WORKING PAPERS

Evolution of climate-related migration and displacement in IPCC reporting

Robert McLeman, Celina Hevesi and Edi Cadham

Working Paper No. 2025/14
October 2025

The *Working Papers* Series is produced jointly by the Toronto Metropolitan Centre for Immigration and Settlement (TMCIS) and the CERC in Migration and Integration
www.torontomu.ca/centre-for-immigration-and-settlement
www.torontomu.ca/cerc-migration

Toronto Metropolitan University

Canada Excellence Research Chair in Migration & Integration

Toronto Metropolitan Centre for Immigration and Settlement

Working Paper

No. 2025/14

Evolution of climate-related migration and displacement in IPCC reporting

Robert McLeman, Celina Hevesi, Edi Cadham
Department of Geography & Environmental Studies, Wilfrid Laurier University

Series Editors: Anna Triandafyllidou, Richa Shivakoti and Zhixi Zhuang

Toronto Metropolitan University | Canada Excellence Research Chair in Migration & Integration | Toronto Metropolitan Centre for Immigration and Settlement

The *Working Papers* Series is produced jointly by the Toronto Metropolitan Centre for Immigration and Settlement (TMCIS) and the CERC in Migration and Integration at Toronto Metropolitan University.
Working Papers present scholarly research of all disciplines on issues related to immigration and settlement. The purpose is to stimulate discussion and collect feedback. The views expressed by the author(s) do not necessarily reflect those of the TMCIS or the CERC.
For further information, visit www.torontomu.ca/centre-for-immigration-and-settlement and www.torontomu.ca/cerc-migration.

ISSN: 1929-9915

Abstract

Concerns about climate change impacts on migration and displacement have been expressed regularly by the Intergovernmental Panel on Climate Change (IPCC) since its first report in 1990. The 2022 Working Group II Sixth Assessment Report (AR6) presented the most comprehensive IPCC assessment to date of how climate affects migration and displacement, emphasizing complex causal linkages and multidirectionality of outcomes. Climate-migration linkages have not always been presented in such a nuanced way by the IPCC. Here we present results from a systematic identification and analysis of migration and displacement messaging in IPCC reports published prior to AR6. We chronicle an evolution from 1990s reports that stoked fears of environmental refugees and suggested "solutions" to prevent migration, to reports from the early 2000s that considered how to manage millions of displaced people and the potential financial costs, to more recent reports that considered migration and displacement within the wider context of human security. We identify inconsistencies in messaging about migration and displacement between reports (and sometimes within the same report) that persisted through Special Reports published in 2018 and 2019. We conclude by identifying topics and themes that by virtue of omission or under-reporting may warrant greater attention in future IPCC reports. This report also includes a visual timeline summarizing key developments. A link is provided at the end of this manuscript (p30) to MS Excel Tables that identify and summarize each occurrence of substantive discussion of migration, displacement and related topics in each IPCC report.

Key words: IPCC; migration; displacement; climate-related migration

Key messages:

- Concerns about the impacts of climate change on migration and displacement have been expressed regularly in IPCC reporting since the very first Assessment Report in 1990
- Messaging about the relationship between climate and migration/displacement in IPCC reports has evolved considerably since 1990, with notable inconsistencies occurring over that period
- The *IPCC Special Report on Oceans and Cryosphere* and the 2022 *Working Group II Assessment Repo*rt provide the most comprehensive and reliable IPCC accounts of relationships between climate and migration/displacement. Future reports will want to build upon these with more detailed estimations of future migration and displacement at regional and sub-regional levels, accompanied by more detailed examples from current experiences

Table of Contents

Introduction

Since its very first report in 1990, the Intergovernmental Panel on Climate Change (IPCC) has expressed concerns that climate change may affect human migration and mobility. Descriptions in IPCC reports of how it might do so have evolved considerably over the subsequent thirty-five years, and the amount of attention given to this topic has expanded with each subsequent report. There are multiple possible factors to explain this, which we delve into in greater detail in this article, including growing interest in the subject on the part of policymakers, an expanding amount of peer-reviewed research available for assessment, changes in the structure of IPCC reports and in the composition of IPCC author groups, and the increasing focus over time of the UN Framework Convention on Climate Change (UNFCCCC) process (which IPCC reporting is intended to support) on adaptation and climate-related loss and damage.

The IPCC 2022 Working Group II Sixth Assessment Report (WGII AR6) provides one of the most comprehensive assessments to date of how climate currently influences the migration, displacement, and mobility of people at regional and global scales, and how it is likely to do so in the future. The terms of reference for WGII AR6 authors included explicit instructions to authors of Chapter 7, entitled *Health, wellbeing and the changing structure of communities* (Cissé et al 2022) to assess, “Observed impacts and projected changes in migration, displacement, and trapped populations, and linkages to adaptation”. Given the strong connections between migration and urbanization (the focus of Chapter 6 of WGII AR6) and livelihoods (Chapter 8), and the differences in migration processes and patterns across geographical regions (Chapters 9-15), a dedicated team of Lead Authors from across chapters was formed to coordinate the assessment of relevant scholarly literature, to ensure consistency in conclusions and presentation of findings, and to eliminate duplication across chapters. This team collaborated on the writing of a Cross Chapter Box entitled “Climate-related Migration” found within the main body of chapter 7 at pages 1080-1083, which begins by summarizing five key messages found in the WGII AR6 report, as follows:

- Climatic conditions, events and variability are important drivers of migration and displacement, with migration responses to specific climate hazards being strongly influenced by economic, social, political and demographic processes
- Specific climate events and conditions may cause migration to increase, decrease or flow in new directions, and the more agency migrants have (i.e., the degree of voluntarity and freedom of movement), the greater the potential benefits for sending and receiving areas
- Most climate-related migration and displacement observed currently takes place within countries
- In many regions, the frequency and/or severity of floods, extreme storms and droughts is projected to increase in coming decades, especially under high-emissions scenarios, raising future risk of displacement in the most exposed areas
- There is growing evidence about the future prospects of immobile populations (i.e. groups and individuals that are unable or unwilling to move away from areas highly exposed to climatic hazards)

The Cross-chapter box then goes on to summarize climate-migration interactions and outcomes, presents a typology of examples found in sectoral and regional chapters of AR6, and concludes by identifying implications for policymakers. In addition to the global analysis of current and projected climate-related migration and displacement found in the main text of chapter 7, substantive assessments of migration or displacement within specific regional or sectoral contexts are found in twelve other chapters of the 18-chapter assessment.

Previous IPCC reports have not always provided as thorough or nuanced an assessment of migration and displacement as AR6. The present article describes the evolution of how these topics have been treated in IPCC reporting since the very first IPCC Assessment Reports of 1990, and in doing so analyzes the strengths, weaknesses and inconsistencies of past assessments and identifies topics that may warrant greater attention in future reports. As will be shown, the IPCC assessment of migration and displacement has evolved from normative, somewhat alarmist warnings of floods of environmental refugees, with suggestions of how migration might be prevented from rural areas experiencing the impacts of climate change, to more thoughtful and nuanced interpretations of how interactions between climate change and non-climatic processes influence migration and displacement, and how the outcomes are context-specific and multidirectional. Documenting this evolution provides an important resource for the growing number of scholars attracted to the study climate-related migration and displacement, especially those that use IPCC reporting as part of their research, and permits the identification of areas and topics that warrant greater consideration in future IPCC reporting. We should forewarn readers that, despite every effort to be as succinct as possible, this manuscript is lengthy given that twenty-eight different reports were analyzed as part of this project.

Methodology

We obtained and analyzed the digitized PDF texts for every IPCC report ever published that would be likely to contain substantive mention of migration and displacement. For readers unfamiliar with the IPCC structure and reporting process, there are two general types of IPCC reports. The most widely read are periodic Assessment Reports conducted on a regular cycle by three working groups, with Working Group I (WGI) focusing on the physical science of climate change; WGII on impacts, vulnerability and adaptation; and WGIII focusing on ways to reduce greenhouse gas emissions and avert dangerous climate change (commonly referred to as “mitigation”). These Assessment Reports have been published on a five- to seven-year cycle starting in 1990, with each Working Group’s report generated through a multi-year assessment of relevant peer-reviewed scholarship and reliable “grey literature”, such as statistical reports from governments and multilateral agencies. The production of an Assessment Report begins by establishing the structure of the report and the topics it should address through a scoping exercise, followed by selection of an international team of expert authors for each chapter, production of multiple chapter drafts that are reviewed externally by scholars and government experts, and submission of a final draft (for a more detailed description of the process, see IPCC 2024). Before an Assessment Report is published, the exact wording of every line of the Summary for Policymakers for the report must be approved by all governments that are members of the IPCC (currently >190). Each three-volume Assessment Report is typically followed by a Synthesis Report that integrates the findings of the three working groups plus any IPCC Special Reports that may have been published since the previous Synthesis Report. A

second type of IPCC reporting consists of occasional Special Reports which, as the name implies, are commissioned by the IPCC Bureau on specific topics of wide interest to member governments, with recent examples including "The Ocean and Cryosphere in a Changing Climate (2019)", "Climate Change and Land (2019)" and "Global Warming of 1.5°C (2018)". The processes for producing Special Reports are generally similar to those followed for Assessment Reports. In addition to the two aforementioned types of reports, the IPCC also issues occasional methodological reports related to its responsibilities for reporting on national greenhouse gas emissions.

For the present article, we analyzed the content of each of the IPCC reports shown in Table 1. To do this, we took the PDF version of each report and used the "Find" command (Ctrl+F) to search for the terms *migrant, migration,* and all variations (which appear by entering "migra" in the Find dialogue box); *displaced, displacement* and all variations (found by entering "displac" in the Find dialogue box); *relocate, relocation* and variations ("reloca" in the Find dialogue box); *resettlement* and its variants ("resettle" in the Find dialogue box); and *refugee*. Each match was then manually scrutinized; in some cases there were hundreds of potential matches in a single report. Instances that were not relevant to human migration, displacement, relocation and/or resettlement were ignored as being false matches, a common example being the migration of fish or animals (which appear often in report chapters assessing climate change impacts on biodiversity). Where the match clearly pertained to people it was recorded in a customized spreadsheet, with relevant details added in a dedicated row. A separate spreadsheet was created for each report, and these are provided in the Supplemental Materials to this article. A given paragraph or sub-section of a report often used one or more of the key words multiple times; when this occurred, the entire paragraph or sub-section was treated as a single match and recorded as such. Columns in the spreadsheet identified specific attributes for each match, with column headings including: the printed page number on which the key word match was found; the report section/sub-section number; a short summary of the key details of the text where the key word match(es) appear; a copy of the full text of the sentence or paragraph containing the match(es); and, a field for the examiner to enter additional comments/remarks of clarification, as needed. The second and third authors of this article carried out the bulk of this exercise and worked with the first-named author to standardize the vocabulary and style of writing in the spreadsheet summaries. This standardization allowed for easy identification, consolidation and summary of recurrent themes with a given report, conducted by the first author. Any figures in reports directly pertaining to the search topics were also clipped, and a selection of these appear below.

Table 1: IPCC reports analyzed for this article. All reports listed below and their full citations are available at https://www.ipcc.ch/reports/.

Report	Key word matches	Year published
AR1 Working Group I: Climate Change the IPCC Scientific Assessment	0	1990
AR1 Working Group II: Climate Change the IPCC Impacts Assessment	29	1990
AR1 Working Group III: Climate Change the IPCC Response Strategies	17	1990

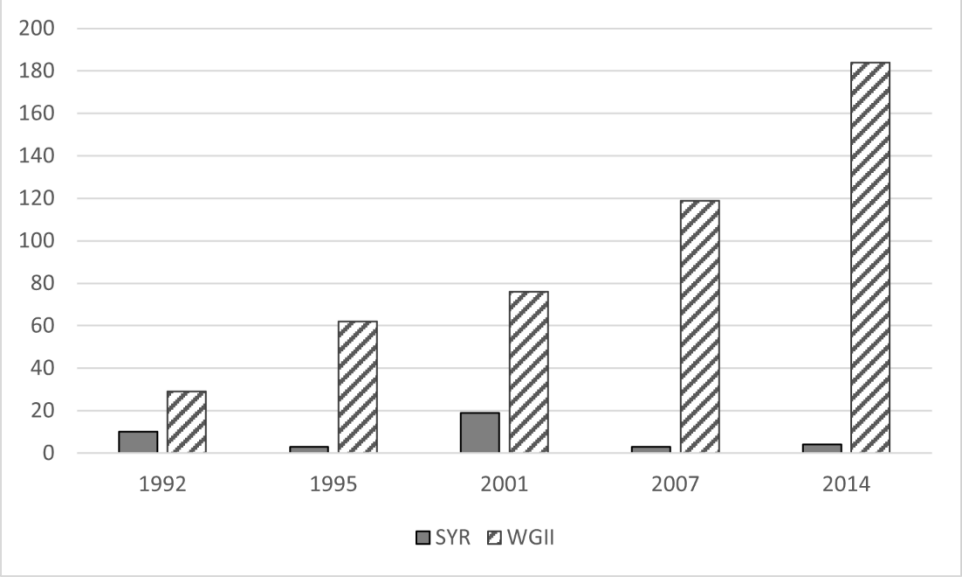
AR1 Climate Change 1992: Supplementary report to the IPCC Impacts Assessment	6	1992
AR1 Synthesis Report: Climate Change: The IPCC 1990 and 1992 Assessments	10	1992
AR2 Synthesis Report: Climate Change 1995	3	1995
AR2 Working Group I: Climate Change 1995: The Science of Climate Change	0	1995
AR2 Working Group II: Impacts, Adaptations and Mitigation of Climate Change: Scientific-Technical Analyses	63	1995
AR2 Working Group III: Economic and Social Dimensions of Climate Change	31	1995
AR3 Synthesis Report: Climate Change 2001	19	2001
AR3 Working Group I: Climate Change 2001 The Scientific Basis	0	2001
AR3 Working Group II: Climate Change 2001, Impacts, Adaptation and Vulnerability	77	2001
AR3 Working Group III: Climate Change 2001 Mitigation	12	2001
AR4 Synthesis Report: Climate Change 2007	3	2007
AR4 Working Group I: The Physical Science Basis	0	2007
AR4 Working Group II: Impacts, Adaptation and Vulnerability	120	2007
AR4 Working Group III: Mitigation of Climate Change	14	2007
AR5 Synthesis Report: Climate Change 2014	4	2014
AR5 Climate Change 2013: The Physical Science Basis	0	2013
AR5 Climate Change 2014: Impacts, Adaptation, and Vulnerability	184	2014
AR5 Climate Change 2014: Mitigation of Climate Change	21	2014
Special Report: The Regional Impacts of Climate Change: An Assessment of Vulnerability	48	1997
Special Report: Land-use, land-use change, and forestry	9	2000
Special Report: Renewable Energy Sources and Climate Change Mitigation	13	2011
Special Report: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation	102	2012
Special Report: Global warming 1.5^{o}C	48	2018
Special Report: Climate Change and Land	82	2019
Special Report: The Ocean and Cryosphere in a Changing Climate	72	2019

We did not review IPCC reports that deal primarily with topics unlikely to make specific reference to migration or displacement, such as “Refinement to the 2006 IPCC Guidelines for National Greenhouse Gas Inventories” (2019), “Renewable Energy Sources and Climate Change Mitigation” (2011), “Safeguarding the Ozone Layer and the Global Climate System”(2005), “Carbon Dioxide Capture and Storage” (2005), “Aviation and the Global Atmosphere” (1999) and so forth. We did not review all volumes of AR6 in the same way as we did for reports that preceded it for reasons that become apparent below.

