have historically influenced large-scale demographic shifts (Corbett et al., 2018). More recent adaptation theory refines this understanding by acknowledging that communities may employ technological, social, or cultural innovations to cope with environmental stress, but that migration becomes necessary when adaptation is insufficient (Ghimire & Chhetri, 2023; Cherupelly, 2025; Silva-Ávila et al., 2025). Thus, climate migration is not merely a reaction to disaster but a complex process mediated by human resilience, political structures, and economic opportunities. Historical records illustrate how climate change has contributed to the rise and fall of civilizations. In Mesoamerica, the collapse of the Classic Maya civilization during the ninth century has been linked to a series of prolonged droughts, which undermined agricultural productivity and fueled political instability (Braun et al., 2023; Arnould, 2024). In Central Asia, recurring periods of drought and environmental degradation contributed to the expansion and movement of nomadic groups, which in turn reshaped empires across Eurasia (Chen et al., 2024; Shaikh Baikloo Islam, 2023; Matloubkari & Shaikh Baikloo Islam, 2022; Lukyanets, 2020). In Europe, the onset of the Little Ice Age between the fourteenth and nineteenth centuries created cooler and wetter conditions that diminished crop yields, leading to recurrent famines, rural depopulation, and waves of migration to urban centers (Costello et al., 2023). Likewise, in Southeast Asia, the decline of the Khmer Empire around the fifteenth century is partially attributed to monsoon failures and hydrological disruptions that destabilized its sophisticated irrigation systems (Klassen et al., 2021; Zhao et al., 2024). These examples reveal that climate-induced migration has not been an episodic occurrence but a structural force in world history, influencing economic systems, political stability, and cultural transformations.

The early modern period and the advent of the Industrial Revolution added new layers of complexity to the dynamics of climate migration (Tagliacozzo et al., 2024; Bell, 2023). In Europe, agricultural crises exacerbated by cold spells and harvest failures spurred rural-to-urban migration, while overseas colonization created outlets for populations displaced by environmental stress (Gillespie, 2020). During the nineteenth and early twentieth centuries, climatic shocks such as droughts in India and China, coupled with global market dependencies, triggered mass famines that displaced millions (Singh, 2022; Wei & Li, 2024; Jiang & Lee, 2025; Liu & Yan, 2020). Famines in Bengal, for example, were closely tied to monsoon variability, leading to large-scale mortality and migration (B. Chatterjee, 2023; Tongwane et al., 2022; Kathayat et al., 2022). In North America, the Dust Bowl of the 1930s caused by a combination of drought and unsustainable farming practices displaced hundreds of thousands of people, primarily from Oklahoma, Texas, and Kansas, toward California in search of survival (Stephens, 2023; Gregory, 1991; Hurt, 1984; Worster, 2004; Schubert et al., 2004). This episode became emblematic of the complex interplay between environmental degradation, climatic variability, and structural economic vulnerability, illustrating how ecological shocks can intensify pre-existing socioeconomic inequalities and trigger large-scale population displacement (Sadler, 2023; Marcantonio et al., 2024; Fakuade & Akilli, 2026). It reflects not merely a temporary crisis, but a structural convergence of environmental stressors and fragile livelihoods that ultimately produced one of the largest waves of internal migration in the history of the United States.

In contemporary times, the scale and urgency of climate migration have reached unprecedented levels. According to the Internal Displacement Monitoring Centre (IDMC), weather-related disasters alone displaced more than 32 million people worldwide in 2022, a figure that surpasses displacements caused by conflict and violence (McLeman, 2025; Ideki & Ajoku, 2024; Babangida et al., 2024; Ivanova et al., 2024; Thorn et al., 2023; Roy et al., 2022; Mugambiwa & Sibanda, 2025; Leal Filho et al., 2023). Regions most affected include South Asia, Sub-Saharan Africa, and small island states in the Pacific, where sea-level rise threatens entire communities with the prospect of permanent relocation (Singh & Feroze, 2023; Qadir et al., 2025; Kankara et al., 2022; Kemgang Ghomsi et al., 2025; Abu et al., 2024; Esteban et al., 2020; Kumar & Saxena, 2021; Ghomsi et al., 2024; Ahmed & Mishra, 2020). Bangladesh, for instance, faces an estimated 13 million internal climate migrants by 2050 due to coastal flooding (Gupta et al., 2025; Davis et al., 2018), while the Pacific Islands confront the existential challenge of nations losing their habitable land (Hoque, 2024; Akash et al., 2024; Rahaman et al., 2021; Gupta et al., 2025; O'Neill et al., 2025; Kumar et al., 2020; Kuir-Ayius, 2024). Unlike historical migrations, which often unfolded over centuries, modern climate displacement occurs at a much faster pace, compounded by population density, urbanization, and global interdependence. Despite these alarming trends, the legal and policy frameworks for addressing climate migration remain underdeveloped. The term 'climate refugees' has gained traction in media and advocacy, but it lacks recognition in international law, which still restricts refugee status to those fleeing persecution. This gap underscores the importance of situating the current crisis within a historical narrative, understanding that climate-induced migration is neither a new nor temporary phenomenon, but a recurrent pattern with profound implications for human security and global governance.

This article is grounded in a historical-comparative analytical framework that seeks to transcend the temporal limitations of much contemporary scholarship on climate migration. Whereas a substantial portion of existing literature concentrates predominantly on present-day vulnerabilities and forward-looking projections particularly those informed by assessments of the Intergovernmental Panel on Climate Change this study adopts a *longue durée* perspective to demonstrate that climatic variability has persistently functioned as a structural driver of human mobility across different epochs. By situating contemporary climate-induced displacement within a broader historical trajectory, the article challenges the implicit assumption that such movements represent an unprecedented phenomenon unique to the twenty-first century. Through a systematic examination of diverse historical contexts including prehistoric human dispersals shaped by glacial-interglacial cycles, the environmental stresses associated with the transformation and collapse of classical civilizations, the climate-related famines of the early modern and modern periods, and current patterns of internal displacement and cross-border mobility the study illuminates both enduring continuities and historically specific divergences in societal responses to environmental pressures. This comparative approach underscores that while climate-related stress has recurrently acted as a catalyst for migration, the scale, direction, and consequences of such mobility have been mediated by political institutions, economic structures, technological capacities, and cultural norms. By foregrounding these mediating variables, the article advances a more nuanced understanding of resilience not merely as an inherent adaptive capacity, but as a historically contingent outcome shaped by governance systems, social inequalities, and access to resources. In doing so, it highlights how state formation, market integration, imperial expansion, and contemporary globalization have profoundly influenced the ways in which environmental stress translates into migration decisions and mobility regimes.

