EXTREME HEAT AND MIGRATION

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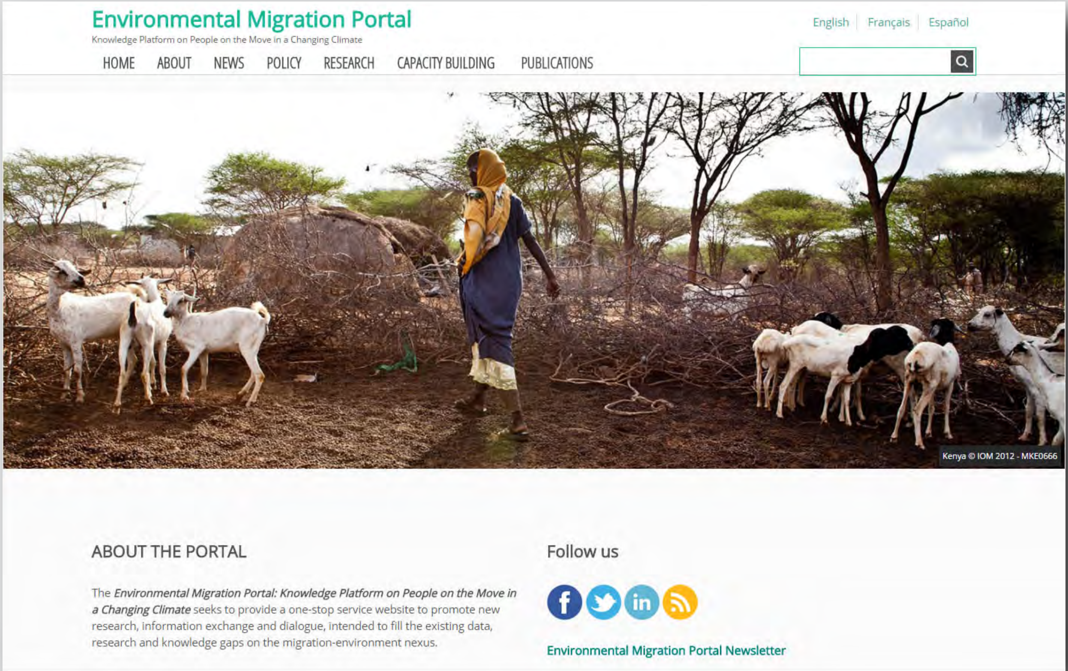

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EXTREME HEAT AND MIGRATION

THE IMPACTS OF THREATS TO HABITABILITY FROM INCREASING AND EXTREME HEAT EXPOSURE DUE TO CLIMATE CHANGE ON MIGRATION MOVEMENTS

Key points

- The Paris Agreement (United Nations Framework Convention on Climate Change (UNFCCC), 2015), which came into force on 4 November 2016, states the importance of keeping global temperature change below 2°C, ideally at 1.5°C. However, it is projected that the combined global temperature increase would rise up to 2.6–3.1°C, if only the given commitments outlined in States' submitted Intended Nationally Determined Contribution (INDC) and Nationally Determined Contributions (NDC) are implemented. Such temperature increase would affect the health of millions of people and threaten the habitability and survivability in hot areas of the world.
- Habitability can be defined as the "capability for sustained occupation by people in the environment of the local area", and survivability can be "the ability to remain alive or continue to exist in the environment of the local area".
- The expansion of super-hot areas in parts of the world is one of the major public health threats that climate change brings, and it also leads to labour productivity loss. In these conditions, the continuation of daily life activities in hot tropical and subtropical parts of the world – where most of the global population lives – is threatened. Migration flows out of these areas are already occurring, and these threats potentially represent an important push factor of future migration as individuals and communities might be forced to or decide to migrate in search of more hospitable environments.
- In addition, increasing heat related to climate change is likely to result in more disruptive events, such as frequent droughts, wildfires, episodes of extreme temperatures and heat waves. Such events are already displacing large numbers of people each year.
- Estimates of heat levels around the world reveal that less than 1 million people currently live in areas with an average "very strong heat stress" in the shade during the hottest month. If global temperature rise is limited to 1.5°C by the end of the century, these hot areas will expand; **30 to 60 million people are projected to live in hot areas where the average heat in the hottest month is likely to be too high for a human body to function well**.
- This projection increases to more than 100 million people in case of a 2°C temperature rise. If only the current policies outlined in INDCs and NDCs are implemented, some densely populated areas will experience "extreme heat" in the hottest months. The main areas affected will be located in tropical low- and middle-income countries, but some subtropical areas in high-income countries will also become extremely hot. If nothing is done in terms of climate change mitigation, more than 1 billion people are projected to live in "very strong heat stress" by the end of this century.
- Even in the best-case scenario of the lowest possible temperature increase, millions of people will potentially be unable to maintain daily life activities during hot periods of each year in their areas of origin in low- and middle-income countries and also in developed countries. In this context, it is important to anticipate potentially reshaped and increasing migration flows and develop migration management strategies to respond to such challenges.