General Trends in IPCC Reports

As seen in Table 1, Working Group II Assessment Reports are where migration, displacement and related topics have been most often discussed, and the frequency of discussions has increased steadily since 1990. Discussions of migration-related topics in Working Group III reports peaked in the 1995 Second Assessment Report and then declined, reflecting a reorientation of Working Group III in subsequent assessments away from general socioeconomic implications of climate change to a greater emphasis on options for mitigation and economic costs/benefits of the options. Working Group I Assessment Reports have never contained substantive discussions of migration and displacement, consistent with the focus on the physical science of climate change. Although discussions of migration and related topics in Working Group II reports grew steadily between AR1 and AR5 (Figure 1), there was no corresponding increase in discussion in the Synthesis Reports over that period. This is a significant disconnect, given that Synthesis Reports are intended by design to be policy oriented and to highlight major findings from the Working Group reports (Livingston et al 2018). We return to the potential importance of this in the Discussion section below.

Figure 1: Discussion of migration, displacement and related subjects in Working Group II Assessment Reports and corresponding IPCC Synthesis Reports. Prepared by authors.



As might be expected, discussions of migration and displacement in Special Reports vary considerably by the subject matter of the Report, with the 2012 Special Report on managing the

impacts of extreme weather events containing the greatest amount of discussion, followed by 2019 Special Reports about climate change impacts on land and on oceans and cryosphere. The frequency and nature of messaging about migration and displacement in Special Reports follows a trajectory that is generally similar to Working Group II reports, with some exceptions that we identify in Section 3.

A notable trend in IPCC reports is an evolution in the terminology used to discuss climate-related migration and displacement (this being the term favored in the most recent Assessment Report (AR6)). In reports conducted in the 1990s, the term “environmental refugees” is routinely used to describe people that move for climate-related reasons, and this is reflective of well-known scholarly reports of the time (e.g. Jacobson 1988, Ramlogan 1996, Myers 1997). Since the Third Assessment Report (AR3, 2001), use of this term has been largely abandoned, being replaced by the terms *migrants*, *refugees*, and *displaced people* that are used in a fashion consistent with how they are used in social science. This in turn likely reflects the greater representation over time of social scientists within author teams, which in the early years of IPCC reporting were dominated by natural scientists (Carey et al 2014) who might not be expected to be versed in migration and refugee scholarship, its key concepts, literature and terminology.

From the Third Assessment Report (AR3) to the Fifth Assessment Report (AR5) there is inconsistency in how IPCC reports frame discussions of migration, sometimes even between different chapters within the same report. Sometimes migration is presented as a form of adaptation, sometimes as being a result of situations when adaptive capacity is exceeded, and at other times as a risk to be avoided. This is also reflective of trends in scholarly reporting since the 1990s and the tensions within social science, where the relationship between climate hazards and migration and displacement outcomes continues to be reinterpreted as additional empirical evidence accumulates. In the next section we summarize how migration, displacement, and related topics have been assessed in each of the reports shown in Table 1.

Summary of Assessment of Migration and Displacement, By Report

IPCC 1990 First Assessment Report (AR1) + 1992 supplements and Synthesis Report

When the IPCC’s first three Working Group Assessment Reports appeared in 1990, it might not have been expected that this exercise would still be continuing 35 years later. The AR1 working group reports are all relatively compact as compared with later ones (WGII’s assessment had only seven chapters), and authorship was heavily dominated by natural scientists based in industrialized countries. The table of contents for the Summary for Policymakers of the Working Group I report contains headings framed as questions that would today form the basis of high school science class discussions, such as “How do we know that the natural greenhouse effect is real?” and “Has man already begun to change the global climate?” The year following the publication of AR1, the IPCC was asked to prepare updated Supplementary reports and a Synthesis to support negotiations for the UN Framework Convention on Climate Change at the 1992 Earth Summit in Rio de Janeiro.

Treatment of migration and displacement in AR1 and its Supplementary and Synthesis reports can best be summarized as issuing a warning about the prospect of environmental refugees. Most discussion of migration and displacement is contained in Chapter 5 of the WGII assessment, which bears the title, “Human settlement; the energy, transport and industrial sectors; human health; air quality; and changes in ultraviolet-B radiation”. The term

"environmental refugees" is used routinely, with authors basing their use of the term on a scholarly publication by Jacobson (1989), a UK Royal Society lecture by Tickell (1989) and a speech given by a retired US military officer (Debrah 1989). The Chapter 5 authors' assessment of migration and displacement associated with climate change is most succinctly captured in a statement made at section 2.2.3 warning that, "Migration and resettlement may be the most threatening short-term effects of climate change on human settlements". The section goes on to state that large scale migration due to the impacts of climate change could lead to loss of housing, loss of "living resources" (i.e. fresh water supplies, food, energy or employment), and loss of social and/or cultural resources, such as cultural properties, and neighbourhood or community networks. Developing countries are identified as being most at risk of involuntary displacements, whilst, "In economically advanced industrialized countries, migration is a likely social and cultural response of specific population groups to new physical/social environments produced by climatic change" (Section 2.2.3).

Elsewhere, Chapter 5 suggests that even a modest increase in sea levels would displace tens of millions of people, a figure that was revised upwards to 20-25 million in the 1992 Supplementary Report. Chapter 5 also warns of multiple risks that may emerge if and when people need to be relocated from areas that are highly exposed to natural disasters, including insufficient capacity of health services, sanitary facilities, and housing in receiving areas, with a greater risk of exposure to communicable diseases. A wide range of potential direct and indirect climatic drivers of migration and displacement are identified, including sea level rise, floods, droughts, hunger, land degradation, permafrost loss, and shifts in the geographical distribution of vector-borne diseases. Although the chapter includes dated language and statements that by today's standards seem simplistic and unsupported by research, it also contains examples of prescient and nuanced observations that stand the test of time. For example, a warning is given about the potential psychological impacts people may experience if they have to relocate involuntarily (Section 2.2.1.7), and, "Climate change could translate into migration of impoverished people from rural to urban areas (developing countries), from coastal lowlands (particularly densely inhabited delta areas) to inland areas, and possibly across national boundaries" (Section 2.3.2).

The 1992 Supplementary report on climate change impacts recommended that monitoring programs be established to make systematic global observations about sea level rise, the impacts on infrastructure, the number of people needing to be relocated, and the associated costs. Part of this recommendation would be met with the establishment of the Internal Displacement Monitoring Centre in 1998 with financial support from the Norwegian Refugee Council. The "Human Settlements" section of the Supplementary Report warns that, "Sea-level rise along with flooding and drought may be the source of a potential international environmental refugee problem, with many persons fleeing their homelands to other countries" and goes on to suggest that climate change is a source of conflict in the Horn of Africa.

IPCC 1995 Second Assessment Report (AR2)

In contrast with AR1's warnings about future climate-related displacements and conflicts, AR2 urged readers to consider how to manage the potential displacement of millions of displaced

people. Over sixty of the 90+ references to migration and displacement are found in WGII report, with the terms “environmental refugees” and “ecological refugees” used frequently. In WGII Chapter 9, which is dedicated to the impacts of climate change on coastal zones and small islands, managed or planned retreat from low-lying areas is suggested as being potentially inevitable but politically unpalatable, especially in areas to which such people would be resettled. Table 9-3 in the chapter lists case studies from selected countries that estimate the number of people that would be affected by a 1m sea level rise and the associated dollar-value damages and costs of adaptation, with Bangladesh and China having the largest numbers of people at risk and Japan having the highest estimated dollar value of property at risk. Chapter 11 (Industry, energy and transportation) suggests people might autonomously decide to relocate from areas exposed to climate hazards, that governments should consider the implications this would have for transportation systems, and flag Bangladesh as being a country especially at risk.

Chapter 12 (Human settlements) contains by far the largest amount of discussion of migration and displacement, and in its executive summary states that by reducing natural resource productivity, climate change might increase rural-urban migration rates in many countries, leading to more crowded cities and depleted rural labour forces. Countries that receive attention in the chapter include China, Bangladesh, Mexico, Nigeria, Syria, and Turkey. The chapter warns that droughts, floods, and sea level rise can lead to displacement, and that ethnic tensions between groups can arise when people are displaced. It also contains a diagram that shows how climate affects cities, with rural-urban migration being one of the indirect pathways (Figure 2). A paragraph in Section 12.5.1 headed “Population migration” describes possible strategies for reducing the ‘pull’ factor of cities so that they receive fewer ‘ecological refugees’ from rural areas, although the authors allow that, “Controlling the degree of urbanization as a solution appears doubtful”. Chapter 22 (Mitigation of impacts on settlements) picks up on this point, suggesting that effective rural development reduces rural-to-urban migration, but it also notes that changing locations for some people is a logical adaptation strategy. Chapter 13 (Agriculture) contains an observation that is hard to imagine appearing in present day IPCC reporting, suggesting that parts of Latin America and the former USSR are underpopulated and might serve as possible destinations for climate-related migrants. Chapter 18 (Human population health) provides statements that continue to appear in more recent IPCC reports, that the health implications of climate-related displacements are complex, that people forced to move might be exposed to new diseases, and that the health impacts on people displaced by weather-related disasters include mental health challenges.

Figure 2: Diagram from IPCC AR2 WGII Chapter 12 in which migration appears as a pathway through which climate affects cities.

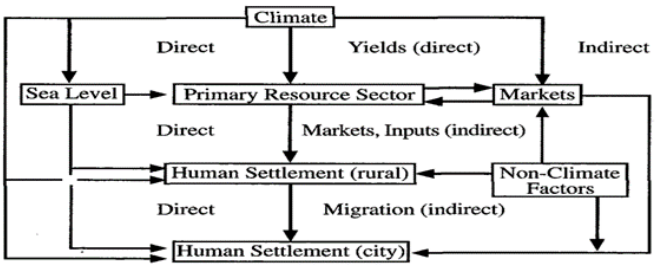


Figure 12-1: Relationship between direct and indirect effects of climate change, sea-level change, and non-climate factors on resource sectors, rural human settlements, and cities.

Of all the Assessment Reports, ARII is where Working Group III (WGIII) makes its largest contribution to the subject of migration and displacement. Chapter 6 of the WGIII report (Social costs of climate change) offers estimates of the number of people that might be displaced by future impacts of climate change and of the dollar value costs of migration and displacement. These are largely based on the authors' own prior work – previously published books and economic reports that may not have been peer reviewed – an approach that would likely not survive the review process for present day IPCC reports. Future estimates of the number of people displaced (in Table 6.5 of this chapter) are based on a Fankhauser (1995) study that suggested under a doubling of atmospheric carbon dioxide and warming of 2.5ºC there would be over 2.7 million additional migrants worldwide, primarily in non-OECD countries. This estimate appears to be based on a straight-line future projection of estimated migration and refugee levels of the time. The authors suggest additional climate-related migration at 2.5ºC warming would cost the United States US$500-600 million, and at 10ºC warming (a level not today foreseen even under high emissions scenarios) would cost US$2.8 billion. These dollar value estimates are based on a Cline (1992) study that estimated each refugee claimant arriving in the US cost local and state governments at the time between US$4,000 and US$4,500. The authors then go on to offer specific estimates of the number of people likely to be displaced by 1m sea level rise in selected countries including Bangladesh (up to 32 million people), India (7 million people) Indonesia (3.3 million people), and Nigeria (3 million people under 1m sea level rise). In the case of Bangladesh, the authors claim that migration away from coastal areas is already occurring "partly for weather-related reasons" but without providing any supporting evidence. Chapter 7 at Section 7.5.2 estimates the costs of relocating people due to SLR will be between 0.01% and 0.03% of GDP for higher income countries and 0.3 and 0.8% of GDP in developing regions. Chapter 11 – which analyzes the economic implications of climate change policy – offers the following statement at Section 11.2.1.3 that foreshadows a question that would continue appearing in IPCC reports, as to whether migration might be considered a form of climate adaptation: "Changes in migration policies in some countries may allow more flexibility for developing countries adaptation to regional population pressure that may arise as consequences of occurrences such as severe drought."

IPCC 1997 Special Report: The Regional Impacts of Climate Change: An Assessment of Vulnerability

This Special Report provided assessments of the risks and impacts of climate change across specific geographical regions (in order of appearance: Africa, Arctic/Antarctica, Australasia, Europe, Latin America, Middle East and Arid Asia, North America, Small Island States, Temperate and Tropical Asia), with each chapter authored by researchers residing within the region in question. Subsequent Working Group II (WGII) Assessment Reports would adopt a structure that includes dedicated regional chapters that perform a similar function. Sea level rise is flagged in the Executive Summary of this Special Report and mentioned in many chapters as an important concern, including the potential need to relocate coastal populations and the social, economic and political challenges this would present. Areas of particular risk identified in the report include heavily populated deltaic regions in countries in Asia (e.g. Bangladesh, China, Burma, Thailand, Vietnam), Africa (e.g. Egypt, Nigeria, The Gambia), and Latin America (e.g. Belize, Guyana, Uruguay, Venezuela), along with small island states in the Pacific and Caribbean. The report suggests that at 1m rise in sea level up to 80% of the population of

Guyana would be affected (Table 6.5), that 8 million people in Egypt might need relocation (Section 2.3.4.1.1), that the entire capital city of The Gambia would be at risk (Section 2.3.4.1.5) and, in the report's own language, a "massive 'environmental refugee' migration will occur" in Nigeria of an estimated 3 million people (Section 2.3.4.1.2). Chapter 9 (Small Island States) warns that in extreme cases residents of atoll nations may need to be relocated outside their national territories, and that Caribbean island countries have such large populations living in coastal areas that internal relocations would present enormous economic, political and social challenges (Box 9-4). Meanwhile, the Executive Summary of Chapter 4 (Australasia) expresses concerns that New Zealand may experience influxes of "environmental refugees" from Pacific Island territories. Chapter 2 (Africa) suggests financial incentives could be offered to people to voluntarily relocate away from low-lying coastal areas (Section 2.3.4.2) and asks where funding would come from to support coastal relocations if they become necessary (Section 2.3.5.1).

