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MIGRATION DYNAMICS DUE TO CLIMATE CHANGE: CLIMATE REFUGEES

Zuzanna Krysiak[1]

[1] University of Economics in Katowice, Poland, zuzanna.krysiak@edu.uekat.pl,
ORCID: https://orcid.org/0009-0002-5187-4296

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ABSTRACT

PURPOSE: The paper aims to analyze the phenomenon of climate migration and understand the dynamics of this process in the context of climate change. The study explores the causes, historical contexts, and forecasting models of migration driven by environmental degradation, focusing on the interplay of climate factors, socio-economic dynamics, and human decision-making processes.

DESIGN/METHOD: The research is based on a comprehensive literature review and analysis of various climate migration prediction models, including the agent-based models, gravity models, econometric models, radiation models, and systems dynamics models. It also examines historical examples of climate change-induced migration to provide insights into current and future challenges.

RESULTS/FINDINGS: The study reveals that climate migration results from a complex interaction between various climatic and socio-economic factors. The historical analyses offer valuable insights into human responses to the changing environmental conditions, which can inform future strategies for managing climate migration.

ORIGINALITY/VALUE: The study gives a new perspective to climate migration research by combining diverse forecast models and historical contexts to provide a comprehensive understanding of the phenomenon. It offers insights into the challenges and opportunities posed by climate change-driven migration for societies worldwide.

KEYWORDS: climate migration, environmental degradation, socio-economic dynamics, prediction models, climate change.

JEL: Q54, R23, O15.

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1. INTRODUCTION

The impact of climate change on migration is an inherent element of contemporary social and political discussions. This phenomenon, which is a consequence of the global environmental changes, has complex and multi-faceted implications for individuals, communities and countries all over the world. This paper focuses on the analysis of the migration caused by climate change, also with consideration of the historical context that provides a background for understanding the current situation. Studying climate change-driven migration dynamics creates multifaceted challenges and opportunities, transforming socioeconomic landscapes, human habitats, and global governance structures. This phenomenon cannot be analyzed in a uniform way because it covers too many aspects, such as extreme weather events, water shortages, rising sea levels, environmental degradation and extreme temperatures. Early recognition of migration patterns and understanding of human behavior are crucial for better preparation for future changes. The analysis of historical examples and application of the modern forecasting models can inspire the development of innovative solutions and approaches to help address the challenges and opportunities associated with climate migration.

The topic of migration is characterized by its complex nature, taking into account the influence of many factors determining population flows. Due to this multithreaded nature, the topic is both extremely interesting and presented in the literature from various aspects (Gemenne & Blocher, 2017; Lustgarten, 2020; Martin & Warner, 2012; McAdam, 2012; Nawrotzki & Bakhtsiyarava, 2017; Rodima-Taylor et al., 2012). However, the aspect of climate migration is focused on to outline how broad the problem is, as well as how complicated the forecasting process is. The 2022 Intergovernmental Panel on Climate Change (IPCC) highlights that climate change may already be one of the main causes of migration in some regions of the world. Comparing the subsequent reports related to climate migration, further analyzes and conclusions are observed: The World Bank report 'Groundswell: Preparing for Internal Climate Migration' (2023) indicates that even moderate climate changes may lead to a significant increase in the number of people migrating in search of better living conditions and security. The next two reports draw attention to the importance of the multi-threaded causes of migration. The World Bank report 'Turn Down the Heat: Confronting the New Climate Normal' (2014): points to the problem of climate migration and its connection with poverty, conflicts and social instability. The European Office for Police Cooperation's report 'Environmental Migration in Europe' (2017) identifies challenges for the migration policy and crisis management. According to The Intergovernmental Panel on Climate Change (IPCC) Special Report on Climate Change and Land (2022), five regions most vulnerable to migration caused by climate change are: coastal and lowland areas, subtropical and desert areas, arctic regions, agricultural areas and arid Africa, islands and small island states. Coastal regions are vulnerable to the sea level rise and related threats, such as coastal erosion and land flooding. Lowland areas, especially those located in river deltas, may be at risk of flooding caused by the rising sea levels and the increase in the frequency of extreme weather events. Subtropical and desert regions are particularly vulnerable to droughts, which can lead to shortages of drinking water, deterioration of crop growing conditions and migration of people in search of better sources of livelihood. The Arctic is experiencing faster rates of climate change than other regions, leading to melting glaciers, reduced ice cover and changes to the marine ecosystem. These changes have serious consequences for the local communities, especially for the indigenous people, whose traditional lifestyle is closely linked to the ice and the Arctic environment. Agricultural areas, especially those that depend on rain, may experience changes in rainfall, leading to drought and reduced crop yields. The Dry Africa, especially the areas of the Sahel, is at risk of deteriorating farming conditions, which may lead to population migration in search of better life opportunities. Islands and small island states are particularly vulnerable to sea level rise, extreme weather events and coastal erosion. These changes may threaten food security, infrastructure and housing, leading to population migration.