Introduction

The purpose of this document is to explore the existing and potential linkages between "very strong heat stress" and continuation of daily life on the one hand, and migration on the other. Knowledge has advanced over the past five years on climate change, heat increase and extreme heat exposure, while issues related to climate migration in all its forms (voluntary migration, forced displacement and planned relocation) are being increasingly studied and understood.

However, the heat-migration nexus is only just starting to be understood, and this report aims to call attention to – and encourage action on – the complex interrelations between very strong heat stress due to climate change and migration. This document first outlines some key facts on extreme heat increase, human exposure and impacts on daily life; then explores the relation between climate change and migration; and finally recommends areas for further research and collaboration across scientific communities.

Our objective is to bring together the two different dimensions of the heat-migration nexus by: (a) calling the attention of the migration community on how increase in strong heat will impact the mobility of exposed communities, and encouraging early consideration of the multiple migration management challenges and opportunities ahead of us; and (b) bringing the migration dimension to the attention of the scientific communities, such as climate change and health researchers, notably regarding the challenges faced by migrants and their communities confronted with the adverse impacts of climate change.

What is at stake?

Currently, the combined commitments of the 194 countries that signed the Paris Agreement adopted at the 2015 United Nations Climate Change Conference (COP21) (UNFCCC, n.d.) to reduce greenhouse gas emissions, as outlined in the submitted Intended Nationally Determined Contribution (INDC) and Nationally Determined Contribution (NDC), are projected to produce a global temperature change (GTC) of 2.6 to 3.1°C, way above the recommended 1.5°C increase. In that context, recent analysis (Kjellstrom et al., 2017) indicates that such an increase in temperatures will create a major threat to daily life and work for millions of people, especially in developing countries.

Increasing heat due to climate change can negatively impact individuals and communities in multiple ways. Excessive temperature inhibits daily life through the loss of capacity to carry out physical activities and labour productivity (Climate Vulnerable Forum, 2016). These risks can adversely affect the continuation of various activities, including work, in the hottest tropical and subtropical parts of the world where most of the global population lives (Kjellstrom et al., 2016).

In addition, increasing heat related to climate change is likely to result in more frequent droughts, wildfires, episodes of extreme temperatures and heat waves, affecting rural and urban communities like never before (Ionesco, Mokhnacheva and Gemenne, 2016); while temperatures in urban areas are already a few degrees hotter due to the "urban heat island effect" (Intergovernmental Panel on Climate Change (IPCC), 2007).

Finally, increasing heat is probably the most robustly estimated health-related exposure of climate change (Collins et al., 2013), as there is a physiological limit to the external heat exposure a person can survive (Parsons, 2014). In addition, heat stress adversely affects workers, especially those in manual occupations (Kjellstrom et al., 2016).

Which regions are most at risk?

Calculations below by Kjellstrom et al. allows to assess the risks of increasing heat on health. This analysis uses climate data for 67,420 grid cells (0.5 x 0.5 degrees) – that cover all land on earth – from two climate models (Warszawski et al., 2014),[1,2] representing the range of global estimates. This data allows the calculation of the Universal Thermal Climate Index (UTCI).[3] It is a heat index based on temperature, humidity, air movement and heat radiation, and considered the most advanced way to quantify heat exposures of relevance to human well-being (Havenith and Fiala, 2015).