Other observations with respect to migration and displacement in this Special Report center upon the impacts of climate change on the rural poor and how this may lead to higher levels of migration to cities (Sections 2.3.3.2.2 and 2.3.5.1). The Latin America chapter warns in its Executive Summary that migration out of rural and coastal areas could fuel political and economic instability and conflicts at national and international levels, that droughts already lead to famine and migration in northeastern Brazil (Section 6.3.4) and that climate-related displacements and migration into Latin American cities will have cultural, socioeconomic and health implications, with some cities facing pressure on water resources (Section 6.3.6). One of the possible adaptation options suggested in the same chapter is for governments to decentralize the provision of services to discourage migration into cities (Table 6.9). The Report also suggests that warming in the Arctic will lead to increased economic activity in that region, attracting labor-seeking migrants (SPM 6.2).

IPCC 2000 Special Report: Land-use, land-use change, and forestry

This Special Report was prepared in response to a 1998 request from the technical support body of the UN Framework Convention on Climate Change (UNFCCC) for a scientific and technical assessment of land-based carbon sequestration strategies. There are nine instances where issues related to migration and displacement arise. In Chapter 2, which discusses definitions and general issues, the authors illustrate the term "activity leakage" with the example of creating a forest reserve to stop deforestation in one location that displaces residents who then start clearing forests elsewhere (Section 2.3.5.2; discussed again at 5.3.3). The report goes on to warn that projects undertaken to increase forest cover and improve and protect rangelands could lead to internal migration of people (Section 2.5.2.5) with economically marginalized people being at greatest risk of displacement (Section 3.6.1). In Chapter 5, which reviews various types of carbon sequestration projects, the authors suggest that bioenergy projects could create additional rural employment opportunities that slow migration to urban centres (Section 5.6.3).

IPCC 2001 Third Assessment Report (AR3)

The WGII report was once again the main place for discussion of migration and displacement in AR3, and it contains a disjointed and often contradictory set of messages ranging from statements that climate migrants could benefit cities (Chapter 11) to the most alarmist messages contained in any Assessment Report about migration, displacement and conflict (Chapter 19). In the introduction to the report, WGII identifies 5 "numeraires" of focus that

include “quality of life”, which is in turn identified as being potentially affected by forced migration and displacement. Chapter 7 (Human settlements, energy and industry) uses of the term “environmental refugees” and expresses concern they will lead to political instability and overcrowded cities where migrants experience food shortages and high levels of exposure to hazards. At Section 7.7 the authors state, “Improved understanding of impacts of climate on human migration and the effects of migration on source destination settlements, is one of the highest priority needs for research on the impacts, adaptation and vulnerabilities in human settlements.” The Executive Summary of Chapter 9 (Human health) contains two key messages about climate-related displacement, one flagging concerns about the health of displaced people living in refugee camps, the other warning of pastoralists being pushed out of their traditional territories.

AR3 began a still-continuing practice of having regional assessments appear as distinct chapters in IPCC Assessment Reports. Chapter 10 (Africa) contains a special text box (Box 10.2) on Sahelian drought that identifies population displacement among the impacts, describes dry-season migration patterns and the impacts of environmental change on migrants and refugees at destination areas, and raises concerns about the welfare of pastoralists. Cases from Mozambique, Senegal, and Kenya are cited. Chapter 11 (Asia) foresees greater migration from Bangladesh to India due to floods and droughts. This chapter also includes two very acute and nuanced statements that are generally accepted by scholars today. First, it describes the motivations for migration as being diverse, and notes that migration is not in itself a sign of climate vulnerability (Section 11.2.6.1). The chapter goes on to describe how immigrants can benefit cities – a significant U-turn from past IPCC reports that also diverges from other chapters in AR3 – and that climate and non-climatic social, economic political factors interact to affect migration decisions, the number of people that move, and the impacts migration has on receiving areas. Chapter 12 contains a brief mention that Australia and New Zealand might receive more migrants from small island states, whilst chapter 14 (Latin America) worries that climate change could lead to more migration of rural poor into cities, leading to overcrowding and health impacts. Chapter 17 (Small island states) expresses concerns about the impacts of migrants on the environment in destination areas.

The final chapter of AR3 (Chapter 19: Vulnerability to climate change and reasons for concern) contains a table (19-6) identifying seven large scale “singularity” events that may emerge in a changing climate, such as non-linear change in thermohaline circulation and rearrangement of biomes. The seventh of these singularities is described as, “Destabilization of international order by environmental refugees and the emergence of conflicts as a result of multiple climate change impacts”. Through a variety of severe physical impacts of climate change, the table warns of, “several types of conflict, including scarcity disputes between countries, clashes between ethnic groups, and civil strife and insurgency, each with potentially serious repercussions for the security interests of the developed world”. Cited as evidence are climate and conflict publications by political scientist Thomas Homer-Dixon and environmental refugee warnings by ecologist Norman Myers that have been shown in subsequent research to have limited reliability (Brown et al 2007). The emphasis on describing the implications for developed countries is reflective of the fact that of 23 authors who contributed to the chapter, only three were from low-income countries.

The Working Group III (WGIII) report contains far fewer mentions of migration and displacement than its AR2 predecessor, reflecting a significant reorientation made in AR3. The introductory chapter contains a curious description of people disproportionately affected by climate change as including, "ecological refugees", "vagabonds”, and "castaways" (Section 1.3.2). Chapter 2 at section 2.4 introduces readers to a database of 124 narrative scenarios for future worlds to the year 2100 for 48 countries – a pre-cursor to the Shared Socio-economic

Pathways (SSPs) scenarios used in climate change impact research today (Riahi et al 2017). This database includes thirty migration scenarios (Section 2.4.3), of which twenty project higher future levels of migration and ten project lower migration. Scenarios described in Table 2.4 foresee higher future greenhouse gas emissions leading to higher rates of migration and conflict, whilst falling emissions lead to lower rates of migration and conflict. The crudity of these assumptions is difficult to ignore in hindsight, but it is important to remember that the authors at the time were drawing upon a smaller body of peer-reviewed scholarship than what is available today, and which was at that time heavily influenced by researchers interested in the security dimensions of climate change (Brown et al 2007).

The AR3 Synthesis report contains 18 mentions of migration and displacement, the most notable being a projection in the Summary for Policymakers that climate change will lead to flood-related displacements of tens of millions of people in deltas and low-lying coastal areas, especially in Asia, with Table 8 in the Technical Summary offering estimates of the number of people exposed to sea level rise in selected Asian countries.

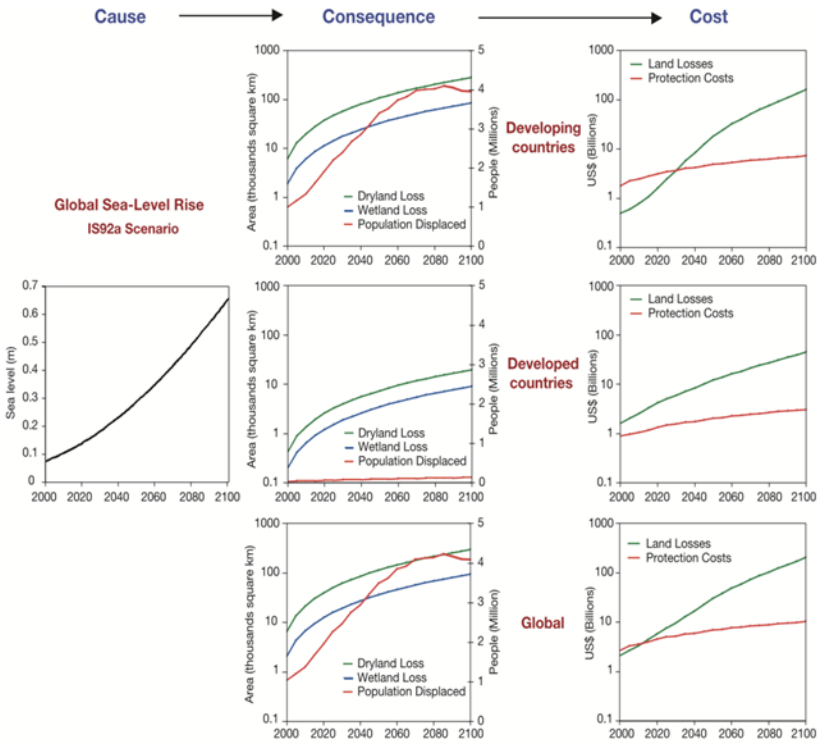
IPCC 2007 Fourth Assessment Report (AR4)

Over 50% more mentions of migration and displacement appear in the AR4 Working Group II (WGII) report as compared with AR3. A heavy emphasis is placed on the implications of sea level rise and coastal hazards, likely reflecting the shocking visuals from New Orleans of the impacts of 2005's Hurricane Katrina. A second immediately visible change from AR3 is the abandonment of the term "environmental refugees", replaced most commonly with "environmental migrants". The overall treatment of migration and displacement issues in AR4 is far more nuanced than any preceding reports, recognizing, for example, that people displaced by climate events are often more vulnerable to future impacts of climate change. Future impacts of climate hazards assessed in AR4 take into consideration demographic processes to a far greater extent than in preceding reports. The heightened concern for coastal populations is reflected in multiple aspects of the WGII Technical Summary (TS). One example is at page TS5.3 where readers are told that "vulnerability", which is one of the key organizing terms used by the IPCC since its inception, "can refer to a system, or an impact to the system such as forced migration…". The TS lists migration as being a possible outcome of multiple climatic risks, including droughts, floods, high winds, and meridional overturn circulation changes, and projects higher levels of climate-related migration into southern Europe. It also expresses concerns that migration will present challenges for urban centers (echoing warnings of previous Assessment Reports) and could heighten the vulnerability of Indigenous peoples. This latter observation – the first time Indigenous peoples receive such recognition in Assessment Reports – likely responds to case studies described in Section 1.3.9.3 that include Shishmaref and Tuktoyaktuk, coastal villages in Alaska and northern Canada with primarily Indigenous populations that will need to be relocated due to coastal hazards. The TS also includes a map (Figure TS8) based on research by Ericson et al (2006) showing coastal deltas home to large numbers of people at risk of displacement by sea level rise by the year 2050 (reproduced here as Figure 3).

Figure 3: Map from AR4 WGII Technical Summary showing major river deltas and the relative number of people estimated to be at risk of displacement in the year 2050 under current rates of sea level rise ("extreme" equals >1 million people; "high" = 1 million to 50,000; "medium" = 50,000 to 5,000) based on Ericson et al (2006).

AR4 is the first Assessment Report to feature significant use of standardized scenarios established by the IPCC for future greenhouse gas emissions and the underlying demographic, economic and technological changes drivers, known as the SRES scenarios from the acronym for the IPCC Special Report on Emissions Scenarios (2000) that established them. SRES-based projections for future migration and displacement appear in Chapter 6 (Coastal systems and low-lying areas) of the WGII report, which charts at Figure 6.10 estimates of the number of people at risk of displacement under selected global sea level rise scenarios for the period 2000-2100 based on research by Tol (2007). The estimates show a peak of slightly more than 4 million people displaced globally in the 2080s, the vast majority living in developing countries (Figure 4). Calculations of the number of people at risk of displacement in the underlying Tol (2007) study start by using estimates from a 1993 Global Vulnerability Assessment study (Hoozemans et al 1993) of the number of people living in one-in-1000-year flood plains, weighted by the chance of inundation under specific sea levels, and then adjusting these for future population growth at a regional basis using estimates from SRES A1/B1, in which world population peaks at 8.7 billion people in 2055, and falls to 7.0 billion in 2100.

Figure 4: Charts in IPCC AR4 WGII report (Figure 6.10) estimating the number of people displaced by sea level rise to the year 2100 under selected scenarios.



Chapter 7 (Industry, settlement, society) contains considerable discussion of migration and displacement, featuring early on a description of the impacts of Hurricane Katrina on New Orleans (including Figure 7.1 showing flood depths in New Orleans five days after the storm) and a special text box (Box 7.2) containing three paragraphs describing “environmental migration”. Box 7.2 begins by stating that most environmental migration is temporary, rural-to-urban, and is a “common response to calamities such as floods and famines”, but later notes that migration may also be a response to seasonal climatic variability and may be undertaken to accumulate wealth, seek out economic opportunities and to escape poverty. The frequency of environmental migration and the ratio of permanent relocation vs temporary migration are both predicted to increase in the future. Box 7.2 notes that making future projections is difficult because:

- migration in affected areas is often temporary, episodic, and multidirectional

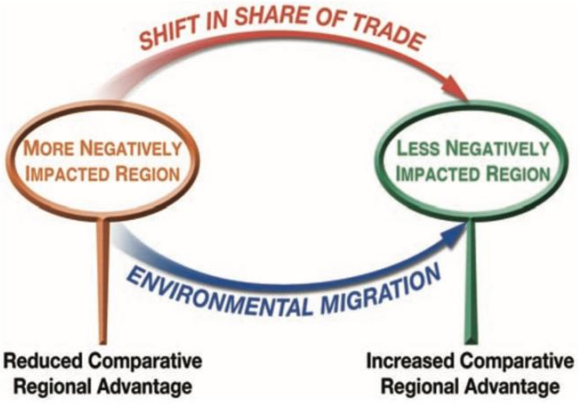
- people may have multiple reasons for migrating, disaggregating climate-related migration is difficult

- there are few reliable data sources

- there is little agreement on how to define environmental migration

Importantly, Box 7.2 ends with a warning to avoid leaping to the conclusion (unlike previous Assessment Reports) that climate-related resource scarcity will inevitably lead to conflicts resulting from forced migration. Chapter 7 later includes a simple conceptual figure (Figure 7.2) suggesting that environmental migration and shifts in trade from regions negatively impacted by climate change to less impacted regions will generate an increased economic advantage for the receiving areas, a suggestion that breaks from the “migration is bad” tone of previous IPCC reports (Figure 5).

