

Critical review of climate change induced migration: An emerging challenge for contemporary society

AHMAD WALI AHMAD YAR¹, STAVROS LAZAROU², VASILIKI VITA², LAMBROS EKONOMOU²

¹Department of Sociology
Vrije Universiteit Brussel
Pleinlaan 5, 1050, Brussels
BELGIUM

²Department of Electrical and Electronic Engineering Educators
School of Pedagogical and Technological Education (ASPETE)
Heraklion Attikis, 141 21 Athens
GREECE

ahmad.wali@vub.be, slazarou@ta.aspete.gr, vasvita@aspete.gr, and leekonomou@aspete.gr

Abstract: Daily life of everyone is affected by the anthropogenic climate change. Nowadays, severe weather phenomena are more frequent and their catastrophes more intense. Even mild temperature and precipitation changes require governments to receive additional measures to safeguard the well-being of their citizens. Unfortunately, not all state actors have the capability to adequately respond, leaving the burden to cope to the local population. This creates tensions and if the resources are not sufficient to cover people's needs, they tend to migrate. Climate change is becoming an issue of paramount importance, as an underlying or prominent factor for migration. This manuscript reviews the available bibliography on the subject. The chosen bibliography encompasses a combination of academic work and reports by international organisations.

Key-Words: Climate Change; Migration; Regional level; Social dimension; Multilateral organisations

I. INTRODUCTION

The increasing importance of the environmental impact on migration has led to a growing amount of scholarly work on the topic. Scholars of varying disciplines such as geography, migration studies, political science, and international relations, among

others, have drawn attention on improving the knowledge and have published extensively. While the advances in the literature have been welcomed by all, the quality, comprehensiveness and the coverage of the literature has been questioned by the scholars of the subject. For instance, studies show certain areas need further research including the relations between human and natural systems, accounting for endogenous attributes and payoffs, and incorporating the existing knowledge on the drivers of migration across sectors [1]. Moreover, further review studies suggest advancing the state of the study of the migration–adaptation area nexus, not just through the study of the causes, but also to review and harmonise the literature on consequences of migration in the context of environmental changes [2].

The amount of literature grows robustly and despite the shortcomings and a lack of extensive original research, the contributions are aimed at covering the gaps in the literature. In a growing universe of literature, it is often of high importance to present a summary of the knowledge with a clear objective and perspective. Therefore, the ultimate objective of this paper is to present an elaborate state of the art and knowledge on climate induced migration within the literature of migration studies and international organisations working on migration. The researchers conduct a systematic review of the literature and put together the main points and provide a brief overview of the main advantages, challenges and shortcomings. The study is focused on certain specific literature and therefore, it does not aim to cover the whole climate change

migration literature. The significance of the study is to facilitate the researchers of the field with the highlights and brief exploration of the existing research on the topic. The paper follows a two steps systematic review of the existing studies on climate induced migration.

The first cluster of the research are mainly the academic articles and reviews, and the second cluster includes the work of international organisations and the United Nations. This study, in fact, contribute to the understanding of the existing state of the art on the topic, their main focuses and shortages, repetitiveness and assesses the lack of original research on the topic.

The point of departure of this work is the discussion over the definition of the phenomenon and the legal status of the population. The evolving discussion on the definition of refugee in the contemporary international law, to a certain degree starts considering environmental refugees. An interesting analysis on this definition as it has evolved up to today is provided by Worster in [3]. He shows that despite the inevitable reality of climate induced migration, the international community failed to present a unified definition for this particular population. The issue of definition is not merely important for the recognition or classification of the population, but it also has a huge impact on their protection and rights. For instance, the UN Codification Division states that “international law has yet to confer refugee status on victims of environmental conditions”. This is an emerging issue that it is becoming more urgent to be dealt with, considering the expanding effects of climate change across the globe. Bettini et al [4] analyse the current situation of “climate refugees” and “migration as adaptation” narratives.

The rest of this paper collects the relevant published information on the subject giving emphasis to four important aspects (Fig. 1). Firstly, it investigates the scholarly work on the connection between climate change and migration. Temperature increase and precipitation changes seem to affect migratory flows. Severe phenomena such as floods, droughts, tropical cyclones, heat waves or cold waves, coastal storms and storm generated surges are more frequent due to climate change, which create massive destruction to human habitats and eventually affect migration. Secondly, the factors underlying the regional conflicts could be a climate-driven phenomenon. Thirdly, the social dimension of climate migration is investigated to the degree that could affect people’s decisions to change their habitat. On a regional level, climate change migratory flows differentiate in terms of continent.

Flows from South to North America demonstrate different characteristics compared to the flows from MENA region to Europe and/or Asia to Europe. Finally, an analysis of the multilateral organisations on migration is provided.

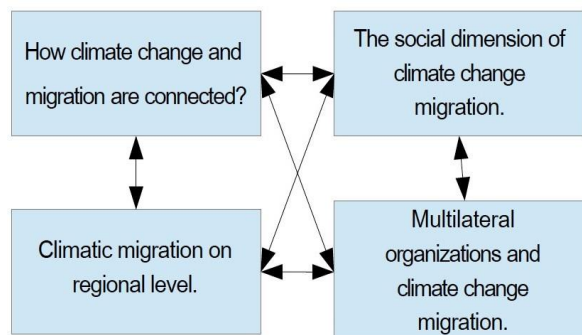


Fig.1 A structure analysis of this work.