1 HadGEM and GFDL data from the Potsdam Institute.

2 Downloaded grid cell data available from www.climateCHIP.org

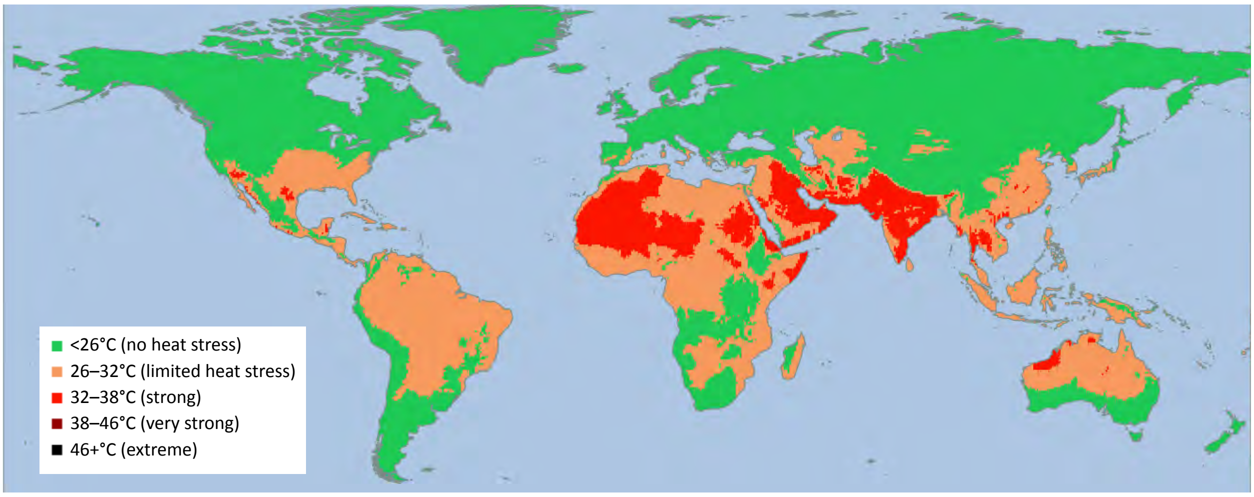
3 The Universal Thermal Climate Index (UTCI) is used for assessing the thermal environment of the human being (see www.utci.org).

On the UTCI scale of heat stress, “strong”, “very strong” and “extreme” are in the value ranges of 32–37°C, 38–45°C and 46+°C, respectively. In terms of common climate variables, for example, “very strong heat stress” corresponds to an air temperature of 36°C in the shade and a relative humidity level at 50 per cent. At this heat level, continuous physical work at moderate intensity (300 W) would lead to increasing the body temperature up to 39°C, and even to a deadly 40°C, within less than four hours (according to an established physiological model) (de Dear, n.d.). Thus, working in these conditions requires frequent rest breaks to protect health and adapt to the temperate increase (International Organization for Standardization, 1989); this however reduces hourly work output by approximately 30 per cent compared to cooler work conditions (Sahu, Sett and Kjellstrom, 2013).

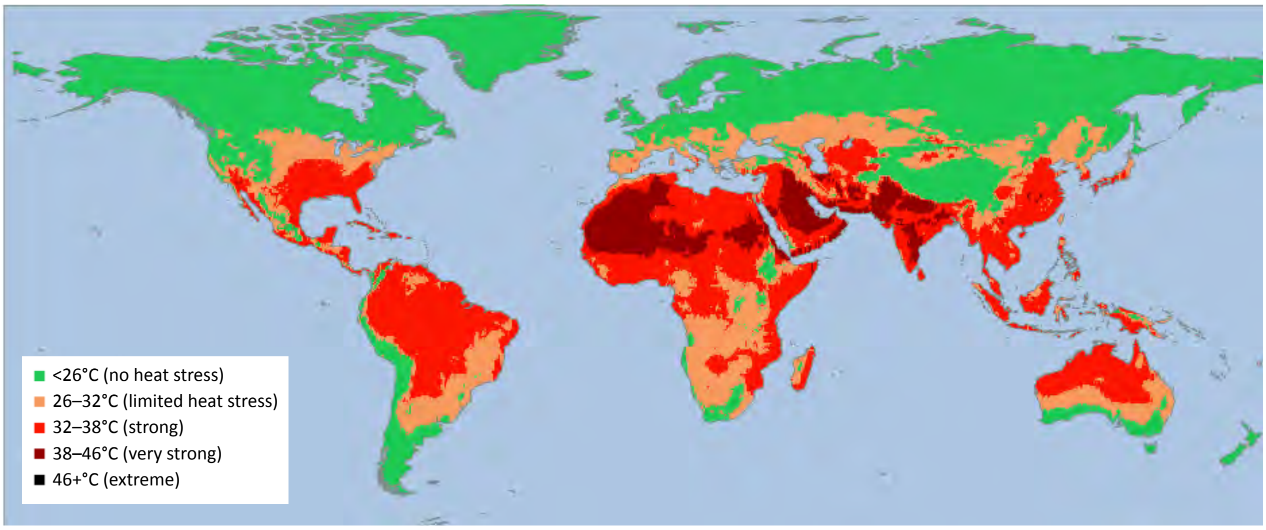
Maps 1 and 2 show the estimated mean UTCI levels in the shade during the hottest month in each grid cell, for a recent 30-year period and for the end of the twenty-first century.