The objectives of this study are therefore twofold. First, it seeks to map the trajectories of climate-related migration across distinct historical periods, identifying recurring patterns of causation, adaptation, and transformation. Second, it aims to reposition contemporary debates surrounding so-called 'climate refugees' within this extended historical continuum, thereby interrogating the novelty often attributed to current displacement dynamics. By embedding present-day policy discussions within a deeper temporal framework, the article contributes to both academic discourse and normative debates, emphasizing that the governance challenges posed by climate-induced mobility cannot be adequately addressed without historical awareness. Ultimately, the study contends that climate migration is not an aberration of the Anthropocene era but rather a persistent feature of the human condition. Recognizing this historical continuity does not diminish the urgency of contemporary climate crises; rather, it compels policymakers and scholars alike to draw lessons from past experiences in order to formulate responses that are more equitable, context-sensitive, and sustainable in the face of intensifying climatic change.

Climate-Induced migration in historical and contemporary perspective

Over the past two decades, the study of climate-induced migration has attracted growing scholarly attention, particularly in response to the escalating scale and frequency of environmental disruptions associated with anthropogenic climate change. Contemporary academic discourse has been significantly influenced by assessments conducted by the Intergovernmental Panel on Climate Change (IPCC), which consistently underscore the role of environmental stressors such as extreme weather events, sea-level rise, and prolonged drought in shaping patterns of internal displacement as well as cross-border mobility (Rudolph et al., 2025; Woodworth, 2024; Tanyanyiwa, 2020). Reports from the International Organization for Migration (IOM) and the Internal Displacement Monitoring Centre (IDMC) have quantified the number of people displaced annually by floods, droughts, storms, and wildfires, framing climate migration as one of the defining humanitarian challenges of the twenty-first century (Trinh & Munro, 2024; Hirsch et al., 2024; Kaczan & Orgill-Meyer, 2020; Ibrahim & Mensah, 2022; Lindvall et al., 2020; Winkler & Rouleau, 2021). Scholars such as Myers (2002) and Black et al. (2011) have provided estimates of potential 'climate refugees,' ranging from 25 million to over 200 million by 2050, highlighting the urgency of policy responses (Myers, 2002; Black, Adger, et al., 2011; Andrew Baldwin, 2020; S. Chatterjee, 2023; Eksi, 2023; Mehta et al., 2025). At the same time, a body of historical and interdisciplinary scholarship has emphasized that climate migration is not a new phenomenon (Jarawura et al., 2024; Degroot et al., 2021; Mallick & Hunter, 2024; Avallone, 2024). Archaeological studies and paleoclimatic research have demonstrated that early *Homo sapiens* migrations were closely tied to shifts in temperature, rainfall, and resource availability (Timmermann et al., 2022; Ao et al., 2024; Peng et al., 2021). Historians such as Weiss and Bradley (2001) have linked the collapse of ancient civilizations, including the Akkadian Empire and the Maya, to episodes of prolonged drought (Weiss & Bradley, 2001; James et al., 2025; Shaikh Baikloo Islam, 2021). More recent works in environmental history, such as those by Geoffrey Parker (2013), have examined the impact of the Little Ice Age on early modern societies, illustrating how climatic stress intersected with warfare, famine, and political instability to accelerate human mobility (Kaniewski et al., 2025; Morales Estévez, 2025; Peregrine, 2020; Duffy, 2020; Tang et al., 2025). These studies underscore that climate-induced migration is a recurrent pattern in human history, although the scale and social consequences have varied. Within migration studies, scholars have debated whether climate change should be considered a direct cause of migration or a contributing factor that interacts with political, economic, and social drivers. Some researchers argue for the concept of 'environmental refugees,' positioning climate change as a primary driver of forced migration (Myers, 2002; Askland et al., 2022; Ayeb-Karlsson et al., 2022; Bose, 2024). Others caution against environmental determinism, emphasizing that migration decisions are mediated by governance structures, livelihood strategies, and individual agency (McLeman, 2025). This debate reflects a broader tension in the field: whether climate migration should be understood primarily as a security threat, a humanitarian challenge, or an adaptive response.

Notwithstanding the expanding corpus of scholarship on climate-induced mobility, several substantive gaps persist within the literature. First, a considerable proportion of contemporary research prioritizes predictive modeling and present-day empirical case studies, frequently neglecting the deeper historical antecedents of climate-related migration. Although environmental historians and archaeologists have generated important insights into particular historical episodes, these findings are seldom systematically integrated into mainstream migration studies, thereby producing a conceptual and analytical disjunction between historical and contemporary perspectives. Second, existing scholarship often remains regionally compartmentalized. Major migratory processes such as prehistoric dispersals out of Africa, the climate-related decline of agrarian polities in Asia, and the contemporary displacement of Pacific Island communities are commonly examined as discrete phenomena rather than as interconnected components of a *longue durée* trajectory of human adaptation. This fragmentation limits the development of a coherent, transhistorical understanding of mobility as a recurring response to environmental transformation.

Third, policy-oriented literature frequently frames climate migration as an impending or future crisis, instead of recognizing it as a historically embedded and enduring adaptive strategy. Such forward-looking narratives risk obscuring the extent to which mobility has long functioned as a structural feature of human-environment interaction. To address these limitations, the present study adopts a diachronic and comparative analytical framework that situates contemporary climate migration within a broader

historical continuum. By synthesizing archaeological findings, paleoclimatic reconstructions, historical documentation, and current migration research, this article elucidates both the structural continuities and the distinctive characteristics of climate-induced mobility across time. In doing so, it seeks to bridge the disciplinary divide between environmental history and migration studies, while advancing a more comprehensive conceptual framework that positions climate migration simultaneously as an ancient adaptive practice and a defining challenge of the contemporary global era.

Theoretical foundation of climate migration

The study of climate migration requires an interdisciplinary theoretical foundation that integrates insights from migration studies, environmental history, and climate science. Traditional migration theories, particularly the push–pull framework, provide a starting point for understanding climate-induced mobility (De Sherbinin et al., 2022; Hunter & Simon, 2023; Garip & Reed, 2025). This model identifies ‘push’ factors such as drought, famine, or flooding, which compel people to leave their homes, and ‘pull’ factors such as the availability of arable land, water resources, or economic opportunities, which attract migrants to new regions (Lee, 1966).