II. HOW CLIMATE CHANGE AND MIGRATION ARE CONNECTED?

The Special Environmental Science and Policy Issue “Migration and extreme environmental events: New agendas for global change research” [5] collects articles that correlate climate change with migration flows. It contributes to the analysis on global and regional level and it demonstrates that even if climate change and migration correlation is a complex issue, the understanding of the subject is improving. The published work points out the importance of public policy interventions to mitigate the phenomenon. An interesting analysis on the subject is developed by the papers published at Special Refuge’ Issue “Introduction Environmentally Induced Displacement and Forced Migration” [6]. The phenomenon of Environmentally Induced Displacement is developed in a conceptual and empirical manner and its complexities, to a certain degree, are demonstrated. Backhaus et al [7] investigate the extent and links to which climate change causes international migration. Their results point out three major issues. Firstly, they show that temperature has a positive causal relation with migration. Secondly, sever changes in precipitation causes forced migration. And finally, there is an increase in the number of forced immigrants from the countries or regions which are more dependent on agriculture compared to others. Missirian and Schlenker [8] attempt to connect weather conditions to asylum applications in the European Union. They consider four-year temperature data in 103 “source countries” from 2000 to 2004 and the relevant asylum

applications, which amount at 351,000 annually. They observe an increase to the number of applications when temperature is above the “moderate optimum” of around 20°C. Then, they project their findings up to the end of the century, expecting a substantial increase to asylum applications. This study does not consider other important factors that affect migration. However, its findings are indicating that climate change is a stressor with high possibility to affect migration.

Furthermore, other studies lay the stress on paying careful attention on the methods used by researchers of the topic while examining the data or drawing conclusions on the matter. Eklund et al [9] illustrate that while analysing the data for climate caused migration, among others, it is of high importance to mind scale related issues. They provide strong arguments and examples to define and explain the importance of scale in the study of migration due to climate change, e.g. scale based on physical geography and human geography, where in one hand scale based on physical geography rely mostly on mathematically measurable, deterministic representation of space and time and on the other hand human geographers doubt this relevance. This study also brings to light the issue of the scarcity of relevant and good quality data while representing a critique of the way data are analysed by the scholars of the field.

According to Monirul Qader Mirza [10] analysis, it is a gigantic burden for developing countries to cope with climate related extreme events. These events are not only the ones that are directly connected to severe climatic phenomena such as floods, droughts and storms. They also include hardships exacerbated due to climate change including access to food, epidemics and clean water shortages. All these aspects, either require large allocation of resources to recover or they further reduce the available resources motivating people to migrate. To the opinion of the author, the solution to a certain degree is with the donors and lending agencies, which shall prioritise capacity building instead of disaster recovery. Bohra-Mishra et al [11] demonstrate the correlation between climate change and outmigration. Although precipitation plays its own role, the increase in temperature has its effect. The decrease and increase of rainfall also enhance migration. Sudden, serious catastrophes demonstrate lower permanent migration flows compared to the gradual effects of climate change. Communities are uprooted due to the event, but they tend to return on permanent basis. Klaiber [1] provides a review of the empirical research on the capability of households to cope with climate change. It appears that new

methods and approaches, as well as further scaling, on the subject are required in order to be able to better depict the current situation and project it to the future. Another important point to be further investigated is the behavioural empirical pattern on which people respond to climate change and vice-versa. Obokata et al [12] also provide a review on empirical research for climate refugees. According to them, new or updates of the existing empirical studies shall focus in extending the time period of their research. New works could provide comparative analysis of the factors that affect the phenomenon under investigation. The global and regional scale shall be also considered. English literature could be further enhanced with studies from South America and Middle East.

McGowan [13] wrote a concise review of the book “Life Adrift: Climate Change, Migration, Critique”. The book provides a strong connection between climate change and migration. It also gives emphasis to the fact that these phenomena need to be addressed immediately, or else, it will become more intrusive and substantially affect our lives. Falco et al [14] have carried out a review of climate change and migration from the economics’ science perspective. They also consider on which degree agriculture is the connection point between them. Their findings show that government initiatives for providing agricultural enhancements could to a certain degree mitigate the phenomenon. Cai et al [15] study the underlying factors that connect migration and climate change. The most important interlinkage is agricultural productivity, however in a nonlinear manner.

In this regard, temperature plays an important role to migration from agricultural countries due to its connection with land yield. The findings of this study could be used by the policy makers to better understand migration and climate change, quantify its connection and create the appropriate mechanisms to take advantage of the positive aspects of migration and minimise its impacts. Cattaneo and Peri [16] analyse data from 115 countries between 1960 and 2000 to connect rising temperature with migration. According to their findings, migration for middle-income countries increase when temperature rises but reduces in low-income countries. Middle-income communities are to a certain degree strengthened by migrating, potentially improving their income and average worker wages. On the other hand, a lack of liquidity exacerbated by climate change creates additional burdens for low-income populations, pushes them even deeper into poverty and not allowing them to afford the costs of migrating to another country. In the same pattern, Mbaye [17] agrees that climate change could affect liquidity of

poor communities, not allowing them to migrate but also agrees on issues of brain drain. The author supports the opinion that migration and remittances received from migrants could be a mitigation mechanism for climate change and disasters, especially for countries that lack such a capability, however, they shall not be considered as the main tool to create disaster resilience. Governments could still facilitate migration and alleviate remittances costs.

