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Perspective

Integrating a Disaster Displacement Dimension in Climate Change Attribution

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Abstract: Populations around the world have already experienced the increasing severity of extreme weather causing disaster displacement. Anthropogenic climate change can intensify these impacts. Extreme event attribution studies center around the question of whether impactful extreme events could have occurred in a pre-industrial climate. Here, we argue that the next step for attribution science is to focus on those most vulnerable populations to future extremes and impacts from climate change. Up until now, the vulnerability dimension has not been systematically addressed in attribution studies, yet it would add urgently needed context, given the vast differences in adaptive capacity. We propose three integrative points to cascade disaster displacement linked to anthropogenic climate change.

Keywords: attribution science; displacement; climate change

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1. Introduction

In different regions of the world, the impacts of climate change have already affected human mobility patterns, including migration and displacement due to weather and climate related events (disaster displacement), as stated with "high confidence" in the latest IPCC WGII report [1], chapters 7, 8, 10, and 16 (Figure 1).

Earlier academic and public debates typically framed climate-related human migration as a security threat [2], where the influx of "climate refugees" threatens international peace and security. However, this discourse has met a lot of criticism for the risk of dehumanizing affected populations and legitimizing military approaches [3–5]. Since the 2000s, science and policy discussions around the topic of climate migration have become more cautious about such alarmist narratives, toward a more positive spin: migration can serve as an effective strategy to environmental change, depending on the socio-economic and political context [6,7]. However, Vinke et al. [8] emphasize that migration is not always a successful strategy for everyone. The accounts of migration due to climatic pressure tend to fall on a continuum from migration as a proactive form of adaptation, to migration as a failed strategy having resulted in disaster displacement from weather and climate-related events, involuntary immobility, and cascading impacts such as higher levels of vulnerability and exposure to future extreme weather events [9,10].

At the same time, the development of large ensembles of comparable high-resolution climate models has made it possible to not only assess large scale climate change, but also to investigate changing hazards on spatial scales more relevant for decision making in the past decade. Although providing the necessary data, these climate model ensembles have not been used to assess changing hazards in a comprehensive way; however, the methodologies developed within the context of extreme event attribution (EEA) now provide a range of approaches that will allow for such a systematic assessment. Key methods combining models and observational data to estimate the change in risk linked to anthropogenic factors have also been developed. Today, attribution science is routinely used to assess how anthropogenic climate change has altered the frequency and intensity of extreme weather events, going back to the pioneering approach by Allen [11,12]. Among those routine assessments is the rapid attribution framework popularized by the World Weather Attribution team (WWA) and their peer-reviewed methodology [13,14]. Most of these attribution studies show that global warming is an important driver of extreme events ranging from flooding, heatwaves, and droughts, to wildfires [15–17].

However, few studies go beyond physical attribution due to the complexity of a fully-fledged top-down attribution analysis [18,19]. One notable example is Schaller et al. [20], who investigate the attributable flood damage to property in the UK. They find that anthropogenic climate change contributed to £24 million of potential additional losses during the intense floods across Southern England in the 2013/14 winter. Other impact studies on the socio-economic dimension of climate change impacts have been conducted [21,22], including Frame et al. [23], who used a linear damage function and employed the value of a statistical life to attribute indirect damages such as mortality due to Hurricane Harvey. Mitchell et al. [24] is arguably one of the best examples to date on how to attribute excess mortality during a heat wave in a systematic and reproducible way. Given that excess mortality data are now widely available, their method could be used as a carbon copy for further attribution studies, including rapid assessments such as those carried out by WWA.

Given the notable acceleration of climate change and its impacts associated with rising numbers of extreme weather events across the globe, there is also increasing recognition in both academia and disaster risk reduction (DRR) practice that exposure and vulnerability are key determinants of hazards becoming disasters [25–28]. This discourse has been gaining ground in the policy realm, e.g., through the #nonaturaldisasters campaign [29]. Here, we outline integrative points within EEA studies to include vulnerability and exposure dimensions in determining population displacement risk related to extreme weather events.