Maps of UTCI monthly mean levels in the shade in 67,000 grid cells for the hottest month

Map 1: Climate Research Unit (CRU) baseline data for the period 1981–2010



Map 2: ISI-MIP data, HadGEM and GFDL model mid-points of Representative Concentration Pathways* 6.0 (increase of global mean temperature between 2.6 and 3.1 degrees) for 2071–2099



Note: Representative Concentration Pathways (RCP). There are four greenhouse gas concentration trajectories adopted by the IPCC for its Fifth Assessment Report (AR5) in 2014 describing four possible climate futures: RCP2.6, RCP4.5, RCP6.0 and RCP8.5. Relative to 1850–1900, global surface temperature change for the end of the twenty-first century (2081–2100) is projected to likely exceed 1.5°C for RCP4.5, RCP6.0 and RCP8.5 (high confidence). Warming is likely to exceed 2°C for RCP6.0 and RCP8.5 (high confidence), more likely than not to exceed 2°C for RCP4.5 (medium confidence), but unlikely to exceed 2°C for RCP2.6 (medium confidence) (See WGI SPM E.1, 12.4.1, Table 12.3, available from http://ar5-syr.ipcc.ch/topic_futurechanges.php)

Map 1 shows that many areas of Asia and Western Africa are already under “strong heat stress”. Map 2 shows that heat stress levels are predicted to increase from “strong heat stress” to “very strong heat stress” by the end of this century in the main affected areas of Asia and Western Africa. Furthermore, “strong heat stress” levels are expected to be reached in South-East United States, Central America and much of South America, sub-Saharan Africa, South-East Asia and the Pacific. The world’s warmest regions, including the tropics and subtropics, are most affected by rising temperatures due to pre-existing heat conditions, in comparison to more temperate regions.

The maps show monthly averages of daily mean heat levels in the shade. The hottest three days in the hottest month are often 3–4°C hotter, and the hottest part of each day (afternoon) is often 4–5°C hotter than the monthly mean UTCI (Kjellstrom et al., 2016). In addition, heat exposure in the sun during hot afternoons adds another 2–3°C to the heat stress index. **Thus, some areas with “very strong heat stress” on the second map (Map 2) are likely to have fatal “extreme heat” stress during the hottest days, making the place uninhabitable**. The UTCI limits for habitability or survivability have not been clearly established, and it is likely to vary within different populations; but occurrences of extreme heat episodes are likely to push people to migrate to escape unbearable heat levels (Mueller et al., 2014).

The table below used the Gridded Population of the World data set from Columbia University, New York (Socioeconomic Data and Applications Center, n.d.) to calculate the projected increase in the number of people exposed to heat stress levels that limits habitability for unprotected people.