Figure 5: Migration is suggested as being potentially advantageous to receiving areas in Figure 7.2 of AR4 WGII report.



Chapter 8 (Health) warns of health implications of large numbers of people being displaced by droughts and sea level rise, including the spread of communicable diseases and poor nutritional status due to overcrowding and unsafe access to water, food and shelter (Section 8.2.3). Regional assessments in Chapters 9 through 16 describe how rural-urban migration will generate higher levels of vulnerability in urban centres, can be a common adaptation to

seasonal climate risks but can also place pressure on natural resources in certain areas and thereby exacerbate the impacts of climate change, and that in some coastal areas a rapid sea level rise would mean that migration and relocation would be the only viable responses. Chapter 11 (written by authors from Australia and New Zealand) expresses concerns that sea level rise will lead to large scale migration from Pacific islands to Australia and New Zealand, while Chapter 16 (written by authors representing small island states) describes how internal migration and migration abroad to seek remittances are important coping strategies, and expresses concerns about how internal migration within small island states may lead to cultural changes and new forms of vulnerability. As might be expected, Chapter 14 (North America) pays considerable attention to the impacts of Hurricane Katrina and wider flood risks across the US.

AR4 includes chapters dedicated to assessing vulnerability, risks, adaptation and links to sustainability in more systematic and structured ways than previous Assessment Reports, and migration and displacement feature in these. Chapter 17 (Assessment of adaptation practices, options, constraints and capacity) notes the importance of social capital in adaptation at Section 17.3.1 and includes a dedicated Box 17.8 asking the question, “Do voluntary or displacement migrations represent failures to adapt?” The Box never explicitly answers its own question but implies that situations when people have no option but to relocate – such as the case of small island states in a scenario of rapid sea level rise – it represents a limit to adaptation. The Box also observes that the ability to migrate as an adaptive strategy is not available to all people, that the geographical distribution of social networks influences adaptation and migration decisions, and that decisions of whether or not to migrate may not be entirely within the control of individuals or households (i.e. recognizing the concept of “migrant agency” without explicitly labeling it as such). Despite the warning in Chapter 7 to avoid jumping to conclusions that environmental migration inevitably leads to conflicts, Chapter 19 (Assessing key vulnerabilities and the risk from climate change) does exactly this in Table 19.1, in which it includes as examples of key vulnerabilities the potential for climate change to cause droughts, water shortages, and flooding that can lead to forced migration and exacerbate conflicts.

The Working Group III report in AR4 contains 14 instances where migration and displacement are mentioned, the most notable being warnings that hydroelectric projects built to produce green energy can displace people, as might measures to reduce deforestation and/or reforest already deforested areas.

IPCC 2011 Special Report: Renewable Energy Sources and Climate Change Mitigation

This Special Report, which focused on assessing renewable energy sources as alternatives to fossil fuels, contains a dozen references of population displacements associated with large hydroelectric projects and the need to have plans to address these in the future. Citing a study from 2000 by the World Commission on Dams, the report estimates at Section 9.5.1.1 that between 40 and 80 million people worldwide have been displaced by dam projects. In Figure 5.14 (not reproduced here) the authors observe that consideration of resettlement needs in general, and the particular needs of Indigenous peoples affected by such projects only started to feature into environmental management planning in the 1990s. The authors state that when displacement cannot be avoided, resettlement outcomes can be improved when affected people participate actively in the planning process. The report also notes concerns about the health and wellbeing of migrant workers that labour on dam construction projects (Table 9.10). At Section

3.6.2 the authors flag concerns about the safety and wellbeing of women and children in refugee situations, as they are often tasked with collection of natural fuels for cooking.

IPCC 2012 Special Report: Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (SREX)

This Special Report on risks associated with extreme weather events, known by the acronym SREX, contains approximately one hundred instances where migration and displacement issues are discussed, the most of any of the Special Reports and trailing only Working Group II reports from AR4 onward. The Summary for Policymakers focuses on three aspects of these issues: the vulnerability of refugees, displaced people and migrants living in informal settlements around cities; the risk that growing numbers of extreme events will potentially generate more migrants and displaced people, with implications for sending and receiving areas; and, that residents of small island nations face especially high risks of displacement, and in some cases may require organized relocation. These themes appear throughout the report, and while there is general consistency in treatment across chapters, there is also a great deal of repetition.

Chapter 1, which provides a general overview of linkages between climate change and extreme weather events, suggests that the number of people displaced by such events provides a metric for quantifying the socio-economic impacts, that current risk management practices for extreme weather events provide a good model for planning climate change adaptation, and that decisionmakers will likely encounter thresholds where the costs of protecting people and infrastructure become so high that relocation becomes the more viable option. Chapter 2, which provides an overview of exposure, vulnerability and the determinants of risk, contains at Section 2.5 a detailed examination of linkages between vulnerability, adaptation, migration and displacement (later repeated in Chapter 5 at Section 5.2). The authors observe that informal urban settlements that emerge and grow through migration from rural areas are often situated in physically hazardous locations and become concentrations of disproportionately vulnerable people (Section 2.5.1.3.1). A section explicitly dedicated to migration and displacement issues (2.5.2.1.1) emphasizes their multi-causal nature, describes migration as being potentially a response to vulnerability or an outcome of it, and cautions against use of terms such as “environmental refugees” and “climate refugees”. Statistics on weather-related displacements from the Internal Displacement Monitoring Centre make their first appearance in IPCC reporting in this chapter. Citing Cernea’s (1996) on planned relocations, Chapter 2 authors suggest that people displaced by extreme weather events face such additional risks as landlessness, joblessness, homelessness, socioeconomic marginalization, food insecurity, increased morbidity, loss of access to common property resources, and/or social disarticulation. Later the chapter states that rural people are more vulnerable than urban people to climate-related displacement.

Chapter 4 (Changes in impacts of climate extremes) notes that migration out of areas exposed to extreme events can be a form of adaptation, but that refugees and involuntarily displaced people may subsequently experience much higher vulnerability (Section 4.2.1). A variety of direct and indirect risks to physical and mental health associated with extreme weather-related displacement are identified as warranting further research (Section 4.3.6), and Chapter 5 revisits this topic with a case study of Hurricane Katrina (Box 5-6). Forced migration is included as one of the potential outcomes of sea level rise that will lead to severe monetary damages in coastal Europe (Section 4.4.5.4). Box 5-1 makes a clear statement that although

the policy community believes there is a causal link between climate change, migration and conflict, there is no clear scientific evidence to support or refute such claims.

Chapter 5 (Managing climate risks at local levels) contains long lists of things that can be done at local levels to reduce vulnerability and risk (including risk of displacement) in a variety of environments in response to a variety of climate hazards. The use of migrant remittances to help households cope after extreme weather events is noted at Section 5.1, which also observes that migration is highly gendered (something not often identified in previous IPCC reports). Where entire communities must relocate because of climate hazards, the authors describe key principles that may improve the outcomes for those relocated, including ensuring the community is organized and participating in the decision-making process, helping participants understand the organizational context within which decisions are being made, giving special attention to social and personal deeds of those being relocated and preserving their social networks (Section 5.2.2). Chapter 6 (National systems for managing climate risks) contains fewer, less comprehensive messages about migration and displacement, with planned relocations being listed in multiple cells of Table 6-1 (a summary of possible national level policies and responses) as a response that would, “Accept and deal with increased and unavoidable (residual) risks”. Chapter 7 (International responses to manage risks) describes displacement after extreme events as a “cascading risk” while at the same time reminding readers again that migration can also be a form of adaptation. The chapter notes that international refugee law does not recognize environmental factors as being grounds to grant refugee status (Section 7.2.5.1) but mentions at Section 7.2.5.4 the Guiding Principles on Internal Displacement as one of a variety of non-binding legal instruments that are potentially relevant. Discussion of this subject continues in Section 7.4.1 where the authors describe debates about how to define climate-related migration and the legal instruments that might best apply.

Chapter 8 (Toward a sustainable and resilient future) reiterates the complexity of links between vulnerability, adaptation, livelihoods and migration described in preceding chapters, and again reviews distinctions between adaptive migration and involuntary displacement. The authors note that attention is most often given to extreme events that affect large numbers of people at once and that the compound effects of multiple smaller events may be overlooked (Section 8.4.3). Few specific recommendations for responding to climate related migration and displacement appear in Chapter 8, although there are extensive descriptions of options for scenario building, monitoring frameworks, and other management tools, accompanied by calls for greater learning, innovation and leadership. Case studies in Chapter 9 include a description of the impacts of drought in Syria from 2008-2011 and the associated migration of tens of thousands of people from rural areas to urban centres (Section 9.2.3.3). The findings of the UN Syrian Drought Response Plan are discussed in detail and a summary of key next steps are identified, but the authors had not foreseen the civil conflict that would begin in Syria by the time the SREX was published. Another case study describes how extreme weather conditions in Mongolia can disrupt the movements of pastoralists and cause people to abandon this livelihood and move to cities (Section 9.2.4). Other case studies include descriptions of flood-related displacements in Mozambique (Section 9.2.6.3) and risks of sea level rise in the Marshall Islands (Section 9.2.9).

IPCC 2015 Fifth Assessment Report (AR5)

The AR5 Working Group II (WGII) report contains a greatly expanded number of mentions of migration and displacement across nearly every chapter, that are for the most part described within the broader context of vulnerability and adaptation. The most concentrated and nuanced attention is found in Chapter 12 (Human security) and several of its key messages make their way into the Summary for Policy Makers (SPM) and the Technical Summary (TS). The Executive Summary of Chapter 12 warns of the impacts climate-related displacement will have on culture and livelihoods in small island states and coastal areas, and of the impacts climate hazards will have on migrants in destination areas. It states that migration and mobility can be adaptation strategies but also warns of risks faced by immobile groups and of uncertainty over the effectiveness of planned resettlement as a means of adapting to climate change. Five pages of Chapter 12 (Section 12.4) are explicitly dedicated to migration and mobility, featuring numerous case studies and dense referencing, and generating two Frequently Asked Questions (FAQs)(a then new feature of Assessment Reports that continues today). It begins by focusing on pathways by which climate change affects migration (Section 12.4.1.2) and echoes the SREX in noting that the risk of people being permanently displaced will rise as extreme weather events increase in frequency and severity, but that most displaced people will typically first try to return home and re-establish themselves if possible. It describes the diversity of potential migration outcomes in response to climate events, using a set of 37 tabulated case studies (in Table 12.3) from across continents and organized according to event type (drought/land degradation, floods, and sea level rise) to explain how climate events may lead to higher levels of outmigration from affected areas in some cases, lower levels of outmigration in others, new in-migration to affected areas, and greater immobility (i.e. inability to migrate) depending on the circumstances.

In addition to a generally expanding empirical literature on environmental migration and displacement, Chapter 12 draws heavily on research done as part of the UK government's Foresight project on global environmental migration (Foresight 2011) and the EU funded "Where the Rain Falls" multi-country study (Warner & Afifi 2013). Figure 12.1 in the chapter (reproduced here as Figure 6) borrows from Foresight to illustrate conceptually how vulnerability and socio-economic well-being interact to shape people's ability to move in response to climate events and how immobility may result. The Chapter offers estimates of the number of people potentially at risk of future displacement due to sea level rise (72 million by 2100 assuming a 0.5m rise and no preventative adaptation), but at the same time cautions in FAQ 12.4 (How many people could be displaced as a result of climate change?) that given the complexity of factors that shape migration decisions, it is difficult to define what exactly constitutes a climate migrant or to make robust projections of how many such people there may be in the future. Text Box 12-4 explains why the term "climate refugee" should not be used and describes two possible policymaking directions, one that would create specific legal instruments for responding to climate-related migration and another that would place greater emphasis on including mobility options within adaptation policies, Section 12.4.2 providing additional description of the latter.

Figure 6: Diagram from AR5 WGII Chapter 12 showing how vulnerability, mobility and well-being are interconnected and based heavily on the UK government's Foresight report on global environmental migration (Foresight 2011).

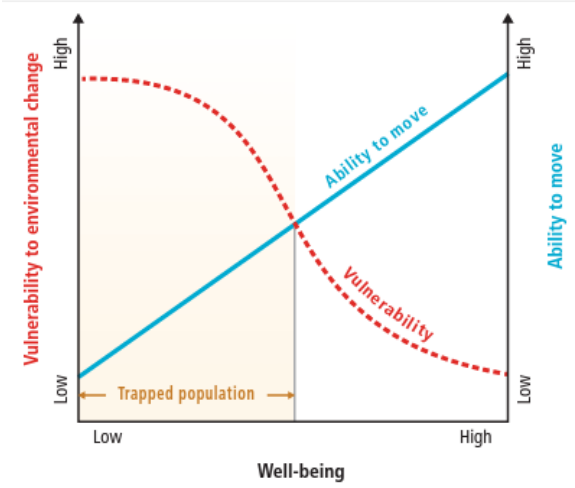
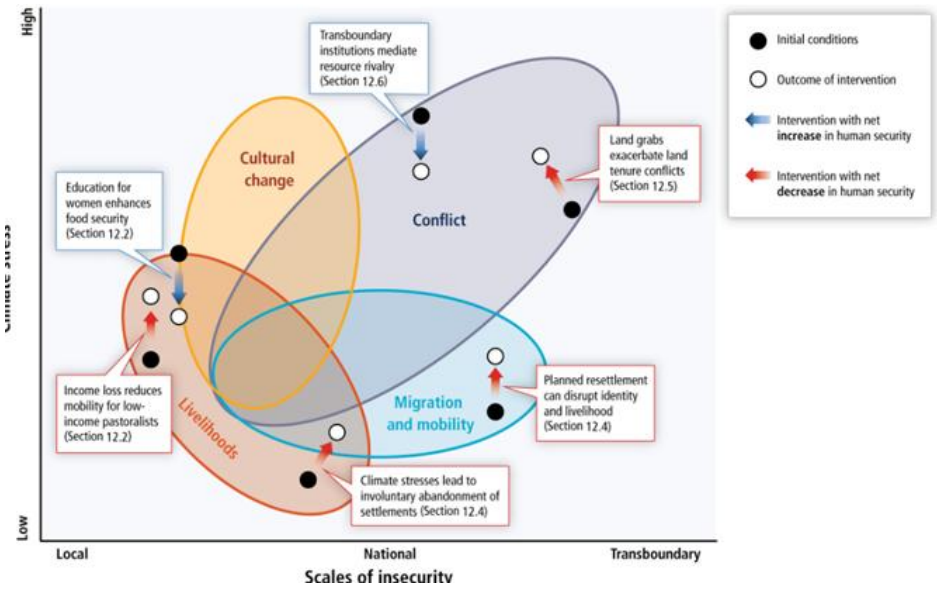


Figure 12-1 | Relationship between vulnerability to environmental change and mobility showing that populations most exposed and vulnerable to the impacts of climate change may have least ability to migrate (adapted from Foresight, 2011; Black et al., 2013).