Climate change amplifies structural push factors by eroding livelihood systems, degrading ecological stability, and diminishing the habitability of affected regions (Intergovernmental Panel on Climate Change, 2022; Black, Bennett, et al., 2011). Simultaneously, it may constrain conventional pull factors, as potential destination areas confront intensified resource competition, governance constraints, and infrastructural limitations that reduce their absorptive capacity (IOM, 2022). Accordingly, climate-induced mobility cannot be sufficiently explained through classical push–pull models alone, as environmental change reconfigures both origin and destination contexts in dynamic and interdependent ways (Lee, 1966). Beyond push–pull dynamics, the vulnerability–resilience framework offers a critical analytical perspective for examining the uneven effects of climate change on migration decisions. Vulnerability is not solely a function of exposure to climatic hazards; rather, it is socially constructed and shaped by socioeconomic inequalities, institutional capacity, governance arrangements, and culturally embedded adaptive strategies (Adger, 2006; Cutter et al., 2012). These interacting dimensions influence both the propensity and the capability of individuals and communities to employ migration as a form of adaptation. In this respect, mobility outcomes reflect differentiated resilience capacities across social groups and territories, underscoring the importance of integrating environmental, political, and socioeconomic variables into migration analysis (Papathoma-Köhle et al., 2021; Gellu et al., 2025; Osei-Amponsah et al., 2023). Communities with strong adaptive capacity may withstand climatic stress without large-scale displacement, while marginalized or resource-dependent populations are more likely to migrate. This explains why, historically, climate variability triggered collapses in some societies while others adapted through technological innovation, social reorganization, or mobility.

Another relevant perspective comes from adaptation theory, which positions migration not solely as a crisis but as a form of adaptation to environmental stress. McLeman and Smit (2006) argue that migration can be an active strategy to reduce vulnerability, diversify livelihoods, and ensure survival (McLeman & Smit, 2006). From prehistoric dispersals to contemporary internal migration, mobility has repeatedly allowed human groups to manage risk and sustain resilience (Macdonald & Maher, 2022; Riris et al., 2024; Ngwenya et al., 2025). By reframing migration as adaptation rather than failure, this perspective challenges crisis-oriented narratives and highlights the agency of migrants across history. A final theoretical lens is provided by world-systems theory and political ecology, which emphasize the structural conditions under which climate migration occurs. In the early modern and modern periods, climatic disruptions intersected with global economic systems, colonial expansion, and unequal resource distribution, shaping who migrated, where, and under what conditions (Hoffmann et al., 2024). This approach highlights the political and economic dimensions of climate migration, reminding us that environmental stress alone does not determine outcomes; it interacts with systemic inequalities that magnify risks for certain populations. Together, these theoretical perspectives offer a layered understanding of climate migration as both a recurring response to environmental variability and a phenomenon shaped by historical and structural contexts. The push–pull framework captures immediate drivers, the vulnerability–resilience lens explains differential impacts, adaptation theory reframes

migration as agency, and political ecology situates it within larger systems of power and inequality. This integrated framework allows the present study to interpret climate migration not as a singular or novel event, but as a complex, multidimensional process that has shaped human history from prehistory to the present.

Migration theory is an interdisciplinary body of scholarship that seeks to explain why people move, how migration processes unfold, and what consequences mobility generates for both sending and receiving societies (Hunter et al., 2015). Historically, migration theory emerged from economics and demography, but it has evolved to incorporate sociological, political, and environmental perspectives. At its foundation, migration theory attempts to identify the structural and individual-level factors that influence mobility decisions, recognizing that migration is rarely caused by a single determinant (O'reilly, 2022). Instead, it is shaped by interacting economic opportunities, social relationships, political conditions, demographic pressures, and increasingly, environmental transformations. Classical economic approaches, particularly neoclassical migration theory, conceptualize migration as a rational decision made by individuals who compare expected costs and benefits across locations (Agustín & Jørgensen, 2025). In this framework, wage differentials, employment prospects, and labor demand serve as primary drivers of mobility. Migration is therefore interpreted as a mechanism for achieving equilibrium in labor markets, where workers move from low-wage to high-wage regions. While this perspective remains influential, it has been criticized for oversimplifying decision-making processes and neglecting broader social and institutional contexts (Favell, 2022).

The push–pull framework expanded the analysis by identifying conditions that ‘push’ individuals out of origin areas such as unemployment, political instability, demographic pressure, or resource scarcity and those that ‘pull’ them toward destinations offering safety, economic opportunity, or social mobility (Niu, 2022; Shi et al., 2025). Although analytically useful, this framework has also been critiqued for treating migration drivers as static and independent, rather than dynamic and interrelated. More recent theoretical developments, such as the new economics of labor migration, emphasize that migration decisions are often made collectively within households. Families may send one or more members abroad to diversify income sources, manage risk, and improve long-term security. Social networks further reduce uncertainty and lower migration costs by providing information, financial support, and assistance in destination areas (Nawyn et al., 2024). In their 2023 contribution to migration scholarship, Lori M. Hunter and Daniel H. Simon argue that contemporary migration theory must more fully integrate environmental and climate-related dynamics (Hunter & Simon, 2023). They contend that environmental change has often been treated as a secondary or peripheral driver, rather than as a central component of migration systems. According to their analysis, failing to incorporate environmental variables into migration models risks theoretical misspecification, especially in an era characterized by accelerating climate change, extreme weather events, sea-level rise, and ecological degradation.

Hunter and Simon emphasize that environmental factors rarely operate in isolation. Instead, environmental stress interacts with economic vulnerability, governance capacity, demographic structures, and social inequalities. For example, prolonged drought may undermine agricultural livelihoods, but whether migration occurs depends on access to resources, household assets, migration networks, and policy environments. Environmental pressures can therefore intensify existing socioeconomic disparities, shaping who is able to migrate, who becomes immobile, and who faces forced displacement. By embedding environmental dynamics within established theoretical frameworks, they advocate for a more holistic understanding of migration that reflects real-world complexity. Importantly, their work challenges simplistic narratives such as the idea of ‘climate refugees,’ which can obscure the multifaceted motivations behind mobility. Instead of portraying migration as a direct and automatic response to environmental change, they conceptualize it as a mediated process influenced by structural conditions and agency. This approach reinforces the idea that migration is neither purely voluntary nor entirely forced, but situated along a continuum shaped by interacting constraints and opportunities. Overall, contemporary migration theory, particularly as refined by Hunter and Simon, underscores that human mobility is a complex social process embedded within economic systems, social networks, political institutions, and environmental transformations. Understanding migration in the twenty-first century therefore requires theoretical models that are integrative, context-sensitive, and attentive to the accelerating environmental changes reshaping human livelihoods worldwide.