On the same pattern, Olper et al [18] states that one of the most important challenges the world currently faces is climate change and migration. They use data from 150 countries from 1960 to 2010 and their findings indicate that middle- and low-income communities are more probable to send their members to another country if the weather fluctuates. This is not the case for the poor and rich countries from which for different reasons people do not migrate.

III. THE SOCIAL DIMENSION OF CLIMATE CHANGE MIGRATION

de Guttry et al [19] conducted a qualitative study with immigrants from Italy and China in Hamburg, Germany to have their perspective on climate change issues and their impact on their lives. This study is basically a critique of the lack of theoretical understanding of the issue and the representation of immigrants as victims. Considering the socio-cultural knowledge and understanding of migrants, they try to reframe migrants as actors who can productively contribute to addressing the challenge of climate change. Telford [20], is concerned about the work of researchers, mainly think tank researches on the issue of climate induced migration. He believes that mainly researchers (think tankers) relate or bring the issue of insecurity and radicalisation in the same order as climate induced migration, which will result in convincing the EU politicians and readers that there is a direct link between the two issues. He argues that Muslim migrants from Africa and MENA region are radicalised based on that perception and therefore, he calls to challenge racial logics and the restrictive, unjust possibilities they suggest for future climate security politics. Burrows and Kinney [21] are looking into the potential links between climate change, migration and increased risk of conflict. They first investigate the links between climate change and then the relations between migration and conflict. Their findings signal broad range of visions on the importance of climate change

as a ground for increased migration as well as conflict. They suggest that further research is required to focus on the relations between climate migration and conflict. Also, further work on understanding the pathways by which climate change might exacerbate conflict. They propose five questions to be investigated in the future research on the topic. The questions are posed to understand the local climate risks, the potential for resources scarcity, the status of local stability and destabilising factors, the historical rationality of conflicts and whether migration is economically viable. Berchin et al [22] argue that climate change causes forced migration and therefore it ought to be treated the same way as war and political instability induced migration. They further argue that there is a need to redefine the term refugee internationally, as the present definition in the 1951 UN convention does not represent all the categories of refugees. The time has changed and in the same manner the reasons for forced migration. Hence, the definition ought to be adapted, taking into consideration forced migration due to intra alia climate and environmental changes. The study gives an account of previous definitions of climate induced refugees and describes climate change refugees as any person who has been forced to leave their home, or their country, due to the effects of severe climate events, being forced to rebuild their lives in other places, despite the conditions to which they are subjected.” For Tramel [23] climate change severely affects food security of agrarian and fishing low-income communities. This is in line with resource grabbing from these communities leads in alerting social justice movements, which express their grievances based on a global environmental framework. Climate movements receive authoritarian populism calls, intensified by racism, nationalism and patriarchy. This intensifies their requests for political solutions to safeguard climate change mitigations initiatives and protect migrants, who are the people most affected.

IV. CLIMATIC MIGRATION ON CONTINENTAL REGIONAL LEVEL

A. *Migratory flows from Africa*

When considering regional consequences of climate induced migration, the streetlight effect shall be considered. Hendrix [24] explains that countries with high exposure to environmental events and reduced capacity to mitigate the effects of climate change in Africa receive the lesser attention from scholars due

to a lack of scientific data. Researchers and policy makers shall identify the potential implications of this effect and provide mitigation strategies focused to the specific application under investigation. Wiederkehr et al [25] emphasise the importance of strategies used by the population affected by environmental and climate changes issues. Environmental adaptations cause that people living in vulnerable areas move or migrate. Hence in this article they have focused on two different and important aspects of the issue, first the importance of coping and behaviour of population affected, and second in-existence of relevant data to understand the impacts and correlation of these two phenomena. Since the Sub-Saharan African region is one of these vulnerable territories, this study focuses on analysing data from 63 studies converging more than 9700 rural households collected based on 63 quantitative and qualitative studies. Their results show that household strategies like crop, livestock, soil and water management are very common. The studies stress on direct correlation between environmental changes and migration, which is persistent in about 23 per cent of households.

The study calls for further research to determine what type of support socially and ecologically is needed for sustainable coping with the environmental adaptation. Dumenu and Obeng [26] conducted a survey to analyse social vulnerability due to climate change in Ghana. Their findings demonstrate higher vulnerability index at the rural zones of Sudan and Guinea Savanna. The inhabitants of these zones suffer more from illiteracy and climatic connected livelihoods. The remedies on citizen level include change of occupation, expansion of arable land and crop diversification for farmers and migration to urban zones. Government shall provide irrigation works to reduce climate change impact and further investigate the challenges local population is facing. Mastrorillo et al [27] investigate climate migration outflows at post-apartheid South Africa. They use data from 1997 to 2001 and from 2007 to 2011. They observe that several socio-economic and demographic factors affect migration flows. Black and low-income South Africans are more probable to be affected by climate change events, when high-income and white South Africans are affected to a lesser degree. Agriculture is a possible connection point between climate change and migration in South Africa.