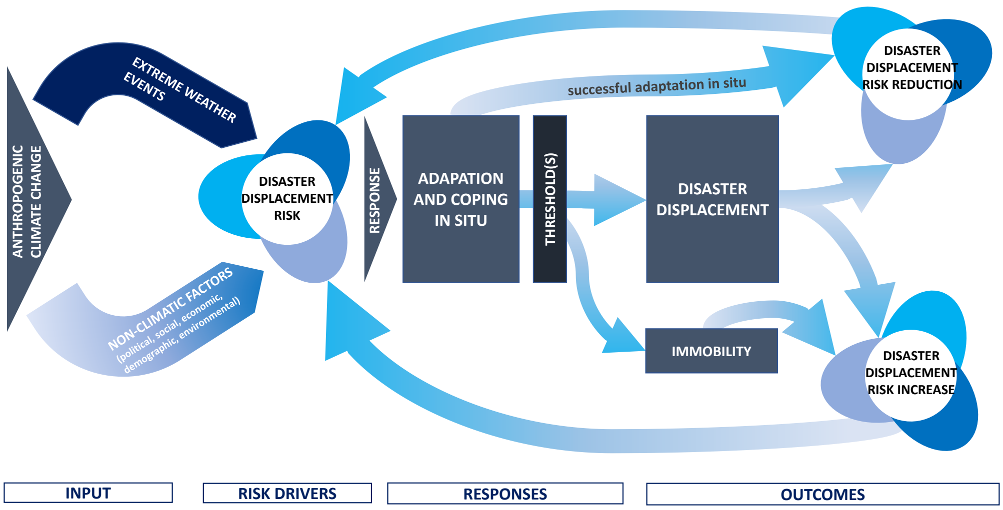

Figure 1. Conceptual framing to integrate extreme event attribution in climate mobility scholarship with the aim to understand disaster displacement outcomes, adapted from IPCC Working Group II, Chapter 7, p. 1081 [1] and McLeman et al. [10]. The propeller-shaped items refer to climatic hazards; the exposure of people, resources, and systems to such hazards; and the vulnerability of those people, resources, and systems to those hazards. These are created by climatic and non-climatic drivers and influenced by anthropogenic climate change that together create disaster displacement risk drivers. If thresholds of adaptation and coping reach a limit, people may be displaced or immobile. Both outcomes affect risk, either proactive displacement decreasing risk or forced displacement increasing risk.

2. Background

2.1. The Attribution of Disaster Displacement

Disaster risk is a combination of hazard, exposure, and vulnerability (and coping capacity) of an individual or a community [1]. Though EEA studies traditionally focus on the "hazard" side of the equation, some attribution studies are beginning to acknowledge the importance of untangling the vulnerability and exposure contexts which turn hazards into disasters or provide resilience to withstand the shock.

For example, the rapid attribution framework applied by the WWA group [13,14] includes a special section on vulnerability and exposure (V&E). Though it has not been incorporated in their framework yet, their special section helps telling a story of each extreme event, including an explainer of the potential impacts. The Red Cross Red Crescent Climate Centre, an international reference center to the Red Cross Red Crescent humanitarian movement, is a core member of the WWA group and has spearheaded the inclusion of V&E analysis in WWA studies from its inception in 2014. Thereby, WWA research demonstrates the importance of cross-disciplinary partnerships to advance science that informs society. The attribution results of the 2019–2021 drought in Madagascar showed that the very high levels of vulnerability in the Southern region of the country played a significant role in turning moderately average rainfall seasons into the severe food insecurity situation that ensued (Harrington et al., 2021), which is one recent example of the enhanced societal focus reflected in WWA's efforts. A similar WWA study about the 2022 India–Pakistan heatwave—made thirty times more likely by climate change—showed that certain groups were considerably more vulnerable to heatwaves than others. The study also highlighted that exposure reduction policies such as planning and warnings may have decreased the impacts on populations.

What these EEA studies are still lacking though is a systematic assessment of the differential and structural vulnerabilities, with a specific focus on exploring what makes certain people more impacted than others by the same weather event, and the root causes of these realities. This is particularly important when speaking about climate mobility and the extent to which climate change made, or is making, people more or less likely to move (see Figure 1). For instance, disaster displacement has been an associated impact of the recent cyclone that affected vulnerable communities in Mozambique, Madagascar and Malawi [30], and Eastern South Africa [31]. Despite progress on disentangling drivers involved in mobility decisions [32,33], the effects of climate on mobility are notoriously difficult to tease out, and the quantitative attribution of human mobility patterns to climate change remains elusive [34,35]. WWA's work on vulnerability and exposure is primarily based on literature and expert interviews. Quantifying the fractional contribution from anthropogenic climate change can contribute to a better understanding of adaptation option for people on the move, including migrants, internally displaced populations, and refugees.