Research methodology

This study employs a historical-analytical methodology to examine the relationship between climate change and human migration across different periods of history (Reinecke & Löhr, 2024; Scholten et al., 2022). Rather than approaching climate migration solely through contemporary policy or demographic analysis, the research situates the phenomenon within a *longue durée* perspective, highlighting continuities and transformations from prehistory to the present. The methodology integrates interdisciplinary sources, drawing from archaeology, paleoclimatology, historical demography, anthropology, and environmental history, to reconstruct the ways in which climate variability has shaped patterns of mobility. The analysis begins with prehistoric and early human migration, using paleoenvironmental data such as ice core records, sediment analysis, and fossil distribution to understand how glacial cycles, desertification, and shifts in rainfall influenced the dispersal of *Homo sapiens*. Archaeological findings are employed to trace settlement abandonment and resettlement patterns, providing evidence of human adaptation strategies (Peleg-Barkat et al., 2025; Marston & Vaiglova, 2024). For classical and medieval societies, the study relies on textual records, agricultural data, and proxy climate indicators such as tree rings and isotopic evidence to correlate climatic shifts with population movements, state collapse, and social transformation. This study combines historical climate data and archival sources with contemporary reports and academic research to analyze climate migration across different periods. Using a comparative and thematic approach, it examines cases from prehistoric times to the present to identify recurring patterns and context-specific factors. By adopting a diachronic and interdisciplinary framework, the research highlights climate migration as a persistent adaptive strategy throughout history while addressing the unique challenges of modern, human-induced climate change. The study ultimately bridges environmental history and contemporary policy analysis to inform more historically grounded approaches to climate mobility in the twenty-first century.

Prehistoric climate variability and early human migrations

The earliest phases of human migration were inseparable from the climatic fluctuations of the *Pleistocene epoch* (Timmermann et al., 2022; Timmermann & Friedrich, 2016; Gibling, 2018). Evidence from archaeology, paleoclimatology, and genetics suggests that the dispersal of *Homo sapiens* from Africa between 60,000 and 70,000 years ago was deeply influenced by environmental shifts (Parker & Underdown, 2023; Ramesh, 2025b). During this period, the planet experienced alternating cycles of glaciation and warming that reshaped ecosystems and forced human populations to adapt or relocate (Lane, 2023; Hughes et al., 2022; Stibel, 2023; Mjærum, 2022). The Sahara, for example, was not always the vast desert it is today, during humid phases, it was a green corridor filled with rivers and lakes that facilitated human expansion into North Africa and beyond (Couper et al., 2025; Knight, 2023; Menviel et al., 2021; Duque-Villegas et al., 2022; Amarathunga et al., 2024). However, repeated desertification events turned the region into an environmental barrier, compelling groups to seek alternative routes through the Nile Valley or along coastal areas. Genetic studies reinforce this narrative, indicating that small groups of *Homo sapiens* moved gradually out of Africa into the Arabian Peninsula and South Asia, following paths determined largely by climate-driven resource availability (Couper et al., 2025; Barreiros, 2025; Scheffran, 2025; Bampton, 2023). Paleoclimatic records show that periods of reduced rainfall in East Africa coincided with human dispersals, while greener conditions in the Arabian Peninsula opened new territories for habitation (Stewart et al., 2020; Khalifa, 2026b; Joshipura, 2025; Rose, 2022; Vaezi et al., 2025). Climate thus operated both as a push factor, driving people away from areas that could no longer support life, and as a pull factor, attracting them to newly habitable environments.

Table 1 highlights that climatic shifts consistently acted as triggers for migration. During the Last Glacial Maximum, for instance, much of northern Europe and Asia was covered by ice sheets, forcing populations to retreat into ecological refugia (Bosson et al., 2023; Fu & Wen, 2023; Stojak & Jędrzejewska, 2022; Leonardi et al., 2022; Reutimann et al., 2026). Archaeological findings indicate population bottlenecks during this time, with small groups surviving in southern Europe, the Levant, and parts of Africa until the climate warmed again (Molloy, 2023; Rozov, 2026b; Rozov, 2026a; Westley et al., 2023). The subsequent Holocene warming, beginning around 12,000 years ago, transformed previously glaciated

Table 1. Key climatic events and their corresponding impacts on human migration during the prehistoric era.

Approximate period (years ago)	Climatic event	Impact on human migration	Adaptation strategies
120,000–90,000	Interglacial warm period	Initial dispersals of <i>homo sapiens</i> into Levant	Used of costal resources, seasonal mobility
70,000–60,000	Sahara desertification, drought in East Africa	Large-scale migration out of Africa toward Arabia and South Asia	Shift to costal migration routes, reliance on marine food
20,000–12,000	Last Glacial Maximum (cold, dry conditions)	Retreat into refugia, population bottlenecks in Africa, Europe, and Asia	Use of caves, improved clothing and tool technologies
12,000–10,000	Holocene warming, end of Ice Age	Expansion into Europe and Northern Asia, Migration to newly opened territories	Domestication of plants and animals, development of agriculture

landscapes into fertile territories (Nogu   et al., 2025; McNeill, 2025). This warming coincided with one of the most significant human transitions in history: the shift from foraging to agriculture. Adaptation strategies were central to the survival of early societies in these shifting environments. Coastal migration routes provided steady access to marine resources during times when inland ecosystems collapsed (Waller et al., 2023). Technological innovations including the refinement of stone tools, the development of tailored clothing, and the controlled use of fire substantially enhanced human capacity to adapt to and survive in colder climatic conditions. Concurrently, social strategies characterized by the formation of larger and more cooperative groups strengthened collective resilience through the pooling of resources, labor, and knowledge. With the relative stabilization of climatic conditions during the early Holocene, human societies increasingly transitioned toward the domestication of plants and animals. While this shift facilitated sedentism and anchored populations to specific geographic regions, it simultaneously generated new forms of vulnerability, particularly through heightened dependence on agriculture and exposure to climatic variability (Semplici & Campbell, 2023; Scheffran, 2025). The prehistoric record indicates that human migration was not a random or purely spontaneous phenomenon, but rather a structured and context-dependent response to climatic opportunities and constraints. Archaeological, paleoenvironmental, and anthropological evidence consistently demonstrates that patterns of mobility were closely synchronized with fluctuations in temperature, precipitation, and ecosystem productivity. Although early human communities developed adaptive strategies such as technological innovation, flexible subsistence practices, and social cooperation that enabled them to survive under adverse environmental conditions, these mechanisms had ecological and physiological limits. When climatic stress exceeded certain environmental thresholds such as prolonged drought, glacial expansion, resource depletion, or abrupt shifts in habitat suitability local adaptation alone proved insufficient, thereby rendering migration a necessary and often unavoidable strategy for survival and continuity. This dynamic interaction between environmental adaptation and spatial mobility established a foundational pattern in human history: movement functioned not merely as a reactive crisis response, but as an integral component of long-term resilience and demographic expansion. Consequently, the prehistoric experience underscores that climate has been among the earliest, most persistent, and structurally embedded drivers of human mobility, shaping settlement patterns, cultural evolution, and the geographic distribution of populations across millennia.