B. Migratory flows from Middle East

According to Gleick [28], Syrian conflict, even if it was initiated to achieve regime change, it was affected by the deterioration of the economic

situation. In the 2000s several droughts appeared in the Eastern Mediterranean region. Water scarcity caused by climate change reduced agricultural production, exacerbating multi-ethnic and religious grievances. The author proposes that policy makers shall better organise the improvements of water and groundwater use efficiency and construct water management irrigation works.

C. Migratory flows from Asia

Koubi et al [29] provide survey data from Vietnam to support their theoretical research question. According to them, communities respond migrating to sudden serious environmental events but to a lesser degree to environmental events that take place in long time frame. Having this said, floods and typhoons are more probable to create immediate migration flows in Vietnam. On the other hand, communities are making efforts to deal with draughts or soil salinization before start migrating. In Philippines, according to Bohra-Mishra et al [30], temperature and typhoons disturb migration flows, possibly due to their effect to rice production. Precipitation increase does not demonstrate direct connection to migratory displacements. On social level, young, educated men are more probable to migrate. In Philippines, as much in other countries, the expected future deterioration of the climate will increase migration flows. Jacobson et al [31] conducted a quantitative research on migration in South East Asia. In accordance to their findings, almost half of the households surveyed have migratory flows, half of which are caused by climate change. They also show that migration per se is not able to cover issues of food security and in parallel creates labour shortages. Maharjan et al [32] made an analysis for the areas where climate change induced migration is more prominent. South Asia, due to the fact that people base their livelihoods to agriculture and the region is frequently hit by climate severe phenomena is one of them. They support the opinion that remittances from migrants can enhance food security and potentially provide opportunities for improving resilience through the acquisition of new arable land. In the same vein, Blondin [33] recognises the existence of hot spot regions in Central Asia. However, the conclusions of this review article read that Central Asia climatic change migration is limited compared to the human movements from other causes. Additional studies are needed to adequately understand the situation. Zander et al. [34] correlated heat with the intention to move in South East Asia. The findings allow to conclude that women and older people that are more sensitive to temperature increase intent more than others to move to cooler places.

Nevertheless, the movement itself is also connected to the ability of these groups to do so and it is procedure that needs time to be materialised.

D. Migratory flows from South America

Thiede et al [35] use data from 25 censuses in South America to define the regional correlation between climate change and migrate. 21 million observations of adults aged 15-40 were considered, showing the complexity of the phenomenon on rural/urban and cross-country settings. Their findings demonstrate that temperature increases tend to have more robust correlation to migration than precipitation. In South American countries, country-based results show potential differences in populace attitude. Nawrotzki et al [36] combined data from Mexican Migration Project (MMP) and Global Historical Climatology Network Daily (GHCN-D) to investigate on which degree climate change affect migration in Mexico. The authors besides the traditional factors that lead to migration added the warm spell duration index (WSDI) and the wet spell duration index (CWD) to connect temperature, precipitation and international migration. Their findings indicate that rural regions with primary occupation at the agricultural sector tend to increase their migration flows when temperature is on average higher. In Costa Rica, according to Robalino et al [37] internal migration during the data period 1995-2000 is affected by hydro-meteorological emergencies. The most severe phenomena that included loss of life decreased migration flows, when mild phenomena create a migration pattern towards the metropolitan areas. Severe phenomena economically deprive poor communities not allowing the liquidity to members to allow them to emigrate. Meteorological phenomena also create emigration flows between metropolitan areas.

E. Migratory flows from Europe

Climate migration was exacerbated in recent times, but it was also evident in 19th century. Glaser et al [38] investigate the degree of which climate change affected migration from southwest Germany to North America in line with the social conditions of the time. Their findings confirm the connection of climate change caused by a mini ice age of the time, reduction of crop yields and the subsequent migration flows. However, the social conditions of the time had been the major stressors towards creating migration outflows. It is unclear, however, on which degree the climate change per se affected the social phenomena in discussion.

V. MULTILATERAL ORGANISATIONS AND CLIMATE CHANGE MIGRATION

In addition to the growing academic literature focusing on climate change and to some extent on the (causal) relation between climate change and migration, several multilateral organisations have shifted focus on the topic as well. This section critically reviews the state of knowledge and the contribution of international and multilateral organisation towards climate induced migration. The IOM's migration data portal has gathered a large collection of publications and literature on migration, environment and climate change (Fig. 2).

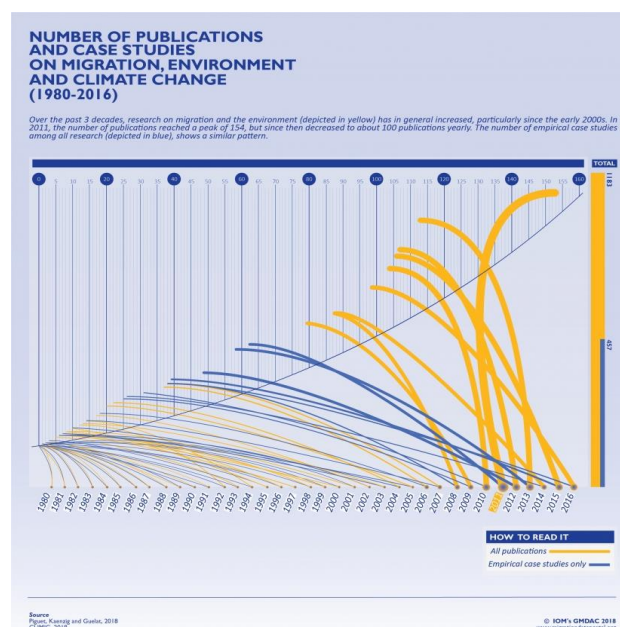


Fig.2 Number of publications and case studies on climate change and migration. Source: IOM Migration Data Portal.