Later sections of Chapter 12 provide detailed assessments of how climate change may affect armed conflicts and state security, and at Section 12.7 the authors warn against making overly simple assumptions about possible connections with migration. Figure 12.3 (Figure 7 here) attempts to show in a single diagram how disruptions to livelihoods under increasing levels of climatic stress can lead to cultural changes, conflicts, and/or changes in migration and mobility patterns at different spatial scales. It is not an especially easy graphic to interpret in isolation from its accompanying text, and the size of oval shapes appears to have minimal connection to the postulated relationships, but it provides a useful reminder of how these various elements of human security should not be considered in isolation.

Figure 7: Diagram appearing in both Chapter 12 and the Technical Summary of the AR5 WGII report showing connections between (and potential for changes to) livelihoods, cultural change, conflict and migration/mobility under different levels of climatic stress and at different spatial scales. The dots and arrows indicate examples of how specific interventions may increase or decrease human security.



Migration and displacement appear in other chapters of the AR5 WGII report, although the treatment is not as detailed or nuanced as in Chapter 12. Chapter 5 (Coastal systems and low-lying areas) repeats a theme from AR3 that hundreds of millions of people could be displaced by 2100 by sea level rise, especially in East, South and Southeast Asia, depending on the extent to which adaptations are implemented. The Chapter notes that the risk is amplified by high levels of migration into coastal environments and river valleys. Section 5.5.7 suggests that relocation of coastal communities could in itself be a temporary source of extra greenhouse gas emissions, although this would seem like a fairly trivial reason for avoiding relocations. Chapter 8 (Urban areas) repeats and refines messages about migration and displacement from previous Assessment Reports, such as that understanding climate change impacts on future migration patterns can help cities better plan their growth, improve their resilience so that they do not become sources of displacement due to extreme weather events, and prepare them for higher levels of climate-related rural-urban migration. Chapter 8 echoes AR4 and is consistent with Chapter 12 in stating that migration can be an important household adaptation strategy. It also contains an FAQ that asks if rural development and investments might reduce the amount of climate-related migration to cities from rural areas – the answer being that it will not necessarily do so, but it will make rural populations more resilient to a changing climate. Chapter 9 (Rural areas) has messaging about migration and displacement generally consistent with its Chapter 8 counterpart, emphasizing that climate change interacts with non-climatic cultural, economic, political, social and other factors to influence migration. It also provides statistics from the Asian Development Bank that 42 million people in the Asia Pacific region were displaced by extreme weather in the years 2010-2011. This chapter notably includes observations missing from previous Assessment Reports that climate change could disrupt transfers of traditional knowledge (Section 9.3.3.3.5) and that the vulnerability of rural women to climate change increases when men migrate out of their communities (Sections 9.3.5.1.4-5). Section 9.4.3.2 observes that planned relocations of low-income households in Vietnam have had adverse impacts on the social and economic networks of those moved. Chapter 11 (Health) includes an FAQ that notes displacement can be an indirect channel by which health is affected by climate change; this captures a Chapter 12 warning about the potential impacts of migration and displacement on the mental health and wellbeing of women.

Chapter 13 (Livelihoods and poverty) describes in greater detail how livelihoods may be directly or indirectly affected by climate change, observing that in low- and middle-income countries urban residents can be displaced by flooding due to poor drainage. The Chapter contains sections discussing rural-urban migration, immobility and the impacts of land grabs, and in Box 13-1 and Table 13.1 makes reference to gendered dimensions of climate migration and displacement, citing examples from Bangladesh, Niger, South Africa, and Vietnam. Section 13.2.1.5 describes the impacts of climate change on displaced Indigenous groups in Latin America. Chapter 14 (Adaptation needs and options) also raises concerns about displaced Indigenous groups, in this case coastal communities in Alaska. An overarching question asked in Chapter 14 is how to define what exactly constitutes “adaptation”, and migration presents a thorny problem for its authors. It is suggested at Section 14.1 that people migrating to take up new livelihoods might be considered a type of transformational adaptation (i.e. one that fundamentally alters an underlying socio-economic system), at Section 14.3.2 that labor migration can be an adaptation strategy but one that has many potentially adverse implications for family relationships and health, and in Table 14.4 that migration can be potentially adaptive or maladaptive (i.e. leading to more harm, not less) depending on the circumstances under which it occurs.

The nuance that characterizes discussion of migration and displacement in Chapter 12 falls away somewhat in closing chapters of the WGII report that provide technical analyses of adaptation, vulnerability, and risk assessments more broadly. Chapter 18 (Detection and attribution of observed impacts) notes that existing research had not yet shown an ability to detect and attribute the effects of observed anthropogenic climate change on migration. For readers unfamiliar with the terms, the IPCC WGII Glossary defines “detection” as being the process of demonstrating that climate or a system affected by climate has changed in a way that can be statistically captured. In the case of migration or displacement, this would mean demonstrating that changes in climate are statistically associated with observed changes in the frequency, timing or scale of migration, with “attribution” meaning the ability to identify with statistical confidence the causal contribution of climate change relative to other potential causal factors. Chapter 19 (Emergent risks and vulnerabilities) at Section 19.4.2.1 makes efforts to distinguish between voluntary/adaptive migration and involuntary displacement when defining what constitutes a “risk” associated with climate change, and notes that at certain times and locations climate change will affect migration flows but that there may be benefits and or risks for migrants, sending and/or receiving areas. A feature new to AR5 is a compendium of Cross Chapter Boxes (CCBs) – collaborations between authors from multiple chapters on specific topics relevant across large sections of the WGII report. Among these is a CCB on Key Risks in which migration features in multiple examples as an element of risks such as poverty traps, higher rural-urban migration rates, flood displacements, health impacts, and social instability (Table KR-1). Another CCB on urban-rural interactions mentions how climate change can interact with political, social and other factors to increase rural-urban migration.

A final observation about the AR5 WGII report is that the FAQs provide very useful information to the non-expert about important dimensions of climate-related migration and displacement. For example, FAQ 12.1 identifies migration that people would prefer to avoid as being an important threat to human security, and FAQ 12.4 provides a concise response to the question, “What role does migration play in adaptation to climate change, particularly in vulnerable regions?” The answer provided is, “Moving from one place to another is a fundamental way humans respond to challenging conditions. Migration patterns everywhere are primarily driven by economic factors: the dominant migration system in the world has been

movement from rural to urban areas within countries as people seek more favorable work and living conditions."

The AR5 Working Group III (WGIII) report contains approximately twenty mentions of migration and displacement, some of which are less nuanced or are inconsistent with the WGII report, such as the Executive Summary of Chapter 4 and Section 4.3.3 that warn climate-related migration may exacerbate political tensions and generate conflict. Notable observations include Chapter 9 (Buildings) noting that climate-related migration to cities will cause building energy services demand to grow, and Chapter 11 (Agriculture, forestry and other land use) warning that hydroelectric, bioenergy and climate mitigation projects could potentially displace people in areas of implementation. Chapter 13 (International cooperation: instruments and agreements) at Section 13.5.2.2 uses 'refugee' terminology that was explicitly discouraged in the WGII report in describing debates on the merits of using the UNFCCC versus the UN Refugee convention to assist people displaced by climate change.

The AR5 Synthesis Report provides no meaningful synthesis of the detailed assessment of migration and displacement dimensions of climate change generated by WGII. It is in this regard a lost opportunity, containing only four general statements about climate-migration linkages and uncertainties in projecting future migration numbers that might have been drawn from AR2.

IPCC 2018 Special Report: Global warming 1.5°C

As part of the 2015 Paris Climate Agreement, signatories to the UNFCCC committed to keeping global warming to no more than 1.5°C higher than pre-industrial average global temperatures (at time of writing the present article, average global temperatures are nearly 1.2°C warmer). This Special Report was the first of three commissioned prior to the Sixth Assessment Report (AR6), and had the task of identifying: mitigation pathways and options for limiting warming to 1.5°C; the impacts that level of warming would have on natural and human systems; how these impacts would differ under 2°C warming; and how to advance adaptation and sustainable development in a 1.5°C warmer world. Migration and displacement are discussed nearly fifty times in this report, although they do not feature in the Summary for Policymakers. The greatest amount of discussion is found in Chapter 3 (Impacts of 1.5°C global warming on natural and human systems) at Section 3.4.5, which examines the impacts of sea level rise and coastal hazards, with many statements echoing or directly repeating statements made in AR5 and therefore not re-summarized here. The Chapter authors note that migration is common among people who live in small island states, sometimes for reasons that include environmental hazards, but for many people adaptation to climate hazards by other means (referred to as *in situ* adaptation) is preferred over migration (Sections 3.5.4.3, 3.4.10.2). In Section 3.4.10.2 (The changing structure of communities: migration, displacement and conflict) the authors note there are no studies that have specifically looked at the potential differences between migration patterns under 1.5 and 2°C warming, but that there are studies that have demonstrated that higher temperatures in general have observed effects on migration patterns (Section 3.4.10.2). As examples, the authors cite studies by Cai et al (2016), which found that temperature has had a positive and statistically significant effect on outmigration in agriculture-dependent countries, and by Backhaus et al (2015), which found that a 1°C increase in average temperature was associated with a 1.9% increase in bilateral migration flows across a selection of countries. At the same time, they also cite a study by Coniglio and Pesce (2015) that found no changes in migration patterns associated with temperature anomalies. The authors conclude on the basis

of a Hsiang and Sobel (2016) study that at 2ºC warming there is potential for significant population displacements in the tropics that would force people to relocate over long distances. Later in Chapter 3, the authors note there is limited evidence to suggest that potential declines in crop yields due to warming would stimulate large flows of migration out of affected tropical regions (Section 3.5.4.8). Section 3.7.2.5 notes that a knowledge gap exists with respect to how risks of people being displaced from small islands and low-lying coastal areas due to extreme events will change under different levels of warming. In Cross Chapter Box 8 (1.5°C Warmer Worlds) at the conclusion of Chapter 3, the authors describe a variety of future warming scenarios. In a scenario where countries are slow to reduce greenhouse gas emissions and warming exceeds 2ºC before declining by the end of the century, the authors project that migration and forced displacement would be extensive in some countries. In a scenario where warming reaches 3ºC by 2100, several small island states would need to be abandoned and their residents would need to seek refuge in other countries.

In Chapter 4, which looks at adaptation pathways, a short section on migration states there is little agreement on whether migration is an effective adaptation given its costs, that it may not reduce vulnerability, and that "its feasibility is constrained by low political and legal acceptability and inadequate institutional capacity" (Section 4.3.5.6). Table 4-4 states that key enabling factors that would facilitate migration as effective adaptation include governance actions such as incorporating migration planning in national disaster risk management policies and national climate adaptation plans. Table 4-13 identifies a lack of knowledge on the cost effectiveness of adaptive migration as being a significant knowledge gap. Cross Chapter Box 12 notes that displacement is among the topics being raised in international discussions about responses to losses and damages associated with climate change. In Chapter 5 discussions of trade-offs between climate adaptation and sustainable development, the authors note that carbon storage projects could displace people. The chapter also notes that adaptive migration and sustainable development could work together synergistically depending on conditions in sending and receiving areas, and warns that adverse development outcomes arise when vulnerable people are left behind or if migration is culturally disruptive (Section 5.3.2).

IPCC 2019 Special Report: Climate Change and Land (SR LAND)

This Special Report (SR), the second to be published between AR5 and AR6, assesses the roles of land use and land management in climate change mitigation and adaptation, and connections to desertification, land degradation and food security. Migration and displacement are discussed over eighty times, but its assessment is notably lacking in nuance as compared with AR4, AR5 and SR1.5. This is reflected in two key themes elevated to the Summary for Policymakers (SPM):

- Climate change can amplify internal and international migration and can cause increased displacement, disrupted food chains, threatened livelihoods, and can increase the potential for conflict (taken from chapter 5)
- Climate change can lead to land degradation, even when measures are taken to avoid it, and this can in turn lead to "undesirable transformational changes" such as forced migration, conflicts or poverty (taken from section 4.8.5.1)

Although the authors temper these statements by assigning them low or medium confidence levels, the fact that they appear in the SPM signals to readers – most of whom are unlikely to dig into the details found in the seven underlying chapters – that there is potentially substance to the climate-migration-conflict nexus that AR4 and AR5 explicitly caution against. The Technical Summary contains six mentions of migration and displacement, including observations that desertification, land degradation and food insecurity can lead to migration although the links are disputed; that once limits to adaptation are exceeded forced migration may occur; that at 1.5ºC warming and under SSP3 livelihood migration will increase and strife and conflict will rise; and, that with permafrost loss some Arctic communities may require relocation.