Classical and medieval periods

As human societies expanded and organized into complex civilizations, the relationship between climate and migration became increasingly visible in recorded history (Degroot et al., 2022; Altaweel et al., 2025; Ramesh, 2025a). Unlike in prehistoric times, where evidence comes mainly from archaeology and paleoclimate reconstructions, the classical and medieval periods provide written accounts that allow for a richer understanding of how climate shifts shaped mobility, empire stability, and cultural transformations (McNeill & Mauldin, 2025; Manning, 2025; Pei et al., 2023; Whitaker et al., 2024). These centuries reveal that climate not only drove the displacement of populations but also influenced the rise and fall of states, the spread of religions, and the reconfiguration of trade and settlement networks (Vince, 2022a; De La Torre, 2022; Vince, 2022b). One of the earliest examples comes from the eastern Mediterranean, around the late Bronze Age (circa 1200 BCE) (Iacono et al., 2022; Hall & Osborne, 2022; Millek, 2023), a prolonged period of drought is thought to have contributed to the collapse of several

advanced societies, including the Hittite Empire and the Mycenaean civilization (Molloy, 2023; d'Alfonso et al., 2020; Maltas et al., 2023; Cline, 2022; Ren et al., 2021). Archaeological and textual records suggest widespread food insecurity, which pushed groups of people often labeled in ancient sources as the 'Sea Peoples' to migrate across the eastern Mediterranean, attacking and resettling in new territories. Although multiple factors played a role, paleoclimatic data showing decades of aridity lend strong support to the climate–migration connection. In China, recurring droughts and shifts in the course of rivers played a central role in migration and political upheaval (Han & Yang, 2021). The fall of the Tang Dynasty in the ninth century, for instance, coincided with widespread famine linked to monsoon failure (Gao et al., 2026; Fan, 2023; Gao et al., 2024; Kempf et al., 2025; Khalifa, 2026a). The shifting monsoon patterns caused agricultural collapse in northern China, forcing populations southward into more fertile regions (Han, 2025). This demographic redistribution not only transformed the agricultural base of China but also reinforced the rise of southern economic and political centers in later dynasties. The medieval period in Europe is strongly marked by the Medieval Warm Period (roughly 950–1250 CE) (Headrick, 2025; Izdebski & Preiser-Kapeller, 2024; Andrea, 2024; Rull & Vegas-Vilarrúbia, 2024), followed by the onset of the Little Ice Age (circa 1300–1850 CE) (Costello et al., 2023; Andrews et al., 2022; Batzel et al., 2026; Y. Li et al., 2025). During the warmer centuries, agricultural productivity expanded, population growth accelerated, and new territories in northern Europe were settled (Santana et al., 2025). Norse populations even colonized Greenland and briefly reached North America, feats made possible by milder North Atlantic conditions (Brunner & Chase, 2022; Jackson et al., 2022). Yet when temperatures began to cool in the fourteenth century, Greenland's Norse colonies collapsed, and northern settlements across Europe faced food shortages. These deteriorating climatic conditions not only triggered local migrations but also intensified broader social crises, including the Great Famine of 1315–1317 (Ljungqvist et al., 2024), which displaced rural populations into urban center in search of sustenance.

According to the Table 2 historical record underscores that adaptation strategies were never static. During the Medieval Warm Period, Europeans expanded agriculture into lands that were only temporarily fertile under warmer conditions, thereby creating vulnerabilities when the climate cooled (Huebner, 2025; Westling, 2025). Norse colonization of Greenland illustrates both opportunity and fragility (Nuttall, 2024; Price, 2023; Jackson & Dugmore, 2025): while initial settlement thrived, reliance on a delicate agricultural-pastoral economy collapsed under harsher winters and reduced growing seasons. Similarly, in China, repeated adaptations to monsoon variability included hydraulic engineering, such as canal building and irrigation systems (Xu et al., 2023). Yet these technological responses could not fully offset the scale of environmental pressures, and migration remained a necessary solution. What is significant about this era is that migration was not only about survival but also about transformation. The southward migrations within China reshaped the cultural and economic map of the empire. The collapse of Mediterranean powers under drought-driven stress opened pathways for new cultural and political formations (Anthony et al., 2024; Singer, 2025). In Europe, urban migration during the Little Ice Age set the stage for shifts in labor systems and social hierarchies, laying groundwork for the later transformation of European societies (Zakaria, 2024; Heleniak, 2025). Thus, in the classical and medieval periods, climate continued to serve as a powerful force in shaping migration, but its effects were increasingly mediated by social complexity (Şengöz, 2025; Hoyer et al., 2023). State structures, technological innovations, and trade networks could delay or soften the impacts of environmental shocks, yet they could not eliminate them. Ultimately, when thresholds were crossed, migration and displacement remained central to human adaptation, just as in prehistoric times.

Table 2. Key climatic events and their migration consequences during the classical and medieval periods.

Period/event	Climatic condition	Migration outcome	Adaptation or consequence
Late Bronze Age Collapse (1200 BCE)	Prolonged drought in Eastern Mediterranean	Displacement of 'Sea Peoples' across the Mediterranean	Collapse or urban centers, widespread resettlement
Tang Dynasty Crisis (9th century CE)	Monsoon failure, drought, famine in Northern China	Southward migration within China	Shift of demographic and political centers to south
Medieval Warm Period (950–1250)	Milder temperatures in Europe and North Atlantic	Expansion of farming into Northern Europe, Norse migration to Greenland and Vinland	Growth of agriculture frontier, temporary colonization of marginal lands
Early Little Ice Age (14th century CE)	Cooling temperature, crop failure in Europe	Internal migration from rural to urban areas, abandonment of marginal settlement	Famines, demographic stress, weakening of feudal structures

Early modern world (1500–1800)