The above-mentioned reports emphasize the importance of migration-related problems. The modern society is faced with humanitarian issues, expanding social awareness of the impact of climate change on migration patterns, and recognizing the potential socio-economic problems with political implications. The global governance regarding the management structures of environmental migrants in countries exposed to sudden inflows (workplaces, schools, social, and places of residence, health care) is also dealt with. Early recognition of migration patterns and human behavior also motivates to recognize the transformative potential of climate change-induced migration and may inspire the development of innovative solutions and approaches to manage both the challenges and opportunities this phenomenon presents.

2. MIGRATION OF HUMAN BEINGS DUE TO CLIMATE CHANGE – HISTORICAL PERSPECTIVE

The human history shows examples of migrations that are related to climate change: the ancient people of Mesopotamia who abandoned their settlements in the face of climate change, or the historical migrations of Germanic people in Europe during the Migration Period. However, today's climate challenges are exceptionally complex and global due to the intensifying processes such as global warming, changes in precipitation, extreme weather events and sea level rise. The following examples from history show that climate change has long had a significant impact on human migration and socio-cultural changes around the world. They provide valuable insights into how people respond to the changing environmental conditions and how important climate migrations are for the settlement of people in selected regions of the world.

The climate migration history has examples from the 8th to 11th centuries BC, when climate change, including the global cooling, might have contributed to the migration of Germanic people and other ethnic groups who migrated to new areas in search of better living conditions (Mauelshagen, 2018). The Anasazi people, living in the areas of today's southwestern USA, struggling with difficult climatic conditions and periods of drought, disappeared from these areas in the 12th and 13th centuries. Climate change, along with ecological transformations, might have played an important role in the disappearance of this culture (Benson et al., 2007). During the so-called 'Viking Age', the Scandinavian population facing unfavorable climatic conditions, such as the cooling of the climate in the 8th and 9th centuries, set out on long sea expeditions, leading to migration and colonization of new areas, such as Iceland, Greenland and partially North America (Pyrhönen et al., 2017). Moving back even further from the Late Pleistocene periods, climate alternated between cooler 'stadials' and warmer 'interstadials' (Brooke, 2018). These changes played key roles in migration processes ultimately expanding the movement ranges of humans at the time and contributing to the globalization of the lacustrine species. The first traces of the appearance of homo sapiens in Europe date back to at least 70.000 years ago. It is believed that they came from Anatolia and are identified with the Aurignacian culture. However, the largest migrations began about 20.000 years later, when homo sapiens left Africa. It is estimated that this was the period of the connection of the Arabian Peninsula, i.e. the southern part of the Red Sea, and the decline in sea levels caused by glaciation (Stola, 2018). However, at the peak of the Last Glacial Maximum LGM, people were forced to migrate from Central Europe to other ecological niches (Mauelshagen, 2018). Other migrations in the Northern Hemisphere are associated with the warmer climate of the late Pleistocene interstage, which has been described earlier in this section. The examples of migration are discussed, focusing on the key role of climate, which is related to the movement of the human species, but it must be remembered that migration processes are highly complex processes influenced by many factors. Understanding the role of the environment and taking it into account in migration dynamics is an essential element in analyzing why people are vulnerable to climate change and how they develop strategies to adapt to it (Piguet et al., 2011).

Natural migration, often presented as a present or future problem, has deep and demonstrable roots as seen in previous examples. In the late 19th century, Ravenstein (1889) emphasized the role of natural factors such as climate in driving human movement. Unfortunately, the popularity of migration analysis slowly faded from texts throughout the 20th century, and natural elements were largely omitted. This decline in interest was due to several patterns, including the rise of Western-oriented thinking, which suggests the diminishing influence of nature as a result of mechanical progress, and the dominance of economic explanations in the speculations of the movement (Piguet et al., 2011). Global warming is the latest in climate change. Human activities such as burning fossil fuels and deforestation contribute to global warming by emitting greenhouse gases. The results of these activities are climate refugees, who belong to a larger group of immigrants called ecological refugees. Environmental refugees include immigrants forced to flee due to natural disasters caused by the effects of climate change and global warming.