2.2. The Anthropogenic Fraction of Disaster Displacement Risk

Estimates indicate that in 2021 alone, about 24 million people were displaced due to extreme weather events [36]. The impacts of a changing climate on human (im)mobility will intensify with future warming [32,34,37–39]. Without any concrete climate (i.e., RCP8.5 scenario) and development action, up to 216 million people could be forced to move internally by 2050 due to advancing climate change [40]. This trend has profound implications for regions that are already affected by recurrent extreme weather such as East Africa. The region, for instance, is not only one of the most vulnerable regions to climate variability and the impacts from weather and climate-related hazards [41,42], but it is also characterized by a traditionally mobile population. Human mobility, especially economic migration and pastoralism, is part of many livelihoods across this region, with populations in Kenya, Ethiopia, and Somalia heavily relying on rain-fed agriculture and water for pastoralism [43,44]. In recent years, recurring floods and prolonged droughts have led to social and economic disruptions, notably exacerbating food insecurity conditions [45,46]. However, in other regions, such as the African Sahel, some argue that conflict, not climate, is the major driver of migration [47].

Several drought attribution studies have assessed whether and to what extent human-induced climate change played a role in the hazards. So far, the evidence landscape remains mixed. The results for drought can vary from region to region: for the 2011 East Africa drought, Lott et al. [48] found a contribution of anthropogenic climate change to the increase in probability of dry or drier weather. In contrast, no human-induced influence was found for a 2014 drought in the Horn of Africa (HOA) region [49]. In this context, the United Nations High Commissioner for Refugees (UNHCR) estimates that over 8 million people have been internally displaced in the HOA region [50]. The IPCC indicates that the long rains (March–May) have experienced a long-term drying trend in recent decades, whereas the short rains (October–December) have shown a wetting trend [51]. Projections for the short rains indicate a longer rainy season and increased rainfall, whereas those for the long rains are more uncertain, with some studies projecting a wetting trend, but others indicating no change. The disconnect between the recent drying trend in the long rains and some long-term projections that indicate a trend towards wetter conditions is coined the "East African rainfall paradox" and contributes to increased uncertainty for long-term planning in the region [52,53].

Until we are able to close this knowledge gap, uncertainty remains as far as pinpointing the scale of climate change induced extreme weather, and, in turn, contributions to humanitarian disasters are concerned. It is also a key reason why EEA studies are often inconclusive regarding attributable links between pre-existing vulnerability and the impacts of anthropogenic climate change [13]: political dimensions, including conflict and violence, as well as economic factors and environmental change, which are well-known drivers of migration in the region [54,55]. The fact that recurrent conflict, internal displacement, and political instability in some East African countries is a complex situation of overlapping calamities in its own right [56], calls for a better understanding of the physical changes of the climate as a crucial first step to reduce vulnerability. As far as rainfall changes are concerned, climate models with higher spatial resolution are indispensable. With their aid, alongside a more focused investigation of the impacts of secondary anthropogenic climate drivers (such as aerosol pollution), the monsoon behavior will eventually be better understood, including the drying and wetting trends in already vulnerable regions.

3. Toward a Human-Centered Impact Focus of Attribution Science

The existing EEA framework offers a window to include mechanistic processes of human responses and compare changes in extreme weather and subsequent disaster displacement between two scenarios. These two scenarios can differ either in the climate or in the risk profiles of those exposed to disaster displacement. Integrating attribution for disaster displacement provides information relevant to present mobility decisions and disaster displacement risk, including vulnerability and exposure. We must put emphasis on three integrative points to close the gap between disaster displacement and anthropogenic climate change and thereby better understand implications for climate and migration policies.

3.1. Understanding Migration Tipping Points

Interdisciplinary research efforts have found that extreme weather events, especially recurring ones, can tip over voluntary migration to forced displacement [33,38]. Other studies have shown that with continued warming, using migration as adaptation to the changing climatic conditions will become increasingly difficult, with some regions potentially reaching inhabitable conditions in the future [39,57–59]. This may create a tipping point for human mobility, potentially leading to large-scale migration and displacement, as people will be increasingly forced to move out from those heavily affected regions if in situ adaptation is no longer possible [10]. Such information can be helpful to define the societal and human impact and disaster displacement risk early on in the event definition of an attribution study. Already, EEA studies refer to socioeconomic impacts such as destroyed or damaged houses in the event definition [31,60]. Event definition is a critical part of the EEA process, as it determines the specific question that is answered, and ensuring it reflects critical questions that can inform adaptation decision-making after the event or improve understanding of social responses such as migration can also make EEA studies more useful for decision-makers in the long-term. A next step would be to use estimates on destroyed and damaged buildings and facilities as a proxy for disaster displacement to select and define the extreme event.

3.2. Quantifying Climate Change Signals in Disaster Displacement

Collaboration between humanitarian actors, policy makers, and attribution researchers is needed to resolve climate change statements regarding extreme weather-related displacement. IPCC WGII [34] highlights the urgency to address the risk associated with displacement. No research to date has disaggregated the risk value to specific migration events, corroborating the quantitative attribution of mobility patterns including disaster displacement to anthropogenic climate change [1,35]. For instance, recent evidence confirms that populations in poorer countries are disproportionately exposed to and affected by the impacts of floods in urban areas [61]. The authors find that across 3000 flood events, the risk for urban disruption increases, in part through migration of displaced populations into large cities. A next step could be to attribute these impacts to climate change by establishing displacement counterfactuals.

In addition, counterfactual scenarios focusing on human components including adaptation could help to determine which options are effective in reducing extreme weather impacts in different geographies, climates, and communities [62]. Including a mobility dimension could also help to better understand feasible policy options minimizing the risk of disaster displacement and social inequalities in these settings.

Next, mechanistic approaches can give insight into vulnerability and exposure of populations in a factual world (the world with climate change) and a counterfactual world (without climate change). In a factual world, the number of vulnerable people can be estimated by dividing the number of observed displacements by the number of affected people. Multiplying these results with the number of affected people in a world without climate change would lead to an estimation for displacement in the absence of climate change. For example, in an impact attribution study of Hurricane Harvey, Frame et al. [23] estimate the direct damage caused by the tropical cyclone with a linear damage function. The authors use the value of a statistical life to attribute indirect damages such as mortality to the event. Expanding the damages function with displacement data would allow the understanding of the risk of displacement and economic costs of displacement, as well as the human damage caused by an extreme event. These authors used a modular attribution approach to attribute if and to what extent impacts of the increasing flood hazard link to pre-existing social inequalities [22]. However, there are limitations to approaches that use multiple sets of assumptions to quantify displacement. For example, such an approach may over-attribute displacement to the event, especially if it is temporary or may overemphasize the climate change component in cases where other factors such as socioeconomics and conflict play a role. This highlights the need to contextualize such analyses.

Another approach are storyline-tool methods of creating and discussing plausible scenarios or narratives of climate change scenarios and societal impacts [63,64]. These are often more qualitative, case-study, narrative approaches than traditional attribution studies, emphasizing the drivers involved, causal links, and their plausibility, including analyses of responses to past events [65]. As one integrated module, storylines provide opportunities to discuss vulnerability and exposure drivers of disasters and the complexity of human mobility in impact attribution studies.

3.3. Identifying Anticipatory Action Approaches to Minimize Disaster Displacement Risks

Though migration could be considered a form of adaptation strategy, few communities are prepared to deal with the cascading risks of extreme weather. There is a lack of appropriate measures to minimize the risk of displacement in the first place. To circumvent the issue, anticipatory humanitarian action would be required to address the hazards before they turn into disasters. This is particularly relevant in light of the future warming scenarios (1.5 °C and 2 °C) and their impacts in vulnerable regions [66,67]. It is essential to shift from solely a reactive (ex-post response) approach to making use of anticipatory (ex-ante) approaches [68]. Anticipatory interventions (e.g., forecast-based financing, forecast-based contingency planning) are increasingly acknowledged in the climate, development, and humanitarian communities [69–71]. Forecast-based financing (FbF) is one anticipatory mechanism which can help ensure disaster displacement risk is kept at a minimum and adverse impacts from extreme weather on displaced populations minimized [72]. For example, in Mongolia, where farmers face impacts from recurring severe winters (also called dzud), FbF mechanisms are designed to reduce impacts through active measures that protect livestock such as the distribution of nutrition kits. In addition, unconditional cash transfers are provided for vulnerable people to give them freedom in prioritizing items needed to survive harsh conditions or continue to be able to make a living where they currently reside. Scientifically guided contingency planning for relocation would be another mechanism to cope with the additional stress and/or conflict during extreme events. However, at the same time, the small window of opportunity between the issue of extreme weather forecasts and natural hazards materializing should be used. Actors currently working on anticipatory action approaches require a measure of forecast skill or uncertainty, adequately set thresholds for action, proper monitoring and communication channels, and robust and actionable plans of action. On the question of displacement, many gaps remain, including questions about early action effectiveness for displacement, an assessment of the risk that early actions may support maladaptation, and long-term visions linking early actions with longer-term adaptation. At longer-time scales, the use of climate projections and quantifications of the climate–displacement nexus will be key to protecting the most vulnerable communities and people [72].

Much work remains to be done in understanding attributable links between climate-related human mobility and anthropogenic climate change. This paper highlighted the need to develop a new framework to estimate climate risks on the scale that impacts are happening, and decisions being made, providing essential information to actors on the ground. A number of concrete action items are provided, such as the counterfactual simulations with a dedicated human mobility dimension. Such a framework will help extend existing climate-driven research from examining hazards (based on meteorological observations and climate modelling) to incorporating data (quantitative and qualitative) about climate-related human mobility (e.g., population and income statistics, government indices), thereby identifying high-risk hazards and compounding vulnerabilities.

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