The early modern period represents a critical phase in the history of climate-induced migration, marked by the growing integration of global trade, the consolidation of empires, and the intensification of population movements across continents (Roy, 2023; White, 2011; Lieberman & Buckley, 2012; Ramesh, 2025c; De Haas & Frankema, 2022; Kelley, 2022). Climate events during this time were deeply intertwined with political and economic processes, shaping not only local displacements but also global demographic transformations (Kelley et al., 2022; Wagner, 2023). The Little Ice Age, spanning roughly from 1300 to 1850, reached some of its most severe episodes in the seventeenth century, producing recurrent famines, epidemics, and widespread instability (Collet et al., 2025; Kaniewski et al., 2025; Sundberg, 2022). In Europe, the colder and wetter conditions of the Little Ice Age contributed to agricultural failures that triggered large-scale internal migrations (Alinezhad et al., 2026; van de Löcht & Axtner-Borsutzky, 2025). Grain harvests declined, and subsistence crises became recurrent, especially in northern and central Europe. The Great Famine of Finland (1696–1697), caused by several consecutive crop failures, killed nearly one-third of the population and forced many survivors to migrate internally or across borders in search of sustenance (Jutikkala, 1955; Lappalainen, 2014; Kujala & Danielsbacka, 2019). Similarly, Scotland's famine of the 1690s displaced rural populations, pushing many to urban centers and stimulating emigration to Ireland and the Americas (Calloway, 2024; Kent, 2025; Williams, 2022; Kennedy & Weston, 2024).

In Asia, the impact of climate fluctuations was equally severe (Habib-ur-Rahman et al., 2022). In China, the seventeenth century was characterized by repeated droughts and flooding along the Yellow River basin (Tao et al., 2022; Wang et al., 2025; Li et al., 2022). These disasters not only devastated agricultural output but also destabilized the Ming Dynasty, contributing to its collapse and the subsequent rise of the Qing Dynasty (Wang et al., 2023; Feng et al., 2025; Zhang et al., 2022).

During periods of severe climatic instability, millions of people in China were compelled to undertake large-scale southward movements or relocate internally to regions perceived as less vulnerable to drought, flooding, and agrarian collapse (Lee et al., 2017; Sen et al., 2025; Balsari et al., 2020). These migratory flows were not merely spontaneous or short-term survival strategies; rather, they constituted profound demographic reconfigurations that reshaped regional settlement patterns, labor systems, and state–society relations. The magnitude and frequency of such movements illustrate that climatic shocks functioned as structural forces within the political economy of imperial China, intensifying fiscal strain, exacerbating social unrest, and, in certain instances, contributing to dynastic instability (Orlandi et al., 2023). Climate events, therefore, cannot be understood as isolated environmental disturbances; they were deeply embedded in broader processes of political transformation and demographic change.

Comparable dynamics unfolded in South Asia during the same period, where monsoon variability played a decisive role in precipitating subsistence crises and population displacement. The failure or irregularity of monsoon rains disrupted agrarian production systems that were heavily dependent on seasonal precipitation, triggering recurrent famines across the subcontinent. Among the most devastating of these was the famine of 1630–1632 in the Deccan Plateau (Houghteling, 2024), which resulted in widespread mortality, forced migration, and severe socio-economic dislocation. Contemporary accounts describe large-scale movements of famine-stricken populations in search of food, employment, and relief, often toward urban centers or comparatively less affected rural regions. These episodes underscore the intricate interdependence between climatic systems and human mobility in pre-industrial agrarian societies. Environmental stress did not operate in a vacuum its impacts were mediated by governance capacity, grain storage and distribution mechanisms, market integration, and existing social inequalities. Consequently, famine-induced migration in both China and South Asia should be interpreted not solely as a reaction to environmental scarcity, but as a complex adaptive response shaped by institutional structures and political authority. In this sense, climatic disruptions acted as catalysts that exposed and amplified underlying vulnerabilities, transforming ecological stress into far-reaching demographic and political consequences (Annapureddy et al., 2024; Roy, 2022; Warren, 2026; Chaudhuri, 2022), which is estimated to have killed millions. Such events pushed survivors into migration corridors toward less-affected regions or into emerging urban centers. Later, under colonial regimes, climate-induced famines became intertwined with political economy, as export-oriented agricultural policies reduced local resilience. Beyond continental impacts, the early modern era also witnessed global migrations shaped

Table 3. Key climate events and their migration outcomes during the early modern period.

Period/event	Climatic condition	Migration outcome	Adaptation of consequences
Great Famine in Finland (1696–1967)	Severe cold, crop failures	One-third of population perished, survivors migrated internally and across border	Long-term demographic decline, regional instability
Scotland's Famine (1690s)	Little Ice Age cooling, harvest failures	Migration to urban center, emigration to Ireland and Americas	Shift toward overseas colonization
Collapse of Ming Dynasty (17th century China)	Monsoon failure, prolonged drought	Millions displaced forced into migration corridors	Depopulation of regions, dependence on relief and trade network
Transatlantic Slave Trade (16th–18th centuries)	Indirectly linked to European expansion during climate stress	Forced displacement of millions of Africans to the Americas	Demographic and cultural transformation across continents

indirectly by climatic conditions. The cooling of the Little Ice Age created economic pressures that contributed to European expansion overseas (Waldinger, 2022). Colonization of the Americas was accompanied by the forced migration of millions of Africans through the transatlantic slave trade, a phenomenon that, while primarily driven by labor demands, was also influenced by Europe's search for resources and agricultural lands less vulnerable to climate variability. Climate stress at home made overseas expansion both a necessity and an opportunity.

This period is distinguished from earlier eras by the unprecedented scale, intensity, and systemic interconnectedness of migratory processes. While climatic fluctuations in prehistoric and medieval contexts primarily generated movements that were regional in scope and relatively localized in impact, the early modern era marked the consolidation of genuinely global demographic transformations. In this period, environmental stressors in Europe and Asia manifested through prolonged droughts, crop failures, extreme winters, and shifting precipitation patterns did not merely produce localized displacement. Instead, they interacted with expanding imperial networks, emerging capitalist economies, and transoceanic trade systems to facilitate and, in some cases, compel long-distance migration across continents and oceans. Consequently, climate-related pressures became embedded within broader structures of global exchange and power, contributing to patterns of mobility that reshaped population distributions on an intercontinental scale. (Moawad, 2024; Cipollina et al., 2024) both voluntary and forced. The Atlantic world became a stage where climate variability, imperial ambition, and economic demand converged to produce one of the largest population redistributions in human history. Adaptation strategies during this period ranged from technological to political. In Europe, improved agricultural techniques such as crop rotation and the introduction of new staple crops like potatoes and maize (originating from the Americas) increased resilience to climate shocks (Zsögön et al., 2022). Yet these adaptations could not always prevent crises, and migration remained a necessary recourse. In Asia, large-scale state projects, including flood-control systems and grain storage policies, attempted to stabilize populations, but extreme events often overwhelmed such measures. The early modern experience highlights the dual character of climate-driven migration: it could be both a response to disaster and a driver of opportunity. For some populations, like those devastated by famine, migration was a desperate survival strategy. For others, like European settlers and traders, climate pressures at home helped fuel expansion into new lands. In both cases, the interaction between environmental change and human mobility reshaped societies in ways that continue to influence global history (see Table 3).