The Intergovernmental Panel on Climate Change (IPCC) is one of the primary UN bodies established in 1988 to assess climate change implications using scientific data and expert's knowledge. In 1990, as part of its circular assessment reports, the IPCC, for the first time, warned that among other potential damages to the planet, the changes in climate would initiate large migration flows of people and will lead to over a number of years to severe disruptions of settlement patterns and social instability in some areas. In their report, the IPCC emphasised that the gravest effects of climate change will be on human

migration, stating that millions of people were already displaced by shoreline erosion, coastal flooding and severe drought. Since then, every assessment report from the IPCC has warned about the consequences of the impact of climate change on humanitarian crisis, especially migration [39]. However, there has not been an attempt to thoroughly evaluate the consequences of climate change on human migration by the IPCC. The IPCC does not conduct its own research but supports other international organisations to conduct research on specific cases of climate change and how it affects the planet. Therefore, a comprehensive scientific study to provide the policymakers and general public with adequate information on the future and current of climate caused migration based on the geography, patterns, population and measures in a global scale is missing.

The UN agencies have pioneered in research on the impact of environmental changes on migration and seek solutions to mitigate climate change. Among their other migration related responsibilities, the IOM and the UNHCR have a particular focus on climate induced migration. They have published several reports on the topic, including a report by the UNHCR on displacement due to climate change, the “Migration and Climate Change” [40] and “Climate Change and Migration: Improving Methodologies to Estimate Flows” [41], both supported by IOM. Moreover, in order to tackle the issue of scattered information on climate change’s impact on human migration, the IOM established “The Environmental Migration Portal: Knowledge Platform on People on the Move in a Changing Climate” in 2015 [42]. The portal was created to gather relevant and up-to-date research, data and knowledge on migration, environment and climate change as well as to offer a virtual space of exchange, learning and advocacy for tackling climate change issues (Fig. 3). The portal hosts a handful of publications, policy briefs, infographics, country profiles, and other glossaries available for researchers, policymakers and broader public.

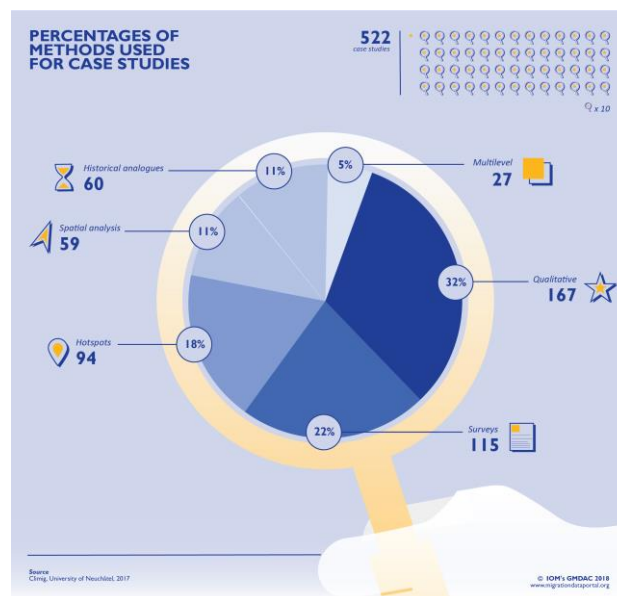


Fig.3 Methods used for case studies on environmental migrations. Source: IOM Migration Data Portal.

In this paper briefly is reviewed the most relevant research conducted by the UNHCR, IOM and other international organisations on climate induced migration. The reports by the UNHCR on displacements due to climate change are mainly focusing on the activities of the agency on improving the situation and providing support to the victims, organising meetings and information sessions to stress on the importance of having a global guiding framework on cross-border displacement. The effectiveness impact of the UNHCR struggle in mainstreaming the importance of climate induced human displacements has been considered rather weak as only five countries agreed on the idea of developing the global guiding framework during the 2011 UNHCR ministerial meeting. Moreover, the amount of online information on providing clear guidance on the depth of the issue and the scale of climate change’s negative consequences on human beings from immediate to long-term based on the available resources from the UNHCR is scarce.