The history of climate migration shows that people have had to adapt to changing environmental conditions for centuries. The contemporary climate change poses new challenges that require both innovative technological solutions and coordinated policies at the local, national and international levels. However, the analysis of historical climate migrations can provide valuable lessons and guidance for modern policymakers and communities on how to effectively respond to a changing climate. Climatic migrations have had various causes throughout the history, from droughts and changes in water availability to climate cooling affecting agriculture and food resources. As it is highlighted by the research (Degroot et al., 2021), climate change varies regionally and temporally, which has resulted in a variety of social responses, from migration to local adaptation. Past societies that have survived climate change have demonstrated the ability to adapt and be flexible. Today's climate policies should focus on strengthening the adaptive capacity of societies to cope better with the upcoming climate change. The key actions include modernizing infrastructure to make it more resistant to extreme weather events such as floods, hurricanes and droughts. Effective management of water resources also seems to be crucial, including the construction of retention reservoirs and the development of water desalination technologies, as well as the introduction of agricultural practices that are resistant to climate change, such as agroforestry, water-saving techniques and drought-resistant crops. It is also important to avoid simplified causal relationships between changes, climate and social impacts. Understanding local and specific contexts is key in predicting future societal responses to climate change.

The history of climate migration shows that climate change has had a profound impact on human societies. The conclusions from this research are of key importance to understand and prepare for today's and future climate challenges. Adaptability, an interdisciplinary research approach and taking into account local contexts are crucial to manage effectively the consequences of climate change in today's world. Leveraging historical experiences can help create more resilient and flexible societies, ready to face the challenges of the 21st century.

3. MODELS AND FORECASTS OF MIGRATIONS DUE TO CLIMATE CHANGE

The research and scientific reports from the last thirty years have warned against mass migrations related to climate change. Previous projections were based on the assumption of a linear cause-and-effect relationship between climate change and migration. However, the current approaches take into account the complexity of migration and the interactions between climate factors and other determinants of migration. Many climate-related migration projection models are still in development, and estimates of future migration should be treated with caution. There are also challenges related to a lack of data and understanding of the full impact of climate change on migration. The conceptualization of climate-related migra-

tion includes both forced and adaptive migration, including various factors that determine migration. Climate-related migration modeling uses different types of models, with different advantages and limitations, which are presented in Table 1 (Schewel et al., 2024).

Table 1. Climate-related migration models

Climate-related migration models	Sample Variable/Parameter
Agent-Based Models (ABM)	Natural resources, agent behaviors, migration flows
Gravity Models	Attraction strength (location attractiveness), distance
Econometric Models	Income, employment, temperature changes, sea level rise
Radiation Models	Influence radius, number of destination locations
Systems Dynamics Model	Population growth rate, water resources, land resources

Source: Own elaboration based on: Schewel et al. (2024).

In the paper by Schewel et al. (2024), five climate-related migration models have been selected based on the literature review. The first is the Agent-Based Models (ABM), which use rich input data to explore the causal mechanisms of migration and complex decision-making processes. An agent-based model by Entwisle et al. (2020) examines the impact of extreme weather events on migration from Thailand. It focuses on social relationships, households and social networks. The results suggest that floods and droughts may affect migration, especially the return migration. A common objection to the agent-based models is that they provide an oversimplified description of reality (Couclelis, 2002). Although the models themselves are very complex, the facts and phenomena they describe are often so complex that they require significant simplifications. Another approach is the Gravity Model, which predicts spatial patterns over large geographic areas using similarities to the Newton's law of gravity. The gravity models do not directly model migration, but assume that it is the main cause of deviations between population distributions. They use population size, distance, and other variables to project future population distributions. The method of using econometric models is based on the analysis of historical climate events and their impact on the past migration patterns, and then it uses these relationships to forecast future migration under various climate scenarios. The statistical extrapolation model presented by Chen and Mueller (2018) analyzes the relationship between climate change and migration from Bangladesh. It has been found that different climatic events have different effects on international migration. For example, the increased soil salinity may lead to increased migration, especially from poorer households. However, the model has limitations, such as a lack of information on migration duration and limited accuracy of soil salinity data. Another approach is the radiation models, which predict migration flows between places with few inputs. In the radiation model, an approach to predict the sea level rise migration in Bangladesh is described by authors Davis et al. (2018). Their model is based on population diffusion combined with the demographic, geographic and climate data. Based on the internal migration data, the model estimates that around 900.000 people could migrate by 2050 due to flooded areas, mainly to Dhaka. However, most migrants would choose destinations close to their homes. Other models also analyze climate-related migration in Bangladesh. The last discussed approach are the system dynamics and general equilibrium models, which examine the impact of the policies on migration, but they have limitations in predicting migration at the micro level. The systems dynamics model developed by Naugle et al. (2022) connects migration decisions with various aspects of social and economic life. Tested in Mali, this model takes into account a number of factors, including political, economic and health ones. The results indicate that migration from Mali to the neighboring countries and other regions increases with temperature, but various policy interventions may influence this trend.