The contemporary escalation of climate-induced migration (19th–21st centuries)

The contemporary period beginning with the nineteenth century represents a decisive shift in the history of climate-induced migration. Unlike earlier periods, when natural climatic variability dominated, the modern era is defined by human-driven climate change combined with the accelerating pace of industrialization, urbanization, and globalization (Bruckmeier, 2024; Longman & Shaw, 2026). This transformation has produced migration on a scale both unprecedented in speed and complex in form, linking environmental pressures with economic, political, and social factors. The nineteenth century already witnessed climate-related crises that influenced major migration flows. The Irish Potato Famine (1845–1852) is one of the most well-documented examples (McMahon & Costello-Sullivan, 2024; Blum et al., 2026;

Ryley & Drenth, 2024). A fungus-like pathogen (*Phytophthora infestans*), exacerbated by unusually wet conditions, destroyed potato harvests for several consecutive years (Cottyn et al., 2023; Dey et al., 2024; Chaithra et al., 2025). As potatoes were the staple crop for much of Ireland's population, famine ensued, killing around one million people and forcing another one to two million to emigrate, primarily to North America and Britain. Although this disaster was triggered by crop disease, climate variability amplified its effects, showing how environmental conditions could interact with agricultural dependency and colonial policies to create mass migration. In Asia, the late nineteenth century brought a series of devastating famines linked to El Niño–Southern Oscillation (ENSO) events, which altered global rainfall patterns (Alizadeh, 2022; Hunt & Harrison, 2025). Between 1876 and 1879, severe droughts in India, northern China, and Brazil caused famine that killed an estimated 30–50 million people (Hang et al., 2025; Gooding, 2022). These crises led to mass internal migrations as rural populations abandoned famine-stricken areas and, in some cases, moved toward colonial cities where limited relief was available. The migration patterns from this period underscore the growing role of global climatic oscillations in shaping demographic change.

The twentieth century intensified these dynamics as rapid industrialization and fossil fuel use altered the global climate system. Episodes such as the Dust Bowl in the United States during the 1930s illustrate how human mismanagement of the environment, combined with drought, produced mass displacement (Stephens, 2023; Sichko, 2025; Gabaccia et al., 2023; Moon, 2025). Approximately 2.5 million people left the Great Plains, with many migrating to California in search of work (Atherwood, 2022). This migration reshaped the American labor market and cultural identity, leaving a lasting imprint on U.S. history. By the late twentieth and early twenty-first centuries, the issue of climate migration became increasingly recognized as part of the global refugee and development agenda. Rising sea levels, desertification, and intensifying storms have displaced millions of people annually. According to the Internal Displacement Monitoring Centre (IDMC), between 2008 and 2020, an average of 24 million people per year were displaced by weather-related disasters. The majority of these movements occur within countries, but cross-border migration is also growing, particularly in regions like the Pacific Islands, Sub-Saharan Africa, and South Asia. Bangladesh, for example, experiences recurrent cyclones and river flooding, displacing millions; projections suggest that by 2050, up to 13 million Bangladeshis could become climate migrants.

Based on the Table 4 the scale of contemporary climate migration highlights both continuity and novelty. Like earlier periods, populations still move in response to drought, floods, and crop failures (Matanó et al., 2022; Teye & Nikoi, 2022; Messori et al., 2025). Yet the speed and magnitude of current displacements are far greater, amplified by the global reach of industrialization and the interconnectedness of economies. Moreover, migration today occurs within a framework of nation-states, borders, and international law, which did not constrain earlier historical migrations. This introduces new complexities, as many displaced people fall into legal gray zones, not recognized as refugees under international law despite being forced to move for survival. Adaptation strategies in the modern era have become more institutionalized, involving not only households but also governments and international organizations. Urbanization serves as both a pull factor and an adaptation mechanism, as rural populations move to cities seeking livelihood opportunities (Singh, 2019). At the same time, state-led resettlement programs, international aid, and climate adaptation projects attempt to mitigate the impacts (Arnall, 2019; Piggott-McKellar et al., 2020; Boston et al., 2021). However, these strategies are unevenly distributed, with

Table 4. Key examples of climate-induced migration during the contemporary period.

Period/event	Climatic condition	Migration outcome	Adaptation of consequences
Irish Potato Famine (1845–1852)	Prolonged wet conditions, crop failure	1 – 2 million emigrated to North America and Britain	Permanent demographic shift, rise of Irish diaspora
Global ENSO Famines (1876–1879)	Severe droughts linked to El Niño	Tens of millions displaced in India, China, Brazil	30 – 50 million deaths, migration to colonial cities
Dust Bowl (1930s USA)	Prolonged drought and soil erosion	2.5 million displaced, migration to California	Transformation of U.S. agricultural policy, cultural change
Bangladesh Flooding and Cyclones (20th–21st centuries)	Sea-level rise, extreme weather	Millions displaced internally, projected 12 million climate migration by 2050	Pressure on urban centers, need for international support
Pacific Island Displacement (21st century)	Sea-level rise threatening habitability	Gradual planned relocation to Australia, New Zealand	Redefinition of sovereignty, cultural loss

wealthier nations better able to invest in resilience while poorer populations face greater vulnerabilities. The contemporary period thus illustrates the culmination of a long historical process: climate has always shaped migration, but in the twenty-first century, human-driven climate change makes this relationship more acute and global. The lessons of earlier historical episodes from prehistoric adaptation to medieval crises and early modern famines show that while migration is a natural human response to environmental stress, the scale of displacement today presents challenges that are unparalleled in human history.