Migration and displacement feature regularly throughout Chapters 3 through 7 of the report. Chapter 3 (Desertification) describes at Section 3.1.4.2 that links between desertification and migration are complex and can lead to a variety of possible outcomes, some of which might lead to more sustainable land management practices, others leading to more intensive agriculture and greater pressure on land. At Section 3.4.2.9 the Chapter provides a succinct yet substantive review of how environmentally induced migration is a function of multiple drivers and adaptation processes, notes that existing forecasts of future displacements are largely based on measures of the number of people potentially exposed to hazards, and provides a variety of examples to show the diversity of migration outcomes from various types of climate events. The mobility of pastoralists is reviewed at Section 3.4.2.10, with a note that droughts in the 1970s and 1980s had significant impacts on migration patterns in Sahelian Africa, but that government policies and programs that restrict pastoralist mobility can also lead to land degradation and out-migration. Section 3.6.2.2 reviews examples of where migration and remittances have helped communities adapt to drought, noting that not all households have the means to send migrants and those that do not can be left behind economically. Chapter 4 (Land degradation) contains similar messaging to Chapter 3 regarding the complex causality and multi-directionality of migration and displacement outcomes associated with land degradation, noting a considerable lack of empirical evidence in this area (Section 4.7.3). This Section, which lumps together linkages between land degradation, migration and conflict, also suggests on the basis of a study by Kassa et al. (2017) that households experiencing natural resource degradation often engage in migration that can lead to land degradation at the destination and subsequent conflict. At Section 4.8.6 the authors explicitly note the indecision within past IPCC reporting over whether migration from an area experiencing a climate hazard is a positive adaptation or an example of lack of resilience or a collapsed livelihood system (Section 4.8.6).

Chapter 5 (Food security) warns at Section 5.1.3 on the basis of an FAO (2018) report that in rural areas with extreme poverty and few employment opportunities, climate change impacts on food security may force people to migrate and exacerbate the potential for ensuing conflicts. This message is inconsistent with more nuanced description of such linkages elsewhere in the same report and in other IPCC reports but was nonetheless elevated to the SPM. At section 5.3.2.1 the report describes outmigration as a potential transformational adaptation to climate change impacts on agriculture, but provides as evidence an erroneous interpretation of focus group discussions held with farmers in the Oldman River basin of Alberta, Canada reported in Hadaritis et al (2017). Section 5.6.4.4 echoes discussions at Section 3.1.4.2 that sustainable intensification of agriculture in a changing climate is important to avoiding involuntary displacement of rural people. At Section 5.8.2, migration and conflict are lumped together for assessment purposes, with Section 5.8.2.1 identifying food insecurity as being a critical push factor for international migration, and stating that the act of migration itself can

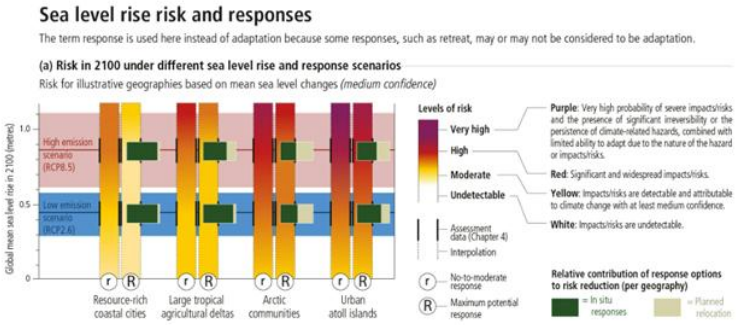
cause food insecurity. The Section goes on to list a variety of studies where climate events have been associated with migration but shows few examples of international migration on any significant scale, and apart from a case study of Pacific atolls states (Box 5.6) provides little evidence to show how food insecurity specifically causes migration. The Chapter concludes by stating, “In summary, given increasing extreme events and global and cross-sectoral interconnectedness, the food system is at increasing risk of disruption, for example, via migration and conflict (high confidence).” This conclusion and its confidence statement are simply not supported by the evidence provided.

Chapter 6, which reviews linkages between climate change, desertification, land degradation and food insecurity and suggests response options, says that delaying action on mitigating greenhouse gases could lead to large scale migration and conflicts, whereas urgent action could lead to lower levels of vulnerability and exposure to risks (Section 6.4.5). Chapter 7, which considers risk management and sustainable development strategies, states at Section 7.2.2.1 that significant population displacement has occurred in tropical regions due to “systemic livelihood disruption in agriculture systems”, with an implication that these disruptions are related to climate change. However, the references cited describe a variety of alternative, non-climatic drivers that also explain these disruptions. Section 7.2.2.4 asserts with medium confidence but with no supporting references that at 2.5°C to 3.5°C warming, migration out of some dryland areas in the Mediterranean region will be the only adaptation option. Table 7.1 includes “migration” as a “risk” that emerges from multiple forms of climate-related hazards, an approach that AR6 would subsequently reject. In Cross Chapter Box 10, Sections 7.4.6.1 and 7.6.3 identify a range of considerations for future planning that may have indirect consequences for or linkages to migration and displacement, and Box 11 notes the need to consider gender dimensions of migration as part of planning. On the whole, the assessment of links between climate, land use practices, food security, migration, displacement and conflict in this SR are more alarmist, less well substantiated, and often inconsistent with other contemporary IPCC reports.

IPCC 2019 Special Report: The Ocean and Cryosphere in a Changing Climate (SROCCC)

The SROCCC contrasts markedly with the SR on Land in terms of depth and nuance of its assessment of migration and displacement. It contains over 70 mentions of migration and displacement, nearly as many as the SR on Land, with most focussing on the potential need to relocate coastal communities and small island populations due to increased risks of flooding, storms, erosion, soil salinization and eventual inundation associated with sea level rise (SLR). The Summary for Policymakers contains six specific mentions of migration and displacement, the most of any IPCC report to that date, flagging such issues as risks faced by Indigenous communities in the Arctic and the important distinctions between planned relocations versus involuntary displacements and autonomous migration (developed at Box 4.3). This also marks the first time that migration or relocation explicitly figure into a “burning embers” diagram (Figure 8), a common IPCC diagram type in which a potential future risk – in this case the potential need for planned relocations in coastal areas – changes under a range of emissions and adaptation scenarios (Zommers et al 2020).

Figure 8: In IPCC *SROCCC* the potential need for planned relocations in specific settings is incorporated into a "burning embers" diagram that appears in the Summary for Policymakers SPM.5.



Cross Chapter Box 2 identifies an important distinction between limits to adaptation versus barriers to adaptation as they relate to coastal hazards. A "barrier" to adaptation is a situation where successful adaptation is possible but the necessary enabling factors are lacking, such as financial resources to build protective infrastructure for a community at risk. An adaptation "limit" is a situation where no amount of resources can prevent the exposed population from experiencing intolerable risks. This important distinction is missing in discussions of migration and displacement in some prior IPCCC reports, particularly the SR on Land. Chapter 3 (Polar regions) describes risks faced by Arctic communities due to the combined effects of permafrost loss, coastal erosion, and SLR, providing examples from Alaska and Russia of settlements already being confronted with the need to relocate (Section 3.5.2.6). The authors note the importance of place attachment, and that residents often do not wish to leave the areas where they live but simply wish to have more secure housing and infrastructure, with a lack of financial resources being a key barrier to adaptation.

Chapter 4, which focuses on SLR risks for low-lying coastal areas, observes in Section 4.3.2 that population numbers are growing in many in low-lying coastal areas due to increased levels of net migration, and this amplifies the number of people exposed to coastal hazards and SLR. Section 4.4.6.2.2 reviews various types of modeling studies that project future migration and displacement numbers due to SLR and associated hazards, and the authors conclude they have limited confidence in these because a large number of underlying drivers of migration are not adequately addressed. Chapter 4 states that adaptation for coastal settlements and small islands is likely to include a mix of building stronger coastal protections, restoration of natural defenses such as coral reefs and mangroves, and strategic relocations, a mix that would be effective in reducing risks up to 80 cm SLR (Section 4.3.4.2.2). The authors note that, at present, there are relatively few demonstrated examples where large numbers of people are voluntarily moving specifically because of SLR risks, with migration patterns in coastal areas and small islands being driven mainly by a mix of cultural, economic, political and social factors (Section 4.4.6.2.1). However, the same section notes there are reliable data on the number of people involuntarily displaced by coastal hazards each year, with most displaced people remaining in their home countries. Planned relocations are already occurring in a growing number of locations, typically initiated after a displacement event has occurred and with an eye toward reducing exposure to future hazards including SLR. The financial costs of displacement and relocation are observed to be highly variable from one locale to another (Section 4.4.2.6.3), and a detailed review of potential beneficial and adverse outcomes of coastal relocations and

migration for sending and receiving communities and for migrants themselves is provided in Section 4.4.2.6.5. Section 4.4.2.6.6 provides a similarly strong review of important considerations for governments and institutions on how to improve the outcomes of planned relocations, while Section 4.4.3.3 notes there may be instances where displacements and migration could be of such a scale they affect socio-economic and political stability. Case studies described in special boxes in Chapter 4 include examples from Fiji, New York City, Shanghai, the Nile delta and the Canadian Arctic, with Chapter 6 providing a case study of migration following 2017's Hurricane Maria. Both Chapter 4 and Chapter 6 (Extreme events) contain multiple mentions of the importance of capturing local and Indigenous knowledge in planning for future migration, displacement and relocations, with Section 6.3.3 observing that planned relocations of coastal communities on large scales have rarely been attempted given the costs and contentiousness. Section 6.9.2 notes that governance structures lack the capacity to deal adequately with the scale of potential displacement risks in coastal regions and need to be strengthened, such as through creating bilateral and multilateral arrangements. A highly useful feature of SROCCC is Cross Chapter Box 9 which summarizes and integrates preceding discussion of risks for coastal areas and small islands, and summarizes possible responses including migration and planned relocations.

Although the greatest attention is given to coastal environments, the SROCCC also assesses migration and displacement in mountainous environments, particularly in Chapter 2. At Section 2.1.3.1.2 the authors note that declining availability of water for irrigation in mountainous agricultural regions can lead to higher levels of wage-seeking out-migration of young adults, and Section 2.3.7 provides a detailed description of how mobility (pastoralist and labor migration) is an important feature of mountain livelihoods, as are occasional displacements due to extreme events and other hazards such as landslides.

IPCC 2022 Sixth Assessment Report (AR6) Working Group II Report

The AR6 Working Group II (WGII) report provides far and away the most detailed and comprehensive assessment of migration and displacement of any IPCC report to date. The sheer frequency makes it it impractical to count and tabulate them all and, unlike preceding reports, AR6 WGII provides in a Cross Chapter Box in Chapter 7 (referred to within the report as "CCB Migrate") its own index of where to find migration and displacement discussions throughout the report. The Summary for Policymakers (SPM) contains twice as many mentions of the subject as preceding reports, and these accurately capture the key messages about migration and displacement from across the report that are summarized below. The level of detail and consistency in messaging throughout the report was achieved by formation of a special working group representing authors from across chapters with backgrounds in climate-related migration and displacement research, who then worked in coordination fashion to assess these topics. Chapter 7 (Health, wellbeing and the changing structure of communities) provides an overarching assessment of linkages between climate change, migration and displacement, with each of the sectoral and regional chapters providing additional details specific to their areas of assessment. CCB Migrate, written by 20 authors from across the report, provides readers with:

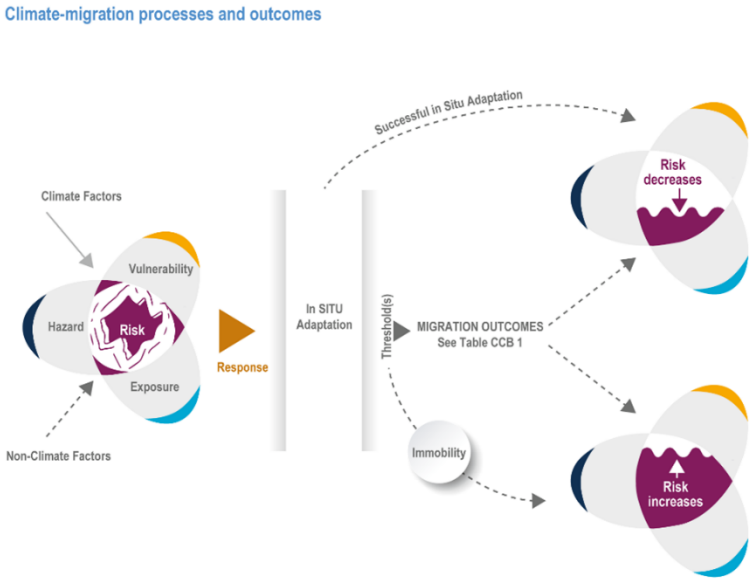
- a summary of key messages about migration from across the entire report
- a figure illustrating general interactions between climatic and non-climatic processes, adaptation, potential migration outcomes and implications for future risk (Figure 9)

- a typology of the different types of migration and displacement identified (including call outs to specific sections of the report where these are found), and
- a summary of the policy implications.

The key messages summarized in the Cross Chapter Box are:

- migration is a universal strategy that individuals and households undertake to improve well-being and livelihoods in response to economic uncertainty, political instability and environmental change, and is not in and of itself a “risk” in IPCC parlance, except when it occurs involuntarily
- climatic conditions, events and variability are important drivers of migration and displacement, with migration responses to specific climate hazards being strongly influenced by economic, social, political and demographic processes (Figure 9)
- specific climate events and conditions may cause migration to increase, decrease or flow in new directions, and the more agency migrants have (i.e., the degree of voluntarity and freedom of movement), the greater the potential benefits for sending and receiving areas
- most climate-related migration and displacement observed currently takes place within countries
- in many regions, the frequency and/or severity of floods, extreme storms and droughts is projected to increase in coming decades, especially under high-emissions scenarios, raising future risk of displacement in the most exposed areas
- there is growing evidence about the future prospects of immobile populations: groups and individuals that are unable or unwilling to move away from areas highly exposed to climatic hazards

Figure 9: Illustration from AR6 WGII Chapter 7 Cross Chapter Box showing general interactions between climatic and non-climatic processes, adaptation, potential migration outcomes and implications for future risk. Migration outcomes in the accompanying table (not shown) include temporary/seasonal migration; permanent migration; internal migration; international migration; rural-urban and rural-rural migration; displacement; planned resettlement; and immobility.



The Chapter 7 assessment of migration and displacement is organized according to currently observed impacts of climate on migration and displacement patterns, projected future patterns, and adaptation options and climate-resilient development pathways. The Chapter's assessment of observed impacts spans seven pages and provides an assessment that highlights the complexity, multi-causality and multi-directionality of climate-associated migration processes and outcomes. The Chapter makes use of a decade of global statistics for weather-related displacements gathered by the Internal Displacement Monitoring Centre, provides a much more detailed assessment of immobility than previous IPCC reports, and identifies links between climate-related migration and health. Box 7.4 provides a succinct description of how migration decision-making and outcomes—in both general terms and in response to climatic risks—are strongly mediated by gender, social context, power dynamics and human capital. Table 7.2 summarizes projected regional changes in the frequency and severity of sudden-onset climate events associated with migration and displacement. Section 7.4.4 identifies key linkages between climate-related migration and household resilience, social networks, and labor markets, with Section 7.4.4.6 identifying potential tools for policymakers in responding to future climate-related migration and displacement, particularly the Global Compact for Safe, Orderly and Regular Migration.