Selection of the appropriate method is an extremely important step in determining the success of subsequent analyses. The complexity of the phenomenon of migration also requires a discussion of the bene-

fits of the previously presented models. The limitations outlined in the chapter and the following benefits of using the data models may facilitate future decisions of researchers regarding the choice of approach to modeling climate-related migration. The agent-based models (ABM) enable the simulation of individual migration decisions, taking into account the complexity of social and economic interactions. Thanks to their flexibility, the ABMs can be adapted to different local contexts, allowing more detailed analyzes. In addition, the ABMs allow the simulation of various political and climate scenarios, which helps predict the effects of various interventions. Therefore, the ABMs are particularly useful in microeconomic research and the analysis of social migration decisions, as well as in assessing the impact of climate change on migration at the local level (Hassani-Mahmooei & Parris, 2012). The gravity models, in turn, are characterized by simplicity and intuitiveness, based on an analogy to the Newton's law of gravity. They are relatively simple to understand and implement, which makes them attractive tools for analyzing migration patterns over large geographic areas (Cattaneo & Peri, 2016). By using readily available demographic and geographic data, the gravity models are scalable and can be effectively used to predict large-scale migration and analyze spatial patterns of population distribution. The econometric models allow the analysis of the historical data on climate change and migration, which helps to understand long-term migration trends. Thanks to the ability to take into account a wide range of climatic and economic variables, the econometric models are particularly useful in forecasting migration based on the historical climatic and economic data and in analyzing the impact of specific climatic phenomena on migration. The radiation models, however, are characterized by minimal assumptions regarding migration decisions, which make them less susceptible to errors related to inappropriate assumptions. Their computational efficiency allows for rapid prediction of migration flows, making them useful tools for rapid analysis of potential migration flows at national and international levels (Simini et al., 2012). Finally, the systems dynamics and general equilibrium models offer a holistic approach to analyzing the impact of different policies and interventions on migration, taking into account the broad social and economic context. By combining various aspects of social, economic and political life, these models enable a comprehensive analysis of migration at the macroeconomic and social levels. Thanks to their interdisciplinary, these models can take into account a wide range of factors influencing migration, allowing for more accurate and comprehensive forecasts.

In summary, the use of different climate-related migration models has the benefit of providing a more comprehensive and accurate understanding of climate migration. Each model has its unique advantages that may be more effective in specific research and forecasting contexts. The agent-based models are particularly useful for studying microeconomic and social migration decisions, while the gravity and radiation models are more effective in analyzing large-scale migration. The econometric models allow for a deeper examination of historical trends, and the systems dynamics models offer a holistic approach to analyzing the impact of policies on migration. The choice of the appropriate model depends on the specificity of the problem under study, available data and the goals of the analysis (Kaczan & Orgill-Meyer, 2020). One of the main limitations of the climate-related migration models is the lack of access to accurate and detailed data. To overcome this challenge, more advanced data collection technologies can be introduced. Remote sensing, IoT sensors and advanced geolocation systems can significantly improve the quality of available information. Furthermore, the use of big data and open data sources can provide more comprehensive information on climate conditions and migration patterns. The introduction of these technologies will enable more precise and comprehensive analyses.