The UN agencies are also involved in studying and finding solutions to mitigate the climate change. The IOM and UNHCR are particularly focusing on climate induced migration, among other migration issues. The reports by the UNHCR on displacements due to climate change are mainly focusing on the activities of the agency on improving the situation and providing support to the victims, organising meetings and information sessions to stress on the importance of having a global guiding framework on cross-border displacement. The impact of the UNHCR struggle in mainstreaming the importance of climate induced human displacements has been considered

rather weak as only five countries agreed on the idea of developing the global guiding framework during the 2011 UNHCR ministerial meeting. Moreover, the amount of online information on providing clear guidance on the depth of the issue and the scale of climate change's negative consequences on human beings from immediate to long-term based on the available resources from the UNHCR is scarce. To date, the major reference on the topic is the 2008 work of Brown [40], a report for the IOM which was published as part of an IOM research series. Since then, there has been no other significant work focusing on the topic, and the findings of the research have been substantially undermined. The report underlines the difficulty of setting up a linear causal relationship between anthropogenic climate change and migration due to the immensity of socio-economic and environmental factors. Therefore, it makes it even more difficult to present a clear and predictable consequence of climate change on human population. The report remains optimistic on the change of the situation in the near future and expects more research and attention on the issue. However, to date, there is not any large and extensive action taken by international bodies on improving the state of the art on the consequences of climate change on human migration. The report splits up the meteorological impact of climate change into two different drivers of migration that contribute to the degree of vulnerability of people being affected. The report warns about the rapidity in the pace of change overtime and the growing number of people being affected by the phenomenon. There has been a very simplistic image of climate induced migration that has been presented for the public. In fact, political refugees are considered as a burden to the broader world community, the climate change refugees are mostly borne by the poorest countries, especially those which are least responsible for emissions of greenhouse gases. The study indicates that the most vulnerable people to climate change are not necessarily the ones most likely to migrate.

The vulnerable populations tend to temporarily migrate, and in many instances, they do not have enough financial and social resources for migration. According to Brown, predicting future flows of climate migration is complex due to the lack of baseline data, uncertainty in population growth, the amount of emission in the future and the evolution of climate change over time. Regrettably, there are very few (if any) studies on forecasting or at least attempts gathering adequate data for academic and policy researches. Brown determines three scenarios based on the scientific findings of IPCC. The "good" case which is the best-case scenario where serious actions

taken to reduce the emissions like a Marshall Plan, the "bad" scenario where a world with large economic growth, a global population at peak until mid-century and the sources of energy is balanced between fossil and non-fossil energy and the third is the "ugly" scenario which is similar to the second scenario with the deference of energy sourced overwhelmingly from fossil fuel supplies. The study identifies four means where forced migration impedes development, including: (i) increasing pressure on urban infrastructure and services, (ii) undermining economic growth, (iii) increasing risk of conflict and (iv) compelling towards worse health, educational and social indicators among migrants. The report points out that there are no measurements taken for addressing these issues at any level and the issue has been widely ignored by many.

Another IOM supported contribution to the literature is the report on "Climate Change and Migration: Improving Methodologies to Estimate Flows" published in 2008 [41]. The paper came out in the same year as the previous report above and therefore most of the conclusions and arguments are in line. This paper also, in turn, lays stress on the importance of having adequate and urgent understanding of the interconnection of climate change and migration. The fact that the volume of publications and literature on the subject is scarce is a matter of concern for this study as well. The data used for the report is also based on scientific discoveries of IPCC's assessments of risk of human-induced climate change. The paper focuses on introducing the most urgent and vulnerable areas which could be hit by climate change caused disasters.

The Atlas of Environmental Migration [43] is a recent ambitious attempt to illustrate the map of environmental migration, to clarify the terminology and concepts, to draw a typology of migration related to environment and climate change, describing the multiple factors at play, to bring up the challenges, and to some extent highlight the opportunities related to the phenomenon. The study is supported by IOM and built based on the (limited) existing research, forecasting and nowcasting being conducted by different organisations. The research contains visual maps, diagrams, illustrations and case studies from different regions in the world. The initial goal behind the report is to guide the readers through the complexity of the phenomenon from the roots of environmental migration to governance. Although the paper is an informative guide for apprentice students and researchers who would like to explore the phenomenon, the paper could not be considered as a comprehensive guide for

policymakers and academics to draw conclusions on the topic.

More recently, the 2020 “World Migration Report” by IOM revealed that the climate and environmental caused migration has resulted in large-scale migration and displacements in many regions around the world and it will increase further in the years to come [44]. The report provides the details of human displacements which occurred between 2018 and 2019.

Private international institutions also contribute to the study of the phenomenon. However, the results are not always in line, in terms of data and numbers. For instance, the Foresight observatory on climate policies and futures [45] reported in 2019 that environmental migrations will make up to one billion by 2050. The World Bank reported in 2018 that there would be over 140 million migration within countries by 2050, while the IOM report predicted 200 million migrants.

VI. CONCLUSIONS

Considering the importance of the issue and potential harm that climate change may have on migration, the existing scientific explorations do not correspond to the needs of policymakers and people working on the topic to mitigate and find better solutions for it. Most of the reports are cross-citing each other and the amount of original research on the phenomenon is scarce. There has been considerable attention towards scientific understanding of the reasons behind climate change.

Additionally, since the 1990s, there is a consensus in the academic literature and reports produced by the multilateral organisations that climate change will have a harsh effect on human lives and will cause massive migrations. However, working on a multilateral and comprehensive endeavour for seeking solutions, collecting data, raising awareness and presenting accurate figures and predictions is yet to happen. One of the very common practices in the reports is forecasting the flow of future migration as a result of climate change. There is a consensus that by 2050, there might be a drastic increase in people seeking asylum globally. However, as shown above, each study (institution) presents different numbers, prediction and perceptions of the impact of climate change on human migration. Another important issue raised in almost every report is that for the time being, prognostication of climate change migration is inherently uncertain owing to the in-existence of adequate information on the impact of global warming on human lives in specific geographical locations.