Sectoral chapters on climate change impacts on water (chapter 4), food (chapter 5), cities (chapter 6), and livelihoods (chapter 8) all contain nuanced and densely referenced assessments of how migration and displacement interact with socio-economic systems, while chapters 9 through 15 providing examples of current and projected future migration and displacement outcomes across geographical regions. Chapter 15 (Small islands) sounds an especially urgent call for action on mitigation and adaptation, observing that even if global warming is limited to 1.5^{o}C as required under the Paris Agreement, small islands will face significantly reduced habitability. In identifying future key risks of climate change, Chapter 16 reinforces the assessment of preceding chapters that when migration occurs in a safe and orderly fashion it can reduce social inequality and facilitate sustainable development, but when it occurs involuntarily it becomes a risk that can cause significant economic losses and non-material costs, an unequal gender burden, and amplified vulnerability to other climate risks (Section 16.5.2.3.8). Throughout the report authors are careful to avoid making strong assertions about possible links between climate, migration and conflict. In short, the AR6 WGII provides one of the most comprehensive and reliable assessments of climate-related migration and displacement available to date.

Three key messages from the AR6 WGII report were included in the AR6 Synthesis Report, published in 2023. These are that (1) displacement and involuntary migration from extreme events generates and perpetuates vulnerability (Section 2.1.2); (2) planned relocations of coastal populations have better outcomes when they are planned ahead, aligned with sociocultural values and development priorities, and include community members in the planning process (Section 4.5.3); and, (3) "…policy interventions can remove barriers and expand the alternatives for safe, orderly and regular migration that allows vulnerable people to adapt to climate change" (Section 4.5.6). Unfortunately, none of these messages were elevated to the Summary for Policymakers, the part of the Synthesis Report people are most likely to read.

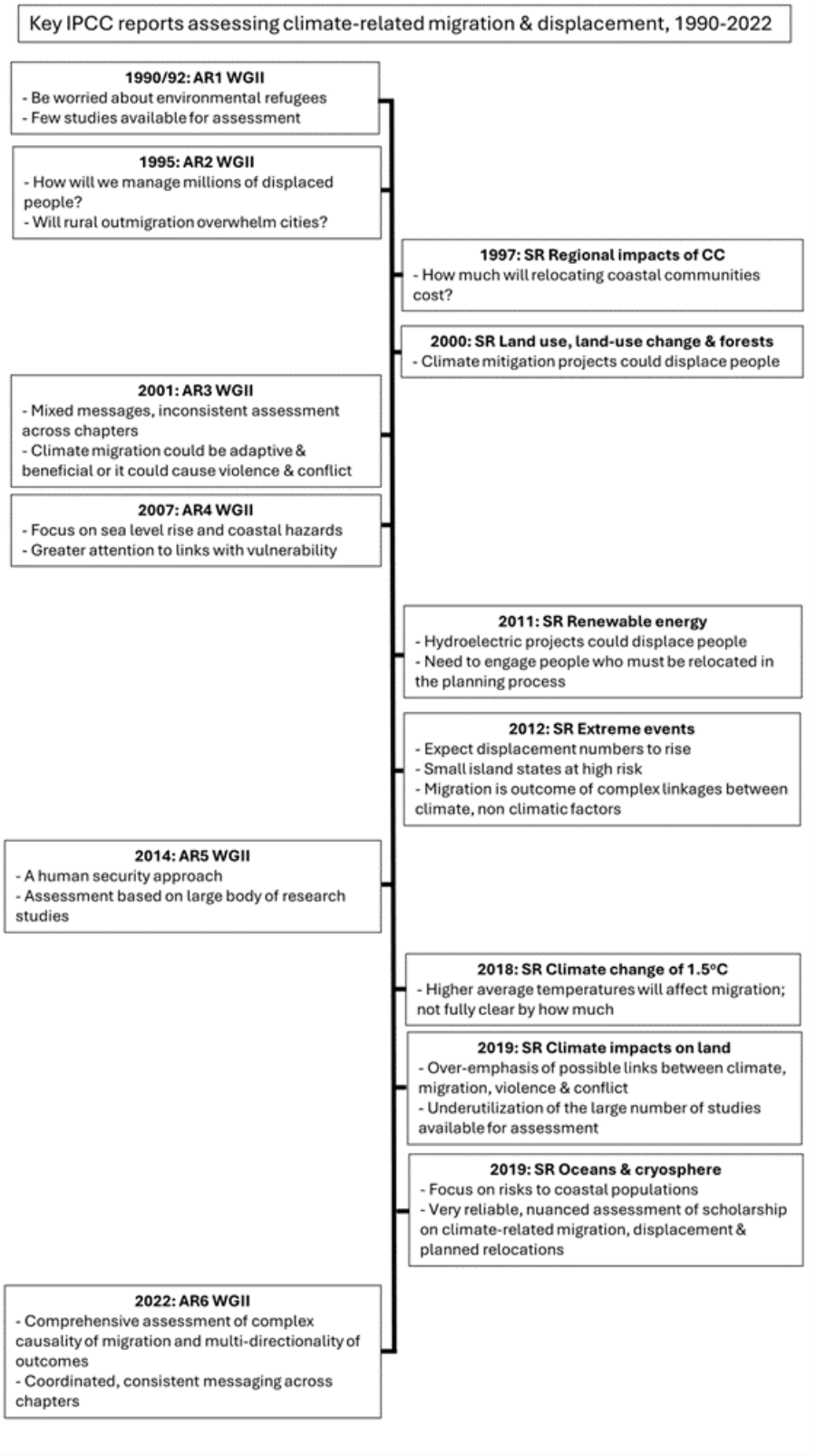
Discussion and Conclusions

From its very first report in 1990, concerns about the impacts of climate change on human migration and displacement have featured in IPCC reporting. The massive expansion

from 1990 to 2022 in the attention given to migration and displacement in IPCC reporting is consistent with a corresponding increase over that same period in (1) the volume of scholarly research being done on the subject and (2) in the number of IPCC report authors with related expertise, especially in Working Group II. In 1990, when AR1 was written, there few published studies on the topic potentially available for assessment, and no online search tools to identify them. AR6 authors were able to draw upon a decade of data collection by the Internal Displacement Monitoring Centre and over a thousand published peer-reviewed studies, including multiple systematic literature reviews and meta-analyses of research on specific topics within the subject area. Authors of AR1 and AR2 came predominantly from the natural and physical sciences and mostly from high-income countries, supported by a handful of economists but few other social scientists. Today, IPCC author teams are selected to capture a wide array of expertise and backgrounds, with attention given to gender representation, geographical representation, and having a mix of experienced authors and newly selected ones. Up until AR3 a challenge for IPCC authors was finding reliable studies on climate-related migration and displacement; today, a challenge for authors is how to inventory, assess and distill in a succinct fashion the sheer number of studies published since the preceding report. The increasing attention to migration and displacement and the depth of analysis also reflects the wider evolution of IPCC reports, with author teams in recent years being directly instructed to assess migration and displacement as part of their work. The evolution of assessment of migration and displacement from AR1 to AR6 is summarized in Figure 10 (next page), which provides a timeline of IPCC reports and a short recap of key themes/messages contained in each.

A notable milestone in the evolution of IPCC assessments of migration and displacement was the shift in terminology from “environmental refugees” and “climate refugees” to more generic terms of migration and displacement that began with the AR3 WGII report. This again reflects both the evolution and expansion of the scholarship more generally and the participation of larger numbers of social scientists with expertise in related areas. Importantly, it was not merely a change of words, but signalled a shift from parroting alarmist fears about the potential worst-case impacts of climate change to conducting a thoughtful assessment and synthesis of the available peer-reviewed scholarship on climate-related migration and displacement, as was already being done for other aspects of climate change and its impacts. In hindsight, it seems unusual that assertions about environmental refugees made in early IPCC reports by authors with no formal training or expertise in migration research would go unquestioned by external reviewers or by IPCC member country representatives; reviewers would certainly not accept assertions about climate dynamics made by authors with no formal training in climatology. But again, the evolution of migration and displacement assessments mirrors the evolving professionalism of the IPCC process as a whole.

Figure 10: Timeline of IPCC reports that assess migration & displacement and notable themes/attributes of each. Prepared by authors.



A challenge with IPCC assessment of migration and displacement from the outset has been consistency from one report to the next, between WGII and WGIII reports of the same assessment, and even between chapters within the same report. The AR3 report provides an early, glaring example of this, Chapters 7 and 19 of WGII both focusing on possible perils of large-scale climate-related migration, but with Chapter 19 warning about threats to international order while the Chapter 11 – in assessing the regional impacts for Asia – approaches the topic more thoughtfully and suggests that migration might even benefit cities. Meanwhile, the AR3 WGIII report used unusual terms such as “vagabonds” and “castaways” to describe vulnerable people and made crude, straight-line assumptions that higher greenhouse gas emissions will lead to higher levels of migration and conflict. AR4 also has its contradictions. Most early chapters of the AR4 WGII report contain careful analyses of climate-migration linkages and avoid simplistic assumptions about cause and effect, with Chapter 7 explicitly warning against jumping to conclusions that climate-related resource scarcity will inevitably lead to forced migration and conflicts. Yet, Chapter 19 of the same report proceeds to state that climate change can cause droughts, water shortages, and flooding that in turn lead to forced migration and exacerbate conflicts. Inconsistencies also arise within and between AR5 Working Group reports. Late chapters in the AR5 WGII report that synthesize overarching vulnerabilities and key risks discard nuanced, human security-based assessments of climate-migration linkages in earlier chapters and provide overly simplified statements instead. The Executive Summary of Chapter 4 of the AR5 WGIII report warns that climate-related migration can cause political tensions and exacerbate conflicts, and Chapter 13 uses the term “refugee” in an outdated context. The best way to avoid such inconsistencies in the future is to aim for greater coordination between author teams as was done by AR6 WGII.

The 2019 Special Report on Climate Change Impacts on Land is notably out of step with the preceding 2015 AR5 WGII report and SR 1.5^{o}C and SRCOCCC in its understanding and assessment of linkages between climate change, migration and displacement. Early chapters on desertification and land degradation provide capable and reasonably nuanced assessments of what is known and not known about how these processes affect migration and displacement, but subsequent chapters revert to old tropes about displacement causing large-scale internal and international migration, political instability and conflicts, and it is these statements that were elevated to the Summary for Policymakers. By contract, the assessment of migration and displacement challenges in SROCCC demonstrates analytical depth, consistency, and reliability.

The potential for inconsistencies within and between reports stems from the nature and structure of the IPCC itself, its operational processes, and how Working Groups are established and function. Author teams for each Working Group chapter consist of two or three coordinating lead authors, and up to a dozen additional lead authors. Author teams inevitably do not possess expert knowledge in every aspect of the subject matter they are responsible for. If a chapter’s author team lacks expertise on migration and displacement issues, it may request contributions from outside experts (who are then acknowledged as Contributing Authors), conduct its own assessment as best it can, or simply pay less attention to such topics. A brief glance at the list of authors for chapters that stood out in IPCC reports as containing inconsistent or unreliable messages about migration showed that in most instances, the lead authors did not have a record of scholarly publications on the topic. Another operational challenge is that there is limited time and opportunity for meetings and collaboration between authors in different Working Groups and between chapter author teams in the same Working Group or on other reports. Although a logical workflow for IPCC Assessment Reports would be that Working Group I

publishes its report before Working Groups II and III begin their work, WGI has often only written a first draft of its report before the other groups begin work. It would also be logical that authors for the sectoral assessment chapters in WGII complete their work first, then collaborate directly with author teams for regional assessment chapters, and only once late version drafts of sectoral and regional chapters are available would authors of subsequent chapters that synthesize key risks, cross-cutting vulnerabilities, and options for action begin work. In reality, each WG's author teams begin working in parallel at the same time, with only occasional, mostly self-initiated communication with other chapter teams. Such a process inevitably creates the potential for inconsistencies. There is even less opportunity for coordination across Working Groups. A confluence of factors that had not been in place for previous IPCC reports allowed the AR6 WGII report to be so much more comprehensive and consistent in terms of its assessment of migration and displacement. Whether by chance or design, the AR6 WGII author team included approximately twenty researchers with expertise on migration and displacement, several of whom had previously collaborated or were familiar with one another's work, and a small number of them took it upon themselves to coordinate regular meetings throughout the multi-year writing process to ensure consistent messaging throughout the report and across chapters. This collaboration also benefited from online tools such as Zoom and shared online documents that were not available to author teams for early IPCC reports, and the switch from periodic in-person author team meetings to online ones necessitated by the pandemic may have spurred more frequent online communications between author teams. Hopefully collaborative approaches of this nature continue in future IPCC reporting exercises.

Yet despite the aforementioned inconsistencies, the overall arc of migration and displacement assessment in IPCC reporting has been toward increasingly nuanced and careful consideration of the complexity of causation and outcomes. Starting with AR4 IPCC authors began moving away from making generic statements abut how climate change will lead to higher rates of migration and speculating about how much it might cost in dollar terms or how it might threaten political stability, and began (1) paying greater attention to how climate-related migration behavior and outcomes are influenced by social inequality, gender, age, place attachment and other factors, (2) raising concerns about the implications for Indigenous populations, (3) emphasizing the importance of migrant agency, and (4) including questions about immobility in their assessments. In this way, IPCC reports have generally followed the evolution of scholarly debates over the past three-plus decades, from early discussions about the merits of the label "environmental refugees" to how we might distinguish climate-related migration from other migration movements, how to identify which groups are most vulnerable to displacement, whether migration is a form of adaptation or a failure of adaptation, the strength of climate and environmental factors in stimulating migration relative to other causal factors, and how migration fits in with wider efforts in mitigating greenhouse gas emissions and advancing sustainable development.