Harmonization of the existing data is the next key step. To make the data consistent and compatible, it is necessary to standardize data collection methods and implement common protocols for the exchange of information between various institutions. Such harmonization will allow for more uniform and useful data sets, which in turn will translate into better results of migration models. Also, integration of the approaches

discussed in this chapter into one integrated model can help provide a more comprehensive picture. For example, combining the agent-based models with the gravity models enables more accurate prediction of migration patterns at both the micro and macro levels. This type of integration allows to take into account both individual migration decisions and larger demographic trends. Collaboration between specialists from different fields, such as climatology, sociology, economics, geography and demography, can bring benefits in the form of more – comprehensive migration models. Organization of regular interdisciplinary workshops and conferences promotes the exchange of knowledge and experiences, which leads to the creation of innovative solutions. This cooperation also enables a better understanding of the interdependencies between the various factors influencing migration. To make the migration models more precise, they should take into account a wider range of socio-economic variables, such as education levels, access to health care, housing conditions and migration policies. The development of more advanced models that include the interactions between various social and economic factors can increase the precision of forecasts. Examining different policy and intervention scenarios, such as migration policies, migrant support programs and adaptation actions at local and international levels, can help to understand better the potential impacts of climate change on migration. Creating what-if scenarios provides valuable information for decision-makers and policy planners, enabling them to make more informed decisions. Another factor to ensure the potential limitations of the models is to increase the transparency of the models and clear interpretation of research results, which are crucial for their effective use by policy makers and society. Publishing detailed reports and available interactive data visualization tools facilitate better understanding and use of the research results. Raising public awareness of the impact of climate change on migration and educating about modeling methods can contribute to a better comprehension of the problem and support appropriate adaptation actions (Degroot et al., 2021). Information campaigns and educational programs can help convey key information to a wider audience, which in turn can lead to better support for action to combat the effects of climate change.

4. EXPECTED DIRECTIONS OF MIGRATION DUE TO CLIMATE CHANGE/ CLIMATE REFUGEES

With climate disasters becoming more frequent and intense, such as floods, droughts and cyclones, more and more people are forced to flee from vulnerable areas. Table 2 presents regions and the impact of the climate on people living there. Regions prone to extreme weather are vulnerable to floods, cyclones, and droughts, with countries such as Bangladesh, India, Pakistan, Vietnam, and the Philippines at high risk of climate-induced migration. The next regions in the presented Table 2 are areas with access to water. They are prone to climatic hazards such as droughts, water scarcity, and soil fertility decline, affecting countries like Nigeria, Somalia, Kenya, and Ethiopia, potentially leading to migration pressures.

Regions most vulnerable to sea level rise are facing the increased sea level rise and tropical cyclones, leading to critical decisions among the populations in Pacific islands such as Tuvalu, Kiribati, and the Marshall Islands regarding the relocation. The next three regions discussed in the table above are regions experiencing environmental degradation, regions affected by extreme temperatures and regions with adaptation effects and weakened infrastructure. The areas experiencing environmental degradation and soil fertility decline are vulnerable to droughts and water scarcity, resulting in environmental hazards for countries such as Uzbekistan, Kyrgyzstan, and Tajikistan, which may trigger climate-driven migration. Other regions are experiencing melting glaciers or facing threats from the sea level rise and extreme weather events. It impacts regions such as Greenland, Alaska, and Northern Russia. Moreover, areas with adaptive effects and weaker infrastructure may be particularly susceptible to spillover effects, i.e. places from which people must emigrate.

