Assessing vulnerabilities to disaster displacement

A good practice review

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- Supporting public planning processes in delivering climate-resilient development outcomes for the poorest
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UNDRR is the United Nations focal point for disaster risk reduction. UNDRR oversees the implementation of the Sendai Framework for Disaster Risk Reduction 2015–2030, supporting countries in its implementation, monitoring and sharing what works in reducing existing risk and preventing the creation of new risk. The United Nations Office for Disaster Risk Reduction Regional Office for Africa (UNDRR-Africa) based in Nairobi, Kenya coordinates DRR initiatives in support of 44 member states in sub-Saharan Africa. UNDRR-Africa has a solid partnership with the African Union Commission, five Regional Economic Communities (RECs) regional UN entities and other development partners. It also engages stakeholders such as science and technology consortia, youth representatives, media, and civil society members and groups.

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Climate-related disasters put millions of people at risk of displacement. To effectively plan and deliver disaster risk reduction and response plans in contexts at risk of disaster displacement, governments and humanitarian agencies require good quality assessments of displacement risk. Social vulnerability is a key displacement risk factor that needs to be well integrated into assessment tools. In this good practice review, the International Institute for Environment and Development takes stock of how social vulnerability is integrated into displacement risk assessments. Finding that prominent risk assessment methodologies offer a limited account of social vulnerability, we propose a series of practical solutions.

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Summary

Predictive models have great potential for forecasting population displacements from climatic and other disasters. But disaster displacement risk assessment approaches often use probabilistic models and big data analysis to make global-level predictions, which have limited utility for planning and delivering local interventions that address vulnerable people's specific needs. This paper reviews current practice for analysing and assessing disaster displacement risks and presents recommendations on how to effectively integrate a detailed vulnerability analysis to improve operational decision making.

Context

As global heating increases, disasters become more frequent and intense, with devastating consequences for vulnerable households and communities, especially in the poorest countries. In the past decade, human-induced or weather-related disasters have displaced hundreds of millions of people. This number will only increase as the frequency and intensity of disasters escalate.

The United Nations Office for Disaster Risk Reduction (UNDRR) works to reduce disaster losses and stop underlying risks impacting people, households, communities and service provision. In the Horn of Africa, it supports governments to strengthen disaster risk reduction (DRR) management systems, catalyse investment and integrate risk information into decision making; it also helps DRR stakeholders develop robust and accurate disaster displacement risk assessments to improve preventative action and rapid response.

The UNDRR's 2019 guidelines for reducing risk, addressing impacts and strengthening resilience in disaster displacement emphasise the need to prioritise social vulnerability data and analysis. Stakeholder consultations in the Horn of Africa in 2021 revealed nuance around displacement risk assessment generation and use in policy and operational decision making, focusing on the need to improve effective targeting of vulnerable groups by integrating robust and locally specific data on vulnerability, resilience, adaptive capacity and coping strategies into displacement risk assessments.

Approach and objectives

Building on this work, this good practice review aims to:

1. Review the tools and methods DRR stakeholders use to assess displacement risk and analyse the extent to which they integrate granular data on vulnerability, resilience and adaptive capacity;
2. Describe tools, approaches, methodologies and databases used by the climate risk management (CRM) community of practice that capture robust data on vulnerability, resilience and adaptive capacity; and
3. Recommend how DRR stakeholders can better integrate vulnerability and resilience into disaster displacement risk assessments and decision making.

Focusing on probabilistic modelling approaches, big data approaches, system dynamics models, risk indices and agent-based models in the Horn of Africa, we analyse whether, to what extent and how they integrate social vulnerability and resilience data. We describe each approach, outline its principal objectives and discuss its strengths and weaknesses in terms of accuracy and usability.

Findings

Despite significant demand among DRR stakeholders for more informative operational knowledge products, most of these approaches are designed to predict only the number of people likely to become displaced as a result of a particular type of disaster event. They do not generate robust disaggregated data on variegated levels of disaster displacement risk in particular locations, so are of limited use for designing and delivering programmes or interventions that meet vulnerable people's specific needs.

Only three of the five main categories of displacement model can predict the number of people likely to be displaced by a future disaster. Probabilistic models — the most widely used — rely on a single indicator of structural damage to capture all dimensions of social vulnerability. This parsimony in vulnerability indicator selection and use, the significant overlap between drivers of displacement and social vulnerability, and the reductionist framing of displacement risk to certain types of hazard — such as floods, tropical storms and storm surges — limit the accuracy of these models, reducing their utility for planning variegated responses.

Other tools integrate more complex vulnerability data, but have limited utility for operational decision makers at subnational and local levels. For example, risk indices use aggregated vulnerability data to understand displacement patterns, and usually offer national- or regional-level outputs, making them unsuitable for local-level use. None of the tools integrate data on resilience and adaptive capacity into assessments.

Over the past decade, the climate adaptation and CRM communities have generated significant learning on how to assess resilience and adaptive capacities at household and community levels. The DRR community could apply this learning to integrate more robust, fine-grained data on vulnerability, resilience and adaptive capacity into their own tools. But doing so will not be straightforward, particularly for the probabilistic models favoured by the DRR community. Further research is therefore needed to understand how to integrate different forms of quantitative and qualitative data, generated at different scales and with different levels of detail, to create more accurate, user-friendly, vulnerability-informed displacement risk assessments for subnational and local operational decision makers.

Recommendations

Integrating more robust, fine-grained data on household, community and social group vulnerabilities and resilience into probabilistic methods for assessing disaster displacement risks in areas with high levels of hazard exposure would:

- Greatly increase the utility of assessment tools for supporting operational decision making, particularly at subnational and local levels
- Produce more accurate displacement risk assessments
- Improve project and programme quality by enabling intervention designs tailored to vulnerable people's specific risks and requirements, and
- Contribute to more effective resource use for DRR activities and disaster responses, lower disaster impacts and a concomitant reduction in the cost of disaster response delivery.

DRR stakeholders working on predictive models should develop the next generation of probabilistic models that provide outputs with granular predictions on the potential impact of disaster events for groups of people based on their socioeconomic vulnerability characteristics. To integrate data on resilience and adaptive capacity, they should collaborate more closely with operational end users — especially subnational and local users — and CRM community experts.

To provide more useful data and outputs for operational decision makers, DRR stakeholders should shift their focus from global or national displacement risk models towards subnational and local models that inform programming in high-risk localities. They should also develop outputs to address disaster displacement risks over different time horizons. A better understanding of vulnerability, resilience and adaptive capacity and how they might change over time under varied conditions could help DRR stakeholders make more accurate displacement risk assessments and develop more appropriate short-, medium- and long-term risk reduction plans.

Finally, we recommend further research to understand how to integrate different forms of quantitative and qualitative data — generated at different scales and with different levels of detail — into vulnerability-informed displacement risk assessments, to increase both their accuracy and utility for subnational and local operational decision makers.

1

Introduction

Climate change-related disasters pose a serious risk to billions of people across developed and developing countries (IFRC, 2020). From heatwaves and wildfires to tropical storms, flash flooding and catastrophic droughts, communities and ecosystems around the world are already suffering from extreme weather events that are more frequent and more intense than anything they have experienced in the past (WMO, 2021). In the past decade, climate- and weather-related disasters have affected an estimated 1.7 billion people and killed more than 410,000, mostly in low- and lower-middle-income countries (IFRC, 2020).

Driven by climate change, the frequency and intensity of these shocks will only worsen as global heating increases, exposing billions to the risk of loss of life, land, homes, income, opportunity, cultural identity, infrastructure, ecosystems, essential services and sustainable development (IPCC, 2018, 2021; Eckstein et al., 2021). These impacts are most devastating for the poorest and most vulnerable, especially in the least developed countries (LDCs) and small island developing states (SIDS) (UNDESA, 2016; IPCC, 2018). While they have done the least to cause climate change, these countries and communities are more exposed to climate impacts and have the lowest levels of capacity to cope and adapt.

When affected by climate shocks, poor households and communities often find it difficult to recover, let alone 'bounce back better'. Disasters can precipitate a cascade of negative consequences that undermine their ability to build resilience or achieve sustainable development, especially in the absence of safety net support. Lives may be lost, assets and shelters destroyed, livelihoods damaged and access to services cut, all of which can contribute to the deepening of poverty and vulnerability. As climate shocks become more frequent, vulnerable people may be impacted by recurrent disasters that cause significant levels of loss and damage, eroding their ability to maintain livelihoods and forcing them to move in search of support or new opportunities.

Over the last 20 years, the scale of displacement caused by climate-related disasters has escalated dramatically. It is estimated that over 283 million people were displaced by weather-related disasters around the globe between 2008 and 2020 (IFRC, 2020). In 2020 alone over 30 million people were displaced by weather-related disasters, primarily in Asia, Africa and Central America (IDMC, 2021). The vast majority of these displacements (86.4%) were the result of flooding and storms, and only around 2% of other weather-related hazards such as landslides, droughts and wildfires. By 2050, more than 2 billion people are projected to be at risk of climate related disasters every year, with over 200 million in need of humanitarian assistance (IFRC, 2019).

Disaster displacement can seriously impact affected households, communities and countries. Not only does it disrupt the lives and livelihoods of displaced and host communities; once displaced, people can become trapped in situations of protracted displacement as they lack either access to the resources they need to rebuild their lives in their places of origin or to the opportunities they need to integrate in their new locations (IDMC, 2021). Displacement also places significant burdens on host communities, governments and civil society organisations, as they struggle to cope with displaced people's specific support, protection and long-term assistance needs.

Displaced populations are highly diverse and have varied needs, depending on their characteristics and the context in which they are displaced. Although women, men, children, young, elderly and disabled people all have specific and differentiated needs, duty bearers do not always take those differences into account, increasing displaced people's suffering and heightening their vulnerability. Women, children and elderly and disabled people are often excluded from decision making and are thus denied the opportunity to share their needs and preferences with the people planning and implementing support programmes.

Recent evidence indicates that displaced people may not be most vulnerable to climate impacts. In highly exposed countries like Bangladesh, many vulnerable people are unable to move when disaster strikes (Black et al., 2013; Ayeb-Karlsson, 2020; Cundill et al., 2021). They may lack the resources to move, have no contacts outside their home area, have limited knowledge of where they can access support, or face mobility obstacles due to age, physical ability or cultural associations with their home area. Disaster impact assessments often overlook such immobile populations, focusing instead on mobile people, who sometimes have more resources and resilience than those they leave behind.

Understanding how communities and households may be vulnerable to and from disaster displacement is vital for programmes and projects to minimise disaster displacement risks or respond to displacement crises effectively. This report presents the results of a review of current practice in the humanitarian and disaster risk reduction (DRR) sectors for analysing and assessing disaster displacement risks. It seeks to understand the extent to which existing tools and approaches take differentiated vulnerabilities into account and identifies ways in which we can better understand vulnerability to disaster displacement at the micro and meso levels. We hope this analysis will support agencies and governments to tackle disaster displacement risks more effectively by integrating vulnerability analysis into their protocols and designing and delivering interventions that consider exposed populations' specific and varied vulnerabilities.

1.1 Tackling disaster displacement

Due to the pace at which weather-related disaster risks are increasing from climate change, governments and agencies must make concerted efforts to reduce the risks to vulnerable people from extreme weather events now and in the future. The Sendai Framework on Disaster Risk Reduction guides global efforts to adopt measures that reduce disaster risk, including specific efforts to "prevent displacement attributed to disasters and reduce displacement risk, address the protection needs of displaced people and promote durable solutions to displacement" (UNDRR, 2019).

The Sendai Framework (United Nations, 2015) has four strategic priorities that guide DRR responses:

- Priority 1: Improving the understanding of disaster risk
- Priority 2: Strengthening disaster risk governance to manage disaster risk
- Priority 3: Investing in DRR for resilience
- Priority 4: Enhancing disaster preparedness for effective response and to 'build back better' in recovery, rehabilitation and reconstruction.

Strategic Priority 1 is particularly important, since an improved understanding of disaster risk underpins the other three priorities: strengthening DRR governance, investing in DRR to build resilience and enhancing disaster preparedness and response efforts.

The UNDRR's guidelines for reducing risk, addressing impacts and strengthening resilience (UNDRR, 2019) emphasise that data and analysis of the different dimensions and dynamic nature of vulnerability should be a priority when assessing various aspects associated with displacement. One of the biggest gaps in current understanding of disaster risk is a lack of disaggregated vulnerability data, which could help DRR experts make displacement risk assessments that more accurately predict who is likely to be displaced by a weather-related hazard and who may be more resilient (UNDRR, 2019). There is therefore a critical need for more accurate data that captures the underlying social, economic, political, religious, caste, race, gender, sex, age, ability, geographic and other characteristics that make people vulnerable or resilient to displacement.

More accurate vulnerability and resilience data, tools and approaches can be useful in displacement risk analysis as they can help identify:

- Specific areas, groups of people, or types of household that may be more vulnerable to displacement as a result of certain hazards, and where they are located

- The most effective interventions for reducing their vulnerability before they are displaced
- The most effective interventions for responding to the differentiated needs of people who become displaced, and
- How displacement risk might change over time in response to changes in vulnerability factors or climate risks.

These data are necessary both as inputs into displacement risk assessment tools (to improve the accuracy of displacement assessments) and as outputs of the models to understand which groups of people are likely to be displaced, disaggregated by gender, sex, age, ability, race, ethnicity, caste, religion and wealth status, among others.

At the same time, understanding who is vulnerable to displacement has become more complex and nuanced in recent years. A growing knowledge base, developed by DRR and climate risk management (CRM) stakeholders, has evolved our collective understanding of vulnerability, displacement and resilience, with important implications for disaster displacement models and assessments, particularly in the context of the increasing risks associated with climate change. Some important findings from these studies include:

Those who are most vulnerable may not have the capacity or desire to move. A growing body of research indicates that the most vulnerable are likely to stay close to home due to the existence of support networks, a lack of resources to migrate, and other reasons. For example, research in Ghana, Bangladesh and India shows that perceived increase in the severity of drought reduces households' likelihood to migrate (Adger et al., 2021), whereas other research in Bangladesh finds that land ownership, place attachment and availability of financial resources are important determinants of nonmigration in coastal Bangladesh, meaning less vulnerable people are more likely to be nonmigrants (Mallick, 2019; Mallick et al., 2021).

Migration can be a positive adaptation strategy made out of choice; it is not always a negative event triggered by a hazard. For example, the World Migration Report 2020 highlights the role migration plays as an adaptation strategy to climate or disaster risks (IOM, 2019). For DRR stakeholders working on displacement risk models, this makes estimating vulnerability to disaster displacement challenging, as what appears to be displacement could be an individual or household decision to respond to rising risks by migrating.

Planned relocation may be an important adaptation. In some cases, it may be better for DRR stakeholders to promote — rather than try to prevent — displacement by strengthening disaster resilience (IOM, 2020). Relocation can help vulnerable people avoid the impacts of climate hazards by moving to a less exposed location; for others, it may be a desirable alternative to staying where they are, allowing them to move toward new and more sustainable livelihoods opportunities (UNHCR, Georgetown University & IOM, 2017).

Overall, there is a strategic need for DRR stakeholders to better understand who is vulnerable to displacement and who is resilient in the context of escalating climate risks. This report aims to support DRR stakeholders to better understand the nature of vulnerability as it relates to displacement risk by:

- Analysing existing displacement risk forecasting models to understand how well those models integrate vulnerability data as an input, and the extent to which they provide outputs or forecasts that include disaggregated vulnerability data that can help DRR stakeholders understand who is at risk of, or from, displacement (Chapter 4)
- Drawing lessons from the CRM community of practice to see if there are relevant tools and methodologies that DRR stakeholders could use to improve their understanding of disaster vulnerability and displacement risk, providing valuable lessons on how and where to collect localised vulnerability data and how to conceptualise local-level resilience (Chapter 5), and
- Providing key findings and recommendations on how DRR stakeholders could better integrate vulnerability data into displacement forecasts to make more accurate displacement risk assessments over different time horizons (Chapter 6).

1.2 UNDRR and disaster displacement in the Horn of Africa

The United Nations Office for Disaster Risk Reduction (UNDRR) actively supports governments in the Horn of Africa — one of the world's most vulnerable regions to the impacts of disasters (IDMC, 2017; ICPAC & WFP, 2017; INFORM Risk[1]) — to strengthen DRR governance, catalyse investment, integrate risk information into decision making and collaborate with DRR stakeholders to implement the Sendai Framework.

[1] https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk

Under the Framework's Priorities 1 and 2 — understanding disaster risk and strengthening disaster risk governance to manage disaster risk — UNDRR is working with partners to develop robust and accurate disaster risk assessments that can forecast displacement.

The UNDRR's guidelines for reducing risk, addressing impacts and strengthening resilience (UNDRR, 2019) emphasise that data and analysis of the different dimensions and dynamic nature of vulnerability should be a priority when assessing various aspects associated with displacement.

This good practice review builds on UNDRR's work to support stakeholders in the Horn of Africa to better integrate vulnerability, resilience and adaptive capacity into displacement risk assessments. Its purpose is to:

- Describe some of the tools and methods DRR stakeholders are using to assess displacement risk and analyse the extent to which they integrate granular data on vulnerability and displacement
- Outline a series of practical tools, approaches, methodologies and databases used by the CRM community of practice that can provide useful lessons to DRR stakeholders on how to capture data on vulnerability, adaptive capacity and resilience, and
- Provide recommendations on how DRR stakeholders can better integrate vulnerability and resilience into disaster displacement risk assessments and decision making.

It is important to emphasise from the outset that the types of DRR approach analysed in this good practice review are tools, methods and approaches to model disaster-related displacement. Our analysis therefore focuses exclusively on how they integrate vulnerability into displacement forecasting approaches. DRR stakeholders may use a variety of other tools and approaches at the operational level — such as short-term knowledge products, surveys or other operational outputs used on the ground immediately before, during or after a disaster — often in contexts with limited information, resource constraints and time pressure. We do not analyse these here, though they warrant further study to understand how stakeholders capture that type of vulnerability data and use it to inform DRR programming.

The good practice review is structured as follows:

Chapter 2 provides an overview of the core concepts and terminology around vulnerability, disaster displacement and CRM used in this report.

Chapter 3 introduces the main tools, methods and approaches that DRR stakeholders use to conduct displacement risk assessments. We analyse each approach to understand its strengths and/or limitations in integrating data on multidimensional social vulnerability into displacement risk assessments. Overall, this chapter highlights gaps in the way different tools and approaches account for social vulnerability as a multidimensional phenomenon.

Chapter 4 introduces key approaches, tools and methodologies that CRM stakeholders use to understand vulnerability, adaptive capacity and resilience in the context of climate change risk. This chapter provides DRR stakeholders with relevant approaches from CRM experts that they can use to generate more context-specific vulnerability data and make more accurate displacement assessments using vulnerability and resilience data.

Chapter 5 presents the key findings from the good practice review, highlighting the need to integrate more granular, context-specific vulnerability data and assessment tools into disaster displacement assessments.

Chapter 6 concludes with recommendations to DRR stakeholders in the Horn of Africa on how to better integrate vulnerability into disaster displacement assessments. We developed and refined these recommendations through a series of roundtable thematic discussion groups with key DRR stakeholders in the Horn of Africa region in September and October 2021 (see Annex 3).

2

Core concepts

This chapter introduces and defines the key concepts and terminology used in the good practice review, including terms related to disaster and displacement risk, the constituent components of the main risk equation (*risk = vulnerability x exposure x hazard*), and other important terms such as resilience and loss and damage. To ensure coherence across key partners, this section uses the UNDRR (2021) terminology online glossary, which is itself informed by UNGA (2016).

A **disaster** is a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds a community's or society's ability to cope using its own resources. Disasters may be triggered by a variety of causes, such as hydrometeorological and climatological natural hazards, including those linked to anthropogenic global heating, and geophysical hazards such as landslides and volcano eruptions. They may also be caused by human factors, such war, violent conflict or socioeconomic or political crises.

Disaster risk is defined as "the potential loss of life, injury, or destroyed or damaged assets which could occur to a system, society or a community in a specific period of time, determined probabilistically as a function of hazard, exposure, vulnerability and capacity".[2] Resulting from the complex interaction between development processes that generate conditions of exposure, vulnerability and hazard, it is considered as the combination of the severity and frequency of a hazard, the number of people and assets exposed to that hazard, and their vulnerability to damage.

A **hazard** is a "process, phenomenon or human activity that may cause loss of life, injury or other health impacts, property damage, social and economic disruption or environmental degradation".[2] Natural hazards are predominantly associated with natural processes and phenomena, such as wind, highly variable rainfall and earthquakes. Human-induced hazards are induced by human activities and choices. Socionatural hazards are a combination of social and natural process, such as environmental degradation and climate change.

Exposure is "the situation of people, infrastructure, housing, production capacities and other tangible human assets located in hazard-prone areas".[2] The terms 'exposure' and 'hazard' are often conflated. Exposure refers to people's situation and context, rather than the external force acting on them.

Vulnerability refers to "the conditions determined by physical, social, economic and environmental factors or processes, which increase the susceptibility of a community to the impact of hazards" (UNISDR, 2005). Regarded as the 'people' component of the risk equation — which is vulnerability multiplied by exposure to hazard (Wisner et al., 2004) — vulnerability is structured by social, economic and political factors, particularly access to resources, social capital and decision-making power. Vulnerability is highly differentiated by gender, sex, age, ability, ethnicity, locality, wealth, indigenous group and marginalisation.

Sensitivity is the degree to which a system is affected — adversely or beneficially — by natural, human-induced or socionatural stimuli (Deressa et al., 2008; Meknonen et al., 2019). It is about the characteristics of people,

[2] www.undrr.org/terminology

families, communities or other types of social system, which make them prone to experience change as hazards (Smit & Wandal, 2006). Exposure is sometimes considered the precondition to sensitivity, as the former represents the physical situation or geographical positioning where change becomes hazardous for sensitive people, depending on their capacity to adapt.

Coping capacity refers to the ability of people, organisations and systems, using available skills and resources, to manage adverse conditions, risk or disasters. The capacity to cope requires continuing awareness, resources and good management, both in normal times and during disasters or adverse conditions.[2] Coping capacities contribute to the reduction of disaster risks.

Adaptation is "the process of adjustment to actual or expected climate and its effects" (IPCC, 2014). Adaptation actions can be either incremental (actions where the central aim is to maintain the essence and integrity of a system) or transformative (actions that change the fundamental attributes of a system in response to climate change and its impacts). The need for adaptation varies, depending on people's or systems' sensitivity and vulnerability to environmental impacts.

Adaptive capacity is the "ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences" (IPCC, 2014). Human adaptive capacity is unevenly distributed across regions and populations, and developing countries generally have less capacity to adapt. It is closely linked to social and economic development: in general, higher levels of development mean higher adaptive capacity (IPCC, 2007).

Resilience refers to "the ability of a system, community or society exposed to hazards to resist, absorb, accommodate, adapt to, transform and recover from the effects of a hazard in a timely and efficient manner, including through the preservation and restoration of its essential basic structures and functions through risk management".[2] Bahadur et al. (2015) developed a useful typology for resilience that identifies three specific resilience capacities or abilities that enable a system to function in a desired state: anticipatory, absorptive and adaptive capacity. This typology classifies interventions that support climate resilience as supporting individuals, groups or systems to anticipate the risks and impacts of climate change and prepare accordingly; absorbing impacts when they occur to maintain a base level of functioning; and/or adapting to climate impacts in a way that makes them less exposed or vulnerable in the future.

Forced displacement refers to the involuntary or coerced movement of a person or people away from their home or home region. Forced displacement may result directly from a natural hazard or indirectly, either from a natural hazard's impact on infrastructure, food and water access, and local or regional economies, or from a wide range of human activities, including political crisis, criminal action, violent conflict, manmade environmental disasters, development projects and government edicts. Internal displacement takes place within the borders of an individual nation state. People can also be displaced across international borders; when this happens because of persecution, conflict, generalised violence or human rights violations, they are classified as refugees. Forced displacement may be temporary, long term or permanent, depending on the scope and scale of the disaster, the area's recovery capabilities, displaced people's access to durable solutions, and their own life preferences.

Disaster displacement refers to situations where people are forced to leave their homes or places of habitual residence due to a disaster or to avoid the impact of an immediate and foreseeable natural hazard. Such displacement results from affected persons being exposed to a natural hazard in a situation where they are too vulnerable and lack the resilience to withstand the impacts of that hazard.[3] It usually occurs within national boundaries. Cross-border displacement is when people flee or are displaced across international borders in the context of sudden- or slow-onset disasters or the effects of climate change.

Internal displacement refers to the involuntary movement of "persons or groups of persons who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of, or in order to avoid, the effects of armed conflict, situations of generalized violence, violations of human rights or natural or human-made disasters, and who have not crossed an internationally recognized State border" (UNOCHA, 1998). Disaster displacement within the boundaries of a nation state is a subset of internal displacement.

Loss and damage refer to the impacts of climate change that have not been or cannot be avoided through mitigation and adaptation. They occur where a society reaches its adaptation limits or does not implement adaptation optimally, perhaps because adaptation actions are unaffordable, physically or technically impossible, or socially difficult. Loss and damage have wide coverage, encompassing impacts of sudden and slow-onset events over a range of timescales and both economic and noneconomic impacts (Warner & Van der Geest, 2013; Van der Geest & Warner, 2020).

[3] https://disasterdisplacement.org/the-platform/key-definitions

3

Good practice review: disaster displacement risk assessment

This chapter introduces and reviews a selection of approaches, tools and methodologies that DRR stakeholders are currently using to develop displacement and disaster risk assessments. It includes probabilistic models, big data models (also known as machine learning and artificial intelligence), system dynamics models, risk indices and agent-based models.

The aim of this section is to analyse whether and how existing DRR approaches, tools and methodologies integrate data on multidimensional vulnerability and resilience. For each set of approaches, this section provides a description of the broad approach and examines the extent to which they integrate vulnerability data into assessment tools and models (Table 1). We also set out the strengths and weaknesses of modelling approaches, assessing their utility for integrating socioeconomic vulnerability into displacement risk analyses, particularly focusing on:

- Accuracy — how closely the approach depicts reality; and
- Usability — the ease with which users can comprehend and apply research outputs.

At the end of each section, there is a list of relevant technical documents for stakeholders who wish to learn more about a specific approach. We highlight good practices for integrating vulnerability data and explore gaps or limitations. At the end of the chapter, we present a synthesis of our findings and a summary table showcasing the state of the art on integrating vulnerability considerations and tips on how to integrate these into disaster displacement risk models.

To ensure that the good practice review is aligned with the needs of DRR stakeholders working in the Horn of Africa, we have drawn, wherever possible, on approaches, tools and methodologies from this region and elsewhere in sub-Saharan Africa.

3.1 Probabilistic risk assessment

The most commonly used assessment tool of the displacement risk community is the probabilistic forecast, as used by the Internal Displacement Monitoring Centre (IDMC), UNDRR and the Norwegian Refugee Council (NRC). It is exemplified in the UNDRR Global Assessment Report (2015) models, and has been updated through the CLIMADA Framework, which provides an open source and probabilistic risk modelling platform (IDMC, 2019).

The common objective of probabilistic risk assessment tools is to provide estimates for future displacement risk under different scenarios — that is, the probability of a certain level of displacement and economic losses over time.

3.1.1 How probabilistic risk assessments work

To build probabilistic assessments, modellers:

1. Use the historical relationship between a hazard and the outcome of economic losses
2. Include an assumption that a certain level of household structural losses will cause people to be evacuated and thus cause displacement, enabling an estimate of displacement
3. Simulate events to generate probable maximum losses for each return period,[4] and then
4. Transform this indicator into an average annual loss or probable maximum loss curves.

This process shows that more extreme events happen less often but have high estimates of damage and higher displacement. Less extreme events happen more often, but both economic damage and displacement are lower. It is possible to make prospective components using data on climate change and more predictable seasonal or annual rains and other events.

Probabilistic risk models are specifically designed for rapid-onset hazards, such as flooding. There is, for example, a strong correlation between the occurrence of a rapid-onset hazard, displacement and other types of loss and damage. But with other kinds of hazard — especially drought and other slower-onset events — the causation between hazard and losses and damages is much more complex and uncertain, which renders the model less reliable and predictions less accurate.

Examples of the formulae applied (UNDRR & CIMA, 2020; IDMC & NRC, 2014) are:

Risk = hazard x exposure x vulnerability / capacity

Risk = hazard x vulnerability x exposure

However, any conception of vulnerability in this type of assessment rests on a focus on household damage and hazards. As such, the interaction is best understood in terms of exposure (as a subcategory of vulnerability) and hazard. Although other components of vulnerability would improve accuracy, they would ultimately result in demands in terms of data.

3.1.2 Strengths and weaknesses of probabilistic risk assessments

Probabilistic models have limited accuracy, good conceptual basis, reductive interpretation of vulnerability, and are usable for a wide audience.

The primary focus of probabilistic models for displacement risk is the link between a hazard and exposure, which leads to displacement and economic loss. This involves getting the measurement and interaction right between the probability of hazard occurrence, exposure of the context in relation to the hazard, and the number of people at risk of being displaced or incurring economic losses. Vulnerability as an input is accounted for through the exposure component. This is a key threshold of a hazard where it has negative social impacts, framed in terms of structural damage to households. But it does not provide an encompassing, and thus accurate, representation of all or most socioeconomic drivers of displacement. By omitting the majority of factors that drive displacement, probabilistic models inevitably produce risk assessment outputs with little precision.

In terms of usability, the reductive approach increases decision makers' ability to understand the model's inner workings. The more they understand the way the model works, the better they can interpret, contextualise and effectively use model outputs in policy-related work. There is therefore a trade-off between making models understandable to a wider audience and developing comprehensive models that simulate the complexity of social life and accurately estimate social outcomes such as displacement and economic losses from hazards.

Feedback from the thematic group discussions suggested that the simplicity of focusing on household damage enables the global scope of the probabilistic assessment. They felt that including more indicators to enrich the vulnerability components would result in countries being excluded, thus compromising the global coverage.

[4] Also known as a recurrence interval or repeat interval, a return period is the average time or an estimated average time between events such as floods.

BOX 1. PROBABILISTIC RISK ASSESSMENT RESOURCES SUPPORTING THE HORN OF AFRICA REGION

- Guidance note on probabilistic country risk profiles for disaster risk management — UNDRR and CIMA Foundation. https://tinyurl.com/satvyydk
- Global Displacement Risk Model — International Displacement Monitoring Centre (IDMC). www.internal-displacement.org/database/global-displacement-risk-model
- Reducing displacement risk in the Greater Horn of Africa: a baseline for future work — IDMC. https://tinyurl.com/3crz9jf6
- Global disaster displacement risk: a baseline for future work — IDMC. https://tinyurl.com/5vtu8464
- Famine Early Warning Systems Network — FEWS NET. https://fews.net/
- Global Flood Forecasting Information System (GLOFIS) — Deltares
- Assessing the impacts of climate change on flood displacement risk — IDMC. https://tinyurl.com/5hx4d7rk

3.2 Big data approaches — dynamic models

Big data approaches — also known as artificial intelligence or machine learning approaches — use advanced data analytics methodologies to predict displacement outcomes. As the name implies, big data approaches use a diverse range of datasets (often of varying forms and quality) and apply machine learning techniques to manage, process and analyse much more data than would be possible with conventional data analytic approaches.

An aggregated database is developed using sensors, digital devices, log files, internet and social media that locate and track online real-time data sources. For example, the Foresight Model (Box 2) uses 18 open source databases — including World Bank development statistics, the Armed Conflict Location and Event Data Project, the Uppsala Conflict Data Program, disaster loss data from the Center for Research on the Epidemiology of Disasters' Emergency Events Database (EM-DAT) and others from many UN agencies, including the United Nations High Commissioner for Refugees (UNHCR), the World Food Programme (WFP) and the Food and Agriculture Organization (FAO) — for the 148 