Given the extensive assessment of climate-related migration, displacement and immobility provided in the AR6 WGII report, a question becomes, what might or should come next in IPCC reporting. A first observation is that, despite the increasing amount of assessment given to migration, displacement and mobility issues in Working Group II reports, these issues have routinely failed to receive significant attention in Synthesis Reports. This is symptomatic of wider concerns previously expressed that the Synthesis reports tend toward oversimplification of many important aspects of climate change impacts and vulnerability (Livingston et al 2017). Simplification is inevitable, given that the purpose of the Synthesis report is to consolidate the thousands of pages of three Working Group reports into a concise document governments can

use to inform UNFCCC negotiations, and trade-offs need to be made over which issues merit greater attention than others. That said, it was a missed opportunity when the 2023 Synthesis Report failed to elevate to its SPM the statement that, “policy interventions can remove barriers and expand the alternatives for safe, orderly and regular migration that allows vulnerable people to adapt to climate change”.

It is likely that governments will want future IPCC Working Group II reports to provide more detailed estimations of future migration and displacement numbers under a range of emissions, warming and adaptation scenarios at global, regional and sub-regional scales. This will be a challenge, for as scholars working in the field are aware, the causal complexity of migration decision-making and its context-specificity make it difficult to model with any great confidence. Further, the question of detection and attribution – i.e. how much additional migration can be expected due to climate change beyond that attributable to ongoing climate variability and extreme weather events – has yet to be answered in IPCC reporting. There are specific scientific methods for detecting and attributing the effects of climate change on human systems and processes (Stone et al 2013) but to our knowledge there are no peer-reviewed studies that have attempted to do this for migration and displacement. Author teams for upcoming IPCC reports may need to conduct their own detection and attribution assessments should they wish to answer this question that policymakers would almost certainly like to see answered.

There will likely be growing interest from IPCC member countries in seeing more detailed examples and analyses of specific cases of current climate-related migration and displacement in their respective geographical regions, and more precise identification of where it is most likely to emerge occur in the next few decades given current greenhouse gas emissions. Low-income countries will be especially interested in seeing such information in IPCC reports to support their claims for compensation under new Loss and Damage mechanisms that are being established under the UN Framework Convention on Climate Change (Naylor & Ford 2023). There will also likely be greater interest from governments and the humanitarian sector in understanding the impacts of climate-related migration and displacement on health systems given heightened post-pandemic awareness of how their resilience can be severely tested by unexpected events (Ebi & McLeman 2022). Given the requirement that IPCC reports be non-prescriptive with respect to policy interventions, it is possible to identify possible legal mechanisms and pathways for international action (as was done in AR6) but authors are not able to make recommendations as to which ones would be best to purse. However, constructing scenarios and providing rough estimates of how much displacement and resulting human hardship might be avoided under various policy pathways would be a way for future IPCC reports to nudge readers toward favoring certain options without being explicitly prescriptive. A small number of existing studies provide examples of how this might be done (e.g. Benveniste et al 2020, McLeman 2020).

To conclude, migration and displacement have been a preoccupation of IPCC reporting from the beginning, and will likely continue to be an area of concern for the foreseeable future. Planned relocations of coastal communities are already taking place in locations as geographically diverse as Fiji and Alaska, the government of the Maldives is constructing artificial islands to house tens of thousands of citizens above rising water levels, wildfires displace tens of thousands of people each year in North America, and extreme storms and floods displace millions more in coastal Asia. As the number of people on the move for climate-related reasons grows, so will the demand from governments, organizations and the wider public for reliable, fact-based assessment of future challenges and opportunities for responding.

Supporting Information

This manuscript is accompanied by MS Excel Tables that identify and summarize each occurrence of substantive discussion of migration, displacement and related topics in each of the IPCC reports identified in Table 1. The tables can be downloaded using this link: https://www.dropbox.com/scl/fi/jipn61o0tjs83j1dspkk4/Supplemental-materials-McLeman-et-al-IPCC-Migration.xlsx?rlkey=glle29g7gvhdzf75k1aa31xya&st=g4pf3wrb&dl=0

References

Adger, W.N., Pulhin, J.M., Barnett, J., Dabelko, G.D., Hovelsrud, G.K., Levy, M., Spring, Ú.O. & Vogel, C.H. (2014). Chapter 12: Human Security. In C.B. Field, V.R. Barros, D.J. Dokken, K.J. Mach, M.D. Mastrandrea, T.E. Bilir, M. Chatterjee, K.L. Ebi, Y.O. Estrada, R.C. Genova, B. Girma, E.S. Kisse, A.N. Levy, S. MacCracken, P.R. Mastrandrea, and L.L. White (eds) *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Part A: Global and Sectoral Aspects. Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change*. United Kingdom and New York, NY, USA: Cambridge University Press, pp. 755–791.

Backhaus, A., Martinez-Zarzoso, I., & Muris, C. (2015). Do climate variations explain bilateral migration? A gravity model analysis. *IZA Journal of Migration*, *4*(1). https://doi.org/10.1186/s40176-014-0026-3

Benveniste, H., Oppenheimer, M., & Fleurbaey, M. (2020). Effect of border policy on exposure and vulnerability to climate change. *Proceedings of the National Academy of Sciences*, *117*(43), 26692–26702. https://doi.org/10.1073/pnas.2007597117.

Brown, O., Hammil, A., & McLeman, R. (2007). Climate change as the “new” security threat: implications for Africa. *International Affairs*, *83*(6), 1141–1154. https://doi.org/10.1111/j.1468-2346.2007.00678.x.

Cai, R., Feng, S., Oppenheimer, M., & Pytlikova, M. (2016). Climate variability and international migration: The importance of the agricultural linkage’, *Journal of Environmental Economics and Management*, *79*, 135–151. https://doi.org/10.1016/j.jeem.2016.06.005.

Carey, M., James, L.C., & Fuller, H.A. (2014). A new social contract for the IPCC. *Nature Climate Change*, *4(*12), 1038–1039. https://doi.org/10.1038/nclimate2442.

Cernea, M.M. (1996). *Eight Main Risks: Impoverishment and Social Justice in Resettlement*. Washington, DC: The World Bank Environment Department.

Cissé, G., McLeman, R., Adams, H., Aldunce, P., Bowen, K., Campbell-Lendrum, D., Clayton, S., Ebi, K.L., Hess, J., Huang, C., Liu, Q., McGregor, G., Semenza, J., & Tirado, M.C. (2022). Chapter 7: Health, Wellbeing, and the Changing Structure of Communities. In H.-O. Pörtner, D.C. Roberts, M. Tignor, E.S. Poloczanska, K. Mintenbeck, A. Alegría, M. Craig, S. Langsdorf, S. Löschke, V. Möller, A. Okem, and B. Rama (eds) *Climate Change 2022: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK and New York: Cambridge University Press, 1041–1170. https://doi.org/10.1017/9781009325844.

Cline, W.R. (1992). *The economics of global warming*. Washington, DC: Institute for International Economics.

Coniglio, N.D. & Pesce, G. (2015). Climate variability and international migration: an empirical analysis. *Environment and Development Economics*, *20*(4), 434–468. https://doi.org/10.1017/S1355770X14000722.

Debrah, C. (1989). *Address to the Conference on Implications of Climate Change for Africa*. Washington, DC: Howard University.

Ebi, K.L. & McLeman, R. (2022). Climate related migration and displacement. *BMJ*, 379, p. o2389. https://doi.org/10.1136/bmj.o2389.

Ericson, J.P., Vörösmarty, C.J., Dingman, S.L., Ward, L.G., & Meybeck, M. (2006). Effective sea-level rise and deltas: Causes of change and human dimension implications. *Global and Planetary Change*, *50*(1), 63–82. https://doi.org/10.1016/j.gloplacha.2005.07.004.

Fankhauser, S. (1995). *Valuing Climate Change: The Economics of the Greenhouse*. London: Earthscan.

FAO (2018). *The future of food and agriculture – Alternative pathways to 2050*. Rome: Food and Agriculture Organization of the United Nations, 224p.

Foresight (2011). *Migration and Global Environmental Change: Future Challenges and Opportunities, Final Project Report*. London, UK: The Government Office for Science, 236p.

Hadarits, M., Pittman, J., Corkal, D., Hill, H., Bruce, K. & Howard, A. (2017). The interplay between incremental, transitional, and transformational adaptation: a case study of Canadian agriculture. *Regional Environmental Change*, *17*, 1–11. https://doi.org/10.1007/s10113-017-1111-y.

Hoozemans, F.M.J., Marchand, M. & Pennekamp, H.A. (1993). Sea level rise: a global vulnerability assessment vulnerability assessments for population, coastal wetlands and rice production on a global scale. Delft, Netherlands: Delft Hydraulics and Rijkswaterstaat. 184p.

Hsiang, S.M. & Sobel, A.H. (2016). Potentially Extreme Population Displacement and Concentration in the Tropics Under Non-Extreme Warming. *Scientific Reports*, *6*(1), p25697. https://doi.org/10.1038/srep25697.

IPCC (2022). *Special Report on the Ocean and Cryosphere in a Changing Climate (SROCCC)*. 1st ed. Edited by H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, and N.M. Weyer. Cambridge, UK and New York, NY, USA: Cambridge University Press. https://doi.org/10.1017/9781009157964.

IPCC/Nakicenovic, N. & Swart, R. (eds) (2000). *Emissions scenarios: summary for policymakers: a special report of IPCC Working Group III - Intergovernmental Panel on Climate Change*. Intergovernmental Panel on Climate Change, Cambridge University Press (IPCC special report).

Jacobson, J.L. (1988). Environmental Refugees: A Yardstick of Habitability. *Bulletin of Science, Technology and Society*, *8*(3), 257–258. https://doi.org/10.1177/027046768800800304.

Kassa, H., Dondeyne, S., Poesen, J., Frankl, A., & Nyssen, J. (2017). Transition from Forest-based to Cereal-based Agricultural Systems: A Review of the Drivers of Land use Change and Degradation in Southwest Ethiopia. *Land Degradation & Development*, *28*(2), 431–449. https://doi.org/10.1002/ldr.2575.

Livingston, J.E., Lövbrand, E. & Alkan Olsson, J. (2018). From climates multiple to climate singular: Maintaining policy-relevance in the IPCC synthesis report. *Environmental Science & Policy*, *90*, 83–90. https://doi.org/10.1016/j.envsci.2018.10.003.

McLeman, R. (2020). *How Will International Migration Policy and Sustainable Development Affect Future Climate-Related Migration?* Washington, DC: Migration Policy Institute, 39p.

Myers, N. (1997). Environmental Refugees. *Population and Environment*, *19*(2), 167–182. https://doi.org/10.1023/A:1024623431924.

Naylor, A.W. & Ford, J. (2023). Vulnerability and loss and damage following the COP27 of the UN Framework Convention on Climate Change. *Regional Environmental Change*, *23*(1), p38. https://doi.org/10.1007/s10113-023-02033-2.

Nicholls, R.J., Wong, P.P., Burkett, V.R., Codignotto, J.O., Hay, J.E., McLean, R.F., Ragoonaden, S. & Woodroffe, C.D. (2007). Chapter 6: Coastal systems and low-lying areas. In M.L. Parry, O. f. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds). *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press, pp. 315–356.

IPCC (2024). *Preparing Reports*. Available at: https://www.ipcc.ch/about/preparingreports/ (Accessed: 26 July 2024).

Ramlogan, R. (1996). Environmental refugees: a review. *Environmental Conservation*, *23*(1), 81–88. https://doi.org/10.1017/S0376892900038285.

Riahi, K., van Vuuren, D.P., Kriegler, E., Edmonds, J., O'Neill, B.C., Fujimori, S., Bauer, N., Calvin, K., Dellink, R., Fricko, O., Lutz, W., Popp, A., Cuaresma, J.C., Kc, S., Leimbach, M., Jiang, L., Kram, T., Rao, S., Emmerling, J., Ebi, K., Hasegawa, T., Havlik, P., Humpenöder, F., Da Silva, L.A., Smith, S., Stehfest, E., Bosetti, V., Eom, J., Gernaat, D., Masui, T., Rogelj, J., Strefler, J., Drouet, L., Krey, V., Luderer, G., Harmsen, M., Takahashi, K., Baumstark, L., Doelman, J.C., Kainuma, M., Klimont, Z., Marangoni, G., Lotze-Campen, H., Obersteiner, M., Tabeau, A., & Tavoni, M. (2017). The Shared Socioeconomic Pathways and their energy, land use, and greenhouse gas emissions implications: An overview. *Global Environmental Change*, *42*, pp. 153–168. https://doi.org/10.1016/j.gloenvcha.2016.05.009.

Stone, D., Auffhammer, M., Carey, M., Hansen, G., Huggel, C., Cramer, W., Lobell, D., Molau, U., Solow, A., Tibig, L. & Yohe, G. (2013). The challenge to detect and attribute effects of climate change on human and natural systems. *Climatic Change*, *121*(2), 381–395. https://doi.org/10.1007/s10584-013-0873-6.

Tickell, C. (1989). *Environmental Refugees: The Human Impact of Global Climate Change, The NERC Annual Lecture*. Royal Society, London: NERC, 1989.

Tol, R.S.J. (2007). The double trade-off between adaptation and mitigation for sea level rise: an application of FUND. *Mitigation and Adaptation Strategies for Global Change*, *12*(5), 741–753. https://doi.org/10.1007/s11027-007-9097-2.

Warner, K. & Afifi, T. (2014). Where the rain falls: Evidence from 8 countries on how vulnerable households use migration to manage the risk of rainfall variability and food insecurity. *Climate and Development*, *6*(1), 1–17. https://doi.org/10.1080/17565529.2013.835707.

Wilbanks, T.J., Romero Lankao, P., Bao, M., Berkhout, F., Cairncross, S., Ceron, J.-P., Kapshe, M., Muir-Wood, R. & Zapata-Marti, R. (2007). Chapter 7: Industry, settlement and society. In M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden, and C.E. Hanson (eds) *Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*. Cambridge, UK: Cambridge University Press, pp. 357–390.

Zommers, Z., Marbaix, P., Fischlin, A., Ibrahim, Z.Z., Grant, S., Magnan, A.K., Pörtner, H.-O., Howden, M., Calvin, K., Warner, K., Thiery, W., Sebesvari, Z., Davin, E.L., Evans, J.P., Rosenzweig, C., O'Neill, B.C., Patwardhan, A., Warren, R., van Aalst, M.K., & Hulbert, M. (2020). Burning embers: towards more transparent and robust climate-change risk assessments. Nature Reviews Earth & Environment, 1(10), pp. 516–529. https://doi.org/10.1038/s43017-020-0088-0.