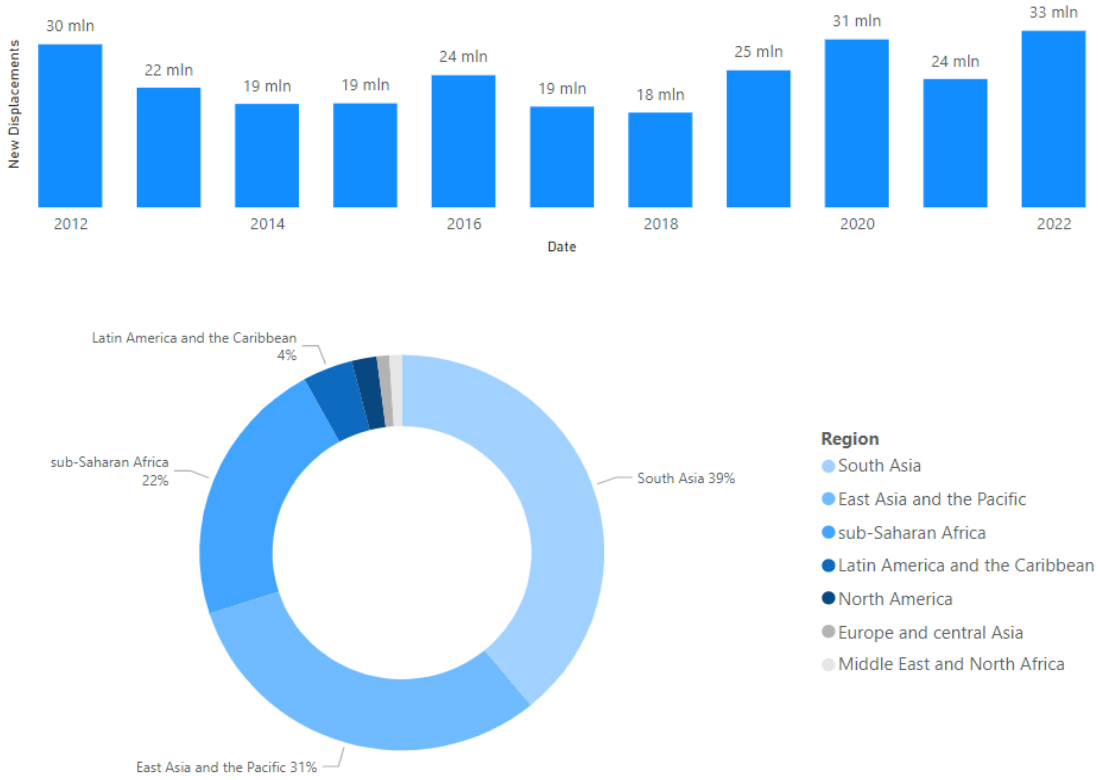
Table 2. Climate vulnerable regions

Region	Impact	Example regions
Regions prone to extreme weather	Areas where droughts, floods, hurricanes, or other extreme weather events occur, leading to migration	South and Southeast Asia, Sub-Saharan Africa
Regions with access to water	Regions experiencing issues due to droughts, melting glaciers, or water spring depletion, leading to displacement	South Pacific, Central Asia
Regions most vulnerable to sea level rise	Coastal regions at risk of flooding due to sea level rise, prompting inland migration or relocation	Coastal and Island areas
Regions containing environmental degradation	Areas experiencing environmental degradation and soil fertility decline, reducing resources and forcing relocation	Sub-Saharan Africa, Central Asia
Regions affected by extreme temperatures	Regions facing increased frequency and severity of heat waves, making them less habitable	Arctic areas
Regions with adaptation effects and weakened infrastructure	Areas with weakened infrastructure and limited adaptation measures	Coastal and Island areas

Source: Own elaboration based on: IDMC (2023).

These regions are just examples of areas that may be particularly vulnerable to climate migration. The actual impact of climate change on migration will depend on many factors, including actions taken to adapt and reduce the effects of climate change.

Figure 1. Internal displacement of people due to climate disasters by region in 2022 and summary for all regions since 2012



Source: Own elaboration based on: European Parliamentary Research Service (2023).

The Figure 1 shows the internal migration of people forced to displace due to climate disasters in 2022. The data comes from the IDMC Data Portal and it includes the data from 148 countries from 2012 to 2022. According to the statistics provided by the IDMC GRID Report (2023), there were 62 movements per minute in 2022, which is almost 33 million new human displacements, related to climate in 2022 as you can see in the chart above. Analyzing the above charts, starting from the Middle East and North Africa, a small share of internal population movements is observed (1%). Similarly for the regions of North America and Europe and Central Asia. However, in Latin America and the Caribbean (4%), a higher percentage of population movements is observed, in Sub-Saharan Africa these movements reach 22%, in East Asia and the Pacific 31%, and in South Asia 39%. Here the highest shares of internal population movements related to climate migrations is observed. The high level of urbanization and dense population in these areas, together with the occurrence of various climatic threats, contribute to the intensification of this phenomenon. This can also be seen in the map below (Figure 2), showing the areas with the biggest population forced to migrate due to climate disasters. These are also regions most susceptible to climatic factors.

Figure 2. Internal displacement of persons due to climate disasters divided into regions in 2022

Source: Own elaboration based on: European Parliamentary Research Service (2023).