Climate migration across the *longue durée*: continuities and transformations

Looking across the long arc of history, from the earliest *Homo sapiens* migrations to twenty-first-century climate displacement, a striking pattern emerges climate has consistently shaped human mobility, yet the ways in which societies respond are conditioned by their technological capacities, political systems, and cultural frameworks. Migration is not simply a reaction to environmental stress but a complex adaptive strategy embedded within broader social and historical contexts. In prehistoric times, migration was largely determined by ecological thresholds. When environments became uninhabitable, small groups moved in search of more favorable conditions. The dispersal of humans out of Africa, the retreat to refugia during glacial maxima, and the expansion into new territories during the Holocene warming all illustrate a mobility that was fluid, small-scale, and often temporary. Adaptation strategies were limited to tool-making, mobility itself, and the cooperative use of resources. Migration here was both a survival mechanism and a means of opportunity, opening new ecological niches that shaped the global spread of humanity. By the classical and medieval periods, the presence of states, urban centers, and agricultural systems made migration both more disruptive and more transformative. Climatic shocks such as prolonged droughts or shifts in temperature could destabilize entire civilizations, as seen in the collapse of the Late Bronze Age societies, the internal migrations within China (Kemp & Cline, 2022), and the abandonment of marginal lands during the Little Ice Age. Unlike prehistoric groups, these societies had more developed adaptation strategies including hydraulic engineering, long-distance trade, and administrative relief yet they remained vulnerable when environmental changes exceeded those systems' capacities. Migration in this era was thus a double-edged phenomenon: it was a means of survival for displaced populations but often contributed to the collapse or transformation of states.

The early modern period magnified these dynamics on a global scale. Climate events such as the Little Ice Age triggered both devastating famines and the reorganization of global demography (Aronova et al., 2025). Famines in Finland, Scotland, China, and India produced internal migrations that destabilized regional populations, while European climate stress was indirectly linked to overseas expansion and colonization (Appleby, 2025; Fraundorfer, 2022). Crucially, this period demonstrates how climate migration was no longer only about survival but also became entangled with empire-building, colonial economies, and forced labor systems such as the transatlantic slave trade. Migration thus became both a response to climate crisis and an instrument of global power reconfiguration. The contemporary period introduces an even more complex picture. Migration today is shaped not only by natural climatic variability but also by anthropogenic climate change, urbanization, and the political structure of the nation-state (Suárez-Orozco, 2023; Ogwu & Izah, 2026; Ajlan, 2026). While drought, floods, and crop failures continue to displace millions, as in earlier eras, the existence of borders, refugee regimes, and international humanitarian systems fundamentally alters the dynamics (Adaawen et al., 2019). Unlike prehistoric or medieval populations, modern migrants cannot simply move freely into new ecological niches. Instead, they face legal, political, and economic barriers that complicate adaptation. Furthermore, the scale of displacement with an average of 24 million people displaced annually by weather-related disasters in the twenty-first century is far greater than in earlier periods, raising new questions about global governance, equity, and responsibility.

Theoretical perspectives help illuminate these patterns. Push-pull models of migration highlight how environmental stress acts as a push factor while habitable or resource-rich regions serve as pull factors (Butler & Bowles, 2024; Butler & Higgs, 2024). Systems theory emphasizes how migration is shaped by the interaction of environmental, social, and political subsystems, evident in how droughts not only destroy crops but also destabilize states and economies (Ali et al., 2023; Dumieński et al., 2026). Resilience theory further suggests that migration itself can be understood as an adaptive strategy (Kuo, 2014; Reich,

2010): a way societies redistribute populations to maintain survival under changing conditions. When adaptation fails, however, migration often coincides with social breakdown, as repeatedly seen in the historical record. A comparative lens also reveals continuities and novelties. Continuities include the central role of water scarcity, food insecurity, and agricultural collapse in driving migration across all periods. Novelties emerge in the modern era, where fossil-fuel-driven climate change, combined with political borders and global inequality, creates challenges of a magnitude and complexity unseen in earlier times. What was once primarily a localized or regional phenomenon has become a global humanitarian crisis that requires coordinated governance and long-term adaptation strategies. The broader implication of this comparative analysis is that climate migration must be understood not as an anomaly but as a fundamental aspect of human history. From early hunter-gatherers moving in search of water to modern populations displaced by sea-level rise, migration has been one of humanity's most consistent strategies for survival and adaptation. Recognizing this continuity challenges the framing of contemporary climate migrants as exceptional or unprecedented. Instead, they are part of a long lineage of human resilience in the face of environmental change though the stakes today, given the speed and global scale of anthropogenic climate change, are far higher.

Conclusion

The historical trajectory of climate-induced migration demonstrates that human mobility has consistently functioned as an adaptive response to environmental change. Across prehistoric, classical, early modern, and contemporary periods, climatic pressures ranging from glacial cycles and prolonged droughts to the disruptions of the Little Ice Age have repeatedly reshaped demographic patterns, political structures, and socio-economic systems. While the fundamental drivers of migration, such as water scarcity and food insecurity, reveal strong continuity over time, the scale, complexity, and governance context of migration have transformed significantly. In the contemporary era, anthropogenic climate change has intensified displacement processes to an unprecedented degree, embedding them within rigid nation-state borders and global inequalities. Unlike earlier historical periods, present-day climate migrants confront restrictive legal regimes and geopolitical constraints that complicate mobility and adaptation. Thus, climate migration should not be framed solely as a crisis, but as a longstanding human strategy of survival that now demands innovative and coordinated governance responses. Ultimately, understanding the deep historical continuity of climate migration enables a more nuanced perspective on current challenges. It underscores that mobility is neither anomalous nor new, but a recurring feature of humanity's interaction with environmental change. The urgent task ahead is to translate this historical insight into equitable, forward-looking policies capable of addressing the distinctive political, ethical, and humanitarian dimensions of contemporary climate displacement. From a practical standpoint, this perspective implies the need to mainstream mobility into climate adaptation planning, strengthen legal recognition for climate-displaced populations, and enhance multilevel governance cooperation between local, national, and international actors. Policies should move beyond reactive humanitarian responses toward anticipatory frameworks that integrate disaster risk reduction, livelihood diversification, and planned relocation strategies grounded in human rights principles. Nevertheless, this study is not without limitations. Its reliance on secondary historical and contemporary sources may constrain empirical specificity, particularly regarding localized experiences of climate mobility. The comparative historical approach, while valuable for identifying long-term patterns, may also underrepresent regional variations and the agency of affected communities. Furthermore, the conceptual framing of climate migration as adaptive risks oversimplifying cases where mobility results in heightened vulnerability or immobility traps. Future research should therefore pursue interdisciplinary and mixed-method approaches that combine historical analysis with ethnographic fieldwork, quantitative climate modeling, and policy evaluation. Greater attention is needed to South–South migration dynamics, urban climate displacement, gendered and intersectional vulnerabilities, and the role of digital technologies in mobility governance. Longitudinal studies examining the outcomes of planned relocation and adaptive migration policies would also contribute significantly to evidence-based policymaking. By expanding empirical depth and theoretical refinement, future scholarship can better inform just and sustainable responses to the evolving realities of climate-induced migration.

Author contributions

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Data availability statement

The data can be requested directly to Author email: kevin.romadhona@staf.unair.ac.id

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