Having mentioned the above, the scientific community will be benefited if additional research is to be conducted in order to correlate more clearly climate change and migration. Agricultural activities seem to be a strong proxy. However, extreme phenomena per se, such as typhoons and droughts, increasing temperature, changing precipitation and others could directly affect the will of people to migrate to other regions inside their countries or to other countries and continents. It has to be mentioned that regional human response to exogenous factors varies based on culture and other social factors.

References:

- [1] H. A. Klaiber, Migration and household adaptation to climate: A review of empirical research, *Energy Economics*, Vol. 46, No.1, 2014, pp. 539-547.
- [2] F. Gemenne and J. Blocher, How can migration serve adaptation to climate change? Challenges to fleshing out a policy ideal, *The Geographical Journal*, Vol. 183, No. 4, 2017, pp. 336-347.
- [3] W. T. Worster, The evolving definition of the refugee in contemporary international law, *Berkeley Journal of International Law*, Vol. 30, No. 1, 2012, pp. 142-149.
- [4] G. Bettini, S. L. Nash and G. Gioli, One step forward, two steps back? The fading contours of (in)justice in competing discourses on climate migration, *The Geographical Journal*, Vol. 183, No. 4, 2017, pp. 348-358.
- [5] R. Black, N. Arnell and N. Adger, Migration and extreme environmental events: New agendas for global change research, *Environmental Science and Policy*, Vol. 27, 2013, S1-S3.
- [6] P. Bose and E. Lunstrum, Introduction environmentally induced displacement and forced migration, *Refugee*, Vol. 29, No. 2, 2014, pp. 5-10.
- [7] A. Backhaus, I. Martinez-Zarzoso and C. Muris, Do climate variations explain bilateral migration? A gravity model analysis., *IZA J. Migration*, Vol. 4, 2015, pp. 1-15.
- [8] A. Missirian and W. Schlenker, Asylum applications respond to temperature fluctuations, *Science*, Vol. 358, 2017, pp. 1610-1614.
- [9] L. Eklund, C. Romankiewicz, M. Brandt, M. Doevenspeck and S. Samini, Data and methods in the environment-migration nexus: a scale perspective, *Journal of the Geographical Society of Berlin*, Vol. 147, No. 2, 2016, pp. 139-152.

- [10] M. M. Q. Mirza, Climate change and extreme weather events: can developing countries adapt?, *Climate Policy*, Vol. 3, 2003, pp. 233-248.
- [11] P. Bohra-Mishra, M. Oppenheimer and S. M. Hsiang, Nonlinear permanent migration response to climatic variations but minimal response to disasters, *Proceedings of the National Academy of Sciences*, Vol. 111, No. 27, 2014, pp. 9780-9785.
- [12] R. Obokata, L. Veronis and R. McLeman, Empirical research on international environmental migration: a systematic review, *Population and Environment*, Vol. 36, 2014, pp. 111-135.
- [13] A. McGowan, Life adrift: Climate change, migration, critique, *Environment: Science and Policy for Sustainable Development*, Vol. 60, No. 4, 2018, pp. 30-36.
- [14] C. Falco, F. Donzelli and A. Olper, Climate change, agriculture and migration: A survey, *Sustainability*, Vol. 10, No. 5, 2018, pp. 1-21.
- [15] R. Cai, S. Feng, M. Oppenheimer and M. Pytlikova, Climate variability and international migration: The importance of the agricultural linkage, *Journal of Environmental Economics and Management*, Vol. 79, 2016, pp. 135-151.
- [16] C. Cattaneo and G. Peri, The migration response to increasing temperatures, *Journal of Development Economics*, Vol. 122, 2016, pp. 127-146.
- [17] L. M. Mbaye, Climate change, natural disasters, and migration, *IZA World of Labor*, Vol. 346, 2017, pp. 1-10.
- [18] A. Olper, C. Falco and M. Galeotti, Climate change, agriculture and migration: Is there a causal relationship?, *Conference of the International Association of Agricultural Economists*, Vancouver, British Columbia, 2018.
- [19] C. de Guttery, M. Döring and B. Ratter, Challenging the current climate change - migration nexus: Exploring migrants' perceptions of climate change in the hosting country, *Journal of the Geographical Society of Berlin*, Vol. 147, No. 2, 2016, pp. 109-118.
- [20] A. Telford, A threat to climate-secure European futures? Exploring racial logics and climate-induced migration in US and EU climate security discourses, *Geoforum*, Vol. 96, 2018, 268-277.
- [21] K. Burrows and P. L. Kinney, Exploring the climate change, migration and conflict nexus, *International Journal of Environmental Research and Public Health*, Vol. 13, No. 4, 2016.
- [22] I. I. Berchin, I. B. Valduga, J. Garcia and J. B. S. O. de Andrade Guerra, Climate change and forced migrations: An effort towards recognizing climate refugees, *Geoforum*, Vol. 84, 2017, pp. 147-150.
- [23] S. Tramel, Convergence as political strategy: Social justice movements, natural resources and climate change, *Third World Quarterly*, Vol. 39, No. 7, 2018, pp. 1290-1307.
- [24] C. S. Hendrix, The streetlight effect in climate change research on Africa, *Global Environmental Change*, Vol. 43, 2017, pp. 137-147.
- [25] C. Wiederkehr, M. Beckmann and K. Hermans, Environmental change, adaptation strategies and the relevance of migration in Sub-Saharan drylands, *Environmental Research Letters*, Vol. 13, No. 11, 2018.
- [26] W. K. Dumenu and E. A. Obeng, Climate change and rural communities in Ghana: Social vulnerability, impacts, adaptations and policy implications, *Environmental Science and Policy*, Vol. 55, 2016, pp. 208-217.
- [27] M. Mastroiello, R. Licker, P. Bohra-Mishra, G. Fagiolo, L. D. Estes and M. Oppenheimer, The influence of climate variability on internal migration flows in South Africa, *Global Environmental Change*, Vol. 39, 2016, pp. 155-169.
- [28] P. H. Gleick, Water, drought, climate change, and conflict in Syria, *American Meteorological Society*, Vol. 6, 2014, pp. 331-340.
- [29] V. Koubi, G. Spilker, L. Schaffer and T. Bernauer, Environmental stressors and migration: Evidence from Vietnam, *World Development*, Vol. 79, 2016, pp. 197-210.
- [30] P. Bohra-Mishra, M. Oppenheimer, R. Cai, S. Feng and R. Licker, Climate variability and migration in the Philippines, *Population and Environment*, Vol. 38, 2017, pp. 286-308.
- [31] C. Jacobson, S. Crevello, C. Chea and B. Jarihani, When is migration a maladaptive response to climate change?, *Regional Environmental Change*, Vol. 19, 2019, pp. 101-112.
- [32] A. Maharjan, R. Safra de Campos, C. Singh, S. Das, A. Srinivas, M. Rashed, A. Bhuiyan, S. Ishaq, M. A. Umar, T. Dilshad, K. Shrestha, S. Bhadwal, T. Ghosh, N. Suckall and K. Vincent, Migration and household adaptation in climate-