Figure 2 also shows the top 15 countries with the most climate migrants in 2022. Ranked first is Pakistan, which is an example of a climate catastrophe that has forced millions of people to flee. This was the result of the 2022 floods in Pakistan, which displaced approximately 8 million people and caused approximately $30 billion in damage. Initially, the movement was internal and mainly involved people evacuating to higher terrain. However, the floods hit the country already struggling with economic collapse and rampant inflation; just a few months later, thousands of Pakistanis illegally immigrated to Europe, a move that made headlines when a boat carrying around 350 Pakistanis and hundreds of other migrants capsized off the coast of Greece. Furthermore, in October 2022, the IEP published its third annual Ecological Threat Report as part of its ongoing monitoring of the level of ecological threats that vulnerable countries are faced with. The report shows that over 1 billion people live in countries whose ability to cope with the predicted climate catastrophes by 2050 is perceived as insufficient.

The map below (Figure 3) shows the main directions of climate migration. It was created by collecting the data on the main destinations of migrants affected by migration disasters from the IPCC report containing a broad analysis of the impact of climate change on various regions of the world, including population migration. The IPCC reports provide both global and regional reviews of the impacts of climate

change. Another source was the report of the United Nations High Commissioner for Refugees (UNHCR) – UNHCR which publishes reports on refugees and migrants, including the detailed analyzes of the causes of migration related to climate change, and the IOM report which conducts research and publishes reports on international migration, including migration climate. To check the reliability of the data from the reports, the World Bank database – World Bank Reports was used, which contains the analyzes of the impact of climate change on migration and forecasts of future migration trends.

Figure 3. Contemporary directions of climate migration

Source: Own elaboration based on: Intergovernmental Panel on Climate Change, 2022; IOM, 2024; The World Bank, 2023; Global Report 2023.

In Europe, Germany is one of the main destination countries for climate migrants from the Middle East, Africa and Asia. The 2015 refugee crisis, which was largely the result of conflicts fueled by droughts and crop failures, contributed to a significant influx of migrants to the country. Germany pursues an active integration policy, offering refugees a wide range of social and educational support. France receives migrants mainly from North Africa, West Africa and the Middle East. High unemployment rates and environmental degradation in countries such as Mali, Niger and Senegal make many people seek refuge in Europe. France is involved in international initiatives to reduce the effects of climate change in these regions, yet it faces challenges related to the integration of migrants. Great Britain is an attractive place for migrants from South Asia (India, Pakistan, Bangladesh), Africa and the Middle East. The country offers many employment and educational opportunities, attracting people affected by natural disasters and environmental degradation in their countries. Spain attracts migrants from Latin America, North Africa and Syria. The rising sea levels and desertification in the Sahel are forcing people to seek refuge in Europe, with Spain being one of the main entry points.

In North America, the main destination for migration from Mexico, Central America, China and India is the United States. The climate crisis in the Central American region, including droughts and hurricanes, is forcing people to flee their homes. Additionally, climate change is affecting Mexico's water resources and

agriculture, which also contributes to migration. Canada accepts migrants from Asia, Africa and the Middle East. The country pursues a proactive policy, offering support and integration programs for people affected by climate change. Thanks to its relatively stable climate, Canada is perceived as a safe place.

In Asia and the Middle East, Saudi Arabia attracts migrants from South Asia, including: India, Pakistan, the Philippines and Bangladesh. These migrations are largely the result of the search for better living and working conditions, especially in the face of growing climate problems in the countries of origin. The United Arab Emirates attracts migrants from South and Southeast Asia. For example, low-lying areas of Bangladesh are particularly vulnerable to the effects of sea level rise, which leads to flooding of inhabited areas and loss of agricultural land. As a result, thousands of residents are forced to leave their homes and move to other parts of the country or abroad. Extreme temperatures and a lack of water resources in the region are forcing many Asians to look for work and better living conditions in wealthier Gulf countries. Turkey is the main transit country for the migrants from Syria and other parts of the Middle East. Armed conflicts exacerbated by climate change are forcing millions of people to flee their homes and seek refuge in Turkey and other European countries.

In Oceania, Australia welcomes migrants from Asia, the Middle East and Africa. Droughts, fires and other extreme weather-related events in the Asia-Pacific region are making many people migrate to Australia in search of a safer environment. New Zealand is a destination for migrants from Asia and the Middle East. The country pursues a policy of openness, offering support to people affected by climate change that forces them to leave their homes. Small island states such as Kiribati and Tuvalu face the threat of being completely submerged by the rising sea levels. The authorities of these countries are already planning mass resettlements of people to neighboring countries such as New Zealand and Australia. These cases highlight the challenges of international cooperation and legal issues surrounding the status of climate refugees.