Summary table: Projected number of people (in millions) in grid cell areas at different heat levels, GFDL/HadGEM midpoint, monthly averages for two 3-decade periods

(Range of estimates for the two climate models are in brackets)

<table>
<tr><th colspan="2">Period</th><th>1981–2010</th><th colspan="4">2071–2099</th></tr>
<tr><td colspan="2">GTC, °C</td><td>0.7</td><td>1.5</td><td>2.0</td><td>2.6–3.1</td><td>4.0</td></tr>
<tr><td colspan="2">RCP alternative</td><td>current</td><td>RCP2.6</td><td>RCP4.5</td><td>RCP6.0</td><td>RCP8.5</td></tr>
<tr><td colspan="2">Climate data source</td><td>CRU</td><td colspan="4">ISI-MIP, Potsdam Institute
(Warszawski et al., 2014)</td></tr>
<tr><td colspan="7">A = UTCI is a recent index designed to interpret heat stress risks for the general public
B = Heat stress category in the UTCI scale; VS = Very strong heat stress; E = extreme</td></tr>
<tr><th>A</th><th>B</th><th colspan="5">Million people in combined grid cells with heat at such high levels</th></tr>
<tr><td>> 38°C</td><td>VS</td><td>0.3</td><td>48
(31–65)</td><td>318
(104–534)</td><td>540
(377–703)</td><td>1,440
(1,139–1,740)</td></tr>
<tr><td>> 39°C</td><td>VS</td><td>0</td><td>16
(6.5–25)</td><td>133
(40–225)</td><td>225
(152–297)</td><td>1,104
(779–1,430)</td></tr>
<tr><td>> 40°C</td><td>VS</td><td>0</td><td>3.3
(0.7–5.9)</td><td>35
(8–63)</td><td>64
(28–101)</td><td>798
(523–1,073)</td></tr>
<tr><td>> 42°C</td><td>VS</td><td>0</td><td>0</td><td>2.3
(0–4.6)</td><td>12
(0–21)</td><td>251
(188–314)</td></tr>
<tr><td>> 44°C</td><td>VS</td><td>0</td><td>0</td><td>0.4
(0–0.8)</td><td>0.7
(0–1.4)</td><td>31
(16–45)</td></tr>
<tr><td>> 46°C</td><td>E</td><td>0</td><td>0</td><td>0</td><td>0.4
(0–0.8)</td><td>4.2
(2.2–6.2)</td></tr>
</table>

Notes: UTCI: Universal Thermal Climate Index is used for assessing the thermal environment of the human being.
CRU: Climate Research Unit, University of East Anglia, Norwich, United Kingdom
RCP: Representative Concentration Pathways. They are four greenhouse gas concentration trajectories adopted by the IPCC for its Fifth Assessment Report (AR5) in 2014, describing four possible climate futures for greenhouse gas emissions.

The table shows that recently, the number of people living in areas with UTCI at "very strong heat stress" level is relatively small (0.3 million people). Although the exact threshold for heat levels that would turn a habitable area into an uninhabitable area has not been established, it is reasonable to set a limit at the monthly mean UTCI of 39°C. If a UTCI of 39°C is reached, there will most likely be major impacts on populations affected by the end of this century:

- More than 1 billion people would live in areas with mean UTCI > 39°C in the hottest month by the end of this century if no climate change mitigation measures are implemented (GTC 4.0°C, RCP8.5). If the current policies outlined in INDCs and NDCs are implemented (GTC 2.6–3.1°C, RCP6.0), 225 million people will live in such hot areas. This figure would fall to 133 million people with a temperature increase of 2°C (RCP4.5) and to 16 million with the lowest GTC (1.5°C) proposed in the Paris Agreement (RCP2.6).
- This means that, even if the lowest possible temperature increase occurs, there would still be millions of people potentially unable to maintain themselves in their areas of origin. In that respect, it is important to anticipate and prepare to manage these potential migration flows.

Environmental change and migration

The link between environmental degradation, displacement and migration is widely debated. While we can surmise that there are biophysical limits to living under extreme heat, it is in the grey area of indirect effects that most climate-related migration occurs currently. Indeed, the indirect impacts of climate change on livelihood, and especially on subsistence agriculture, are critical and interwoven with many other factors to drive migration (Piguet, Pecoud and de Guchteneire, 2012).

Large-scale studies of the impacts of drought, for instance, suggest the relationship is highly contextual. State policies, inter-ethnic relations, farming practices, access to the means of migration and other factors may shape the impacts of drought. What is clear is that drought exacerbates existing social divisions and magnifies the effects of failures in State policy: "a link does exist between rain deficits and migration, but it remains highly contextual" (ibid., 11).