- sensitive hotspots in South Asia, *Current Climate Change Reports*, Vol. 6, 2020, pp. 1-16.
- [33] S. Blondin, Environmental migrations in Central Asia: A multifaceted approach to the issue, *Central Asian Survey*, Vol. 38, No. 2, 2019, pp. 275-292.
- [34] K. K. Zander, C. Richerzhagen, S. T. Garnett, Human mobility intentions in response to heat in urban South East Asia, *Global Environmental Change*, Vol. 56, 2019, pp. 18-28.
- [35] B. Thiede, C. Gray and V. Mueller, Climate variability and inter-provincial migration in South America, 1970–2011, *Global Environmental Change*, Vol. 41, 2016, pp. 228-240.
- [36] R. J. Nawrotzki, L. M. Hunter, D. M. Runfola and F. Riosmena, Climate change as migration driver from rural and urban Mexico, *Environmental Research Letters*, Vol. 10, No. 11, 2015.
- [37] J. Robalino, J. Jimenez and A. Chacón, The effect of hydro-meteorological emergencies on internal Migration, *World Development*, Vol. 67, 2015, pp. 438-448.
- [38] R. Glaser, I. Himmelsbach and A. Bösmeier, Climate of migration? How climate triggered migration from southwest Germany to North America during the 19th century, *Climate of the Past*, Vol. 13, 2017, pp. 1573-1592.
- [39] Impacts Assessment of Climate Change, *Intergovernmental Panel on Climate Change (IPCC)*, <https://www.ipcc.ch/report/ar1/wg2/>, [Assessed January 2020].
- [40] O. Brown, Migration and climate change, *IOM Migration Research Series*, Vol. 31, 2008.
- [41] D. Kniveton, K. Schmidt-Verkerk, C. Smith and R. Black, Climate change and migration: Improving methodologies to estimate flows, *IOM Migration Research Series*, Vol. 33, 2008.
- [42] Environmental Migration Portal, <https://environmentalmigration.iom.int/>, [Assessed April 2020].
- [43] D. Ionesco, D. Mokhnacheva, and F. Gemenne, The atlas of environmental migration, IOM, 2017.
- [44] IOM (2019), Migration in the world, <https://www.iom.sk/en/migration/migration-in-the-world.html>, [Assessed April 2020].
- [45] Foresight observatory on climate policies and futures, <https://www.climateforesight.eu/migrations/environmental-migrants-up-to-1-billion-by-2050/>, [Assessed January 2020].

Author Contributions: Conceptualisation, S.L. and A.W.; methodology, S.L.; formal analysis, A.W.; writing—original draft preparation, S.L. and A.W.; writing—review and editing, V.V.

Acknowledgments: The authors would like to thank Elisebha Platzer from JRC Alumni Network and Frederic Bastide from JRC Refugees Scientists program for their support, without whom this work would have been impossible to be materialised.

Conflicts of Interest: On behalf of all authors, the corresponding author states that there is no conflict of interest.

Abbreviations

The following abbreviations are used in this manuscript:

UN	United Nations
EU	European Union
MENA	Middle East and North Africa region
IPCC	Intergovernmental Panel on Climate Change
IOM	International Organisation for Migration
MMP	Mexican Migration Project
WSDI	Warm Spell Duration Index
GHCN-D	Global Historical Climatology Network-Daily