In Latin America, Argentina receives migrants from neighboring countries such as Haiti and Venezuela. Environmental degradation and economic crises in these countries force people to look for better living conditions in Argentina. Brazil is a destination for migrants from Venezuela and other Latin American countries. Climate change combined with economic crises is contributing to mass political migrations in the region.

In Africa, South Africa attracts migrants from sub-Saharan Africa, including Zimbabwe, Mozambique and Congo. Climate change, such as droughts and crop failures, forces people to leave their homes in search of better living conditions. Uganda welcomes migrants from South Sudan and other countries in the region. Conflicts and climate change in South Sudan are causing mass migrations to the neighboring countries, including Uganda.

Climate migration is a global phenomenon, affecting all continents and regions of the world. Developed countries such as Germany, the United States and Australia receive significant numbers of migrants from regions affected by climate change. In turn, developing countries such as Uganda and South Africa are becoming a refuge for people fleeing the effects of environmental degradation and armed conflicts. Additionally, internal climatic migrations are observed. An example is internal migration in the USA caused by more frequent and intense forest fires in California and hurricanes in certain parts of the coast of the Gulf of Mexico. People are leaving vulnerable regions, leading to demographic and economic changes in other parts of the country.

5. CONCLUSION AND DIRECTIONS FOR FUTURE RESEARCH

The article discusses the significant relationship between climate change and migration, providing a historical overview and emphasizing the contemporary complexity of this phenomenon. The study synthesized the insights from a variety of sources and highlighted the multidimensional nature of climate-induced migration and its consequences for individuals, communities and nations around the world. Climate migration is the result of a complex interaction of climatic, socio-economic, political and cultural factors, which means it is necessary to take into account all these aspects in migration research and policies.

Forecasting climate migration faces difficulties in ignoring non-climatic factors, focusing on slow climate change, neglecting the phenomenon of immobility and irreversible environmental changes. Incomplete databases are also a problem. To successfully predict future migration patterns, the complexities of climate-related migration and the integration of a wide range of environmental, social and political factors into predictive models should be considered. International cooperation and interdisciplinary approaches are key to further research and development of climate migration forecasting methods. Moreover, the use of modern technologies such as machine learning can contribute to better data collection and analysis. Climate change is just one of many factors influencing migration decisions. Economic inequality, social discrimination and political instability also play an important role. Research could take greater account of the political, economic, social and cultural aspects of migration. There is also a need for more advanced forecast models that take into account both slow climate change and sudden environmental events. One solution to this problem may be to collect more complete and accurate data and develop data imputation methods using modern technologies such as machine learning.

The examples of contemporary migrations in the paper show that climate migrations have different causes and effects depending on the local context. However, the need for a holistic approach that takes into account both climatic and non-climatic factors is the common element. Further research should focus on developing advanced forecast models and collecting more accurate data to better understand and manage climate migrations. It is crucial for migration policies to consider a wide range of scenarios. Additionally, international cooperation is crucial for the effective management of climate migration. Strengthening cooperation between countries, joint development of solutions and sharing best practices in managing climate-related migration will significantly improve the situation for migrants, as well as introduction of policies that offer support to people and communities affected by climate change. Examples include humanitarian aid programs, investments in infrastructure adaptation, and the creation of safe and legal migration paths for people forced to leave their homes due to climate change. Another aspect is the use of modern technologies, such as big data and machine learning, in migration management. These technologies can contribute to better monitoring and prediction of migration and optimization of decision-making processes related to migration policy (Standaert & Rayp, 2022).

In summary, further research and development of advanced forecasting models that take into account the complexity of climate migration by integrating a wide range of environmental, social and political factor is suggested. It is necessary to collect more accurate data using modern technologies and conduct research in an interdisciplinary manner. It is also important to take into account the political, economic, social and cultural aspects of migration and analyze sudden climate events. Flexible migration policies that respond to dynamically changing conditions and closer international cooperation in order to develop common solutions is recommended. It is also necessary to support regions affected by climate change through humanitarian aid programs and investments in infrastructure adaptation, create safe and legal migration paths and use modern technologies in migration management.

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