Similar insights have been drawn from the analysis of the civil conflict in drought-prone regions affected by climate change. The civil war in Darfur, in Sudan, often characterized as the "world's first climate conflict", was mainly a result of a national strategy that subsequently made the population especially vulnerable to drought (Verhoeven, 2011). Displacement was linked to civil conflict and inter-ethnic persecution that forced a wave of outmigration, defined under international conventions as a refugee crisis. A similar narrative emerges from studies of the Syrian conflict, where a prolonged drought led to internal displacement in the north of the country of about 1.5 million people, putting new pressure on the State and its social legitimacy (Gleick, 2014). The ensuing civil conflict was partly related to these internal displacements, and the conflict provoked a massive wave of refugee movements (Fröhlich, 2016). In these contexts, it can be difficult to separate the climate impacts from wider social and political factors in which they are embedded.

Climate change impacts linked to heat or drought do not always lead to displacement and migration. Case studies of drought or extreme heat episodes also reveal that little or no migration occur in some contexts, but the lack of mobility could also reflect the impossibility for the concerned population to escape.

The emphasis on the contextual nature of the link between migration and climate change is highlighted by Scheffran et al. (2012), in *Science*, who stress existing structures of vulnerability: "Many of the world's poorest people are exposed to various risks to life, health, and well-being. If climate change adds to these risks, it can increase humanitarian crises and aggravate existing conflicts without directly causing them" (2012:870). They further speculate about the consequences of a truly unprecedented rise in global temperatures that would overwhelm both ecological resilience and social coping structures, creating new "tipping points" towards social instability. Their call for further research into the social linkages and consequences that would be created by these kinds of heat shocks is relevant to the issues discussed in this paper: What social mechanisms come into play when the human habitat literally becomes biophysically unbearable?

What are the links between heat, climate change and migration?

Environmental change has always been a major driver of migration (International Organization for Migration (IOM), 2014). However, climate change predictions indicate that more people are expected to be on the move in the future as slow- and sudden-onset weather-related disasters become more frequent and intense (IPCC, 2001), severely impacting lives and livelihoods (IOM, 2014a).

One of the climatic drivers – seldom recognized as a root cause of migration due to lack of understanding of the issues at stake – is increasing heat stress in the habitat. In this context, climate migration might be the direct outcome of increasing heat exposure caused by climate change, as people move to minimize the effects of rising temperatures on their health and/or to compensate for reduced productivity in the workplace. A recent study from Australia, for example, shows that 11 per cent of citizens intend to move away from their current place or residence because they feel heat stressed (Zander, Surjan and Garnett, 2016). People might also be forced to, or decide to migrate due to the indirect consequences of increasing heat levels, notably those related to food and water insecurity, land degradation and drought, and the associated loss of livelihoods.

Who are the environmental migrants?

Environmental migrants are defined as "persons or groups of persons who, predominantly for reasons of sudden or progressive change in the environment that adversely affects their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move either within their country or abroad" (IOM, 2014b). The working definition of IOM encompasses both forced and voluntary, short- and long-term and internal and international movements; and highlights that both slow and sudden environmental events can lead to migration.

Climate change, as a global environmental change, was formally recognized as an underlying factor of migration in the UNFCCC Paris Agreement with the inclusion of "migrants" in the Preamble and in the Decision on Loss and Damage (IOM, 2016), and in the New York Declaration for Refugees and Migrants (Ionesco and Mach, 2016). The terminology of climate migration, a subsection of environmental migration, is used as an advocacy definition (Chazalnoël and Ionesco, 2016).

Extreme heat stress limits possibilities of in situ adaptation due to its physiological implications on the human body. Such changes in habitability, especially in the long term, are likely to have significant implications on migration, with more frequent and prolonged extreme high temperatures episodes predicted to drive people to move internally or internationally as a way to adapt to loss of habitat and change in the thermal environment.

While sudden-onset disasters often result in internal and temporary migration, research has showed that people tend to move for a prolonged period of time when impacted by slow environmental change (Mueller et al., 2014). Global temperature rise is classified as a climatic environmental change and a slow-onset process as it can lead to more frequent extreme temperature occurrences and an increased annual temperature mean. In response to such environmental change driven by climate change, people adopt various mobility patterns, from temporary migration for a few weeks or months, to longer-term seasonal migration each year and permanent outmigration.[4]

When analysing heat-related population movements in a historic perspective, it can be noted that urban to rural amenity migration has often been linked to efforts to minimize the health effects of heat during times of hot temperatures; while rural to urban migration flows can be observed when people move to cities to find help and access basic services during protracted heat-related environmental stress. The former type of movement has been observed in countries that develop recreational areas specifically designed to host tourists from nearby cities seeking to escape sweltering heat – as seen historically in the development of hill stations in India. The latter type of migration is observed in countries where drought is recurrent, such as Bangladesh, Ethiopia (Gray and Mueller, 2012), Ghana, Mali and Mexico (Ionesco, Mokhnacheva and Gemenne, 2016), and generally in agriculturally dependent areas where high temperatures damage crops and livestock to such an extent that people can no longer make a living from them (Mueller et al., 2014).

However, it is important to remember that, in most instances of climate migration, the decision to migrate stems from more than a change in climate alone. Reasons for migration are diverse and interweaved with economic, social and security drivers, as people might choose to migrate in search of better economic opportunities, for family and educational reasons or to escape conflicts. Climate change and heat stress can mediate these drivers – providing an additional reason for people to consider migration – but they are rarely the only cause for migration (Bardsley and Hugo, 2010; Black et al., 2011; Zander, Surjan and Garnett, 2016); and it is difficult to determine whether these movements are forced or voluntary (Chazalnoel, 2016). Yet, in the case of heat-related migration, thermal conditions might make it physiologically impossible to stay in some places if people lack the necessary resources (such as access to air cooling systems) to adapt to the changing environment or if these resources prove to be inappropriate to extreme conditions.

[4] In a 21-year longitudinal survey conducted in rural Pakistan, heat stress was identified as the most serious driver of long-term migration (V. Mueller, C. Gray and Kosec, 2014).

How can these challenges be addressed?

Innovative partnerships

Climate change is now recognized as one of the main drivers of migration (Cancun Adaptation Framework 2010; Doha and Warsaw Programme on Loss and Damage 2012, 2013; Paris Climate Agreement 2015) across the globe, and increasing global temperatures are the most visible impact of climate change. Currently, there is a substantial lack of data on the interdisciplinary field of heat exposure and migration. Further research should be developed across sectors, involving migration specialists, climate scientists, geographers, physiologists, occupational and environmental health specialists, epidemiologists, heat control engineers, sociologists and economists. In that regard, the emerging collaboration between selected research institutions and IOM aims to contribute to the research base and tackle the paucity of hard data.

Country-specific research to identify hotspots

More in-depth country-level analysis is needed to identify geographical hotspots and the most vulnerable communities, in order to provide evidence for policy development for the protection of heat-exposed people, including current and potential migrants. Such mapping research is crucial to support informed and proactive policymaking in the areas of risk management and adaptation, and for targeted adaptation financing. Research also helps to identify and consider the needs of exposed communities in order to better plan and manage inevitable migration flows.

Proactive adaptation policies promoting migration as an adaptation option to climate impacts

Populations at risk of increasing heat exposure, or living in areas potentially becoming uninhabitable, must have the choice to move if thermal conditions threaten their basic human rights to life and health. The decision and the ability to migrate are intrinsically linked to pre-existing vulnerabilities, as many individuals do not have the financial and social means to plan for and act upon their migration aspirations in the face of environmental change. In some cases, people may be reluctant to leave because of uncertain prospects elsewhere, or because leaving would result in losses of land and assets. Thus, they may choose to stay in areas at risk of increasing temperatures, exposing themselves to even greater health danger (Ionesco and Chazalnoel, 2015).

Under certain conditions, facilitating migration as a proactive adaptation measure would reduce the exposure of individuals to extreme heat impacts while providing host areas with some of the benefits of migration, such as filling labour gaps. Migration management solutions might take many forms, from seasonal migration schemes and permanent relocation to financing adaptation measures through diaspora investments. Therefore, effective and concrete action in support of affected individuals, communities and States is possible. For these reasons, it is critical to better understand the extreme heat-migration nexus in order to respond to current migration flows and anticipate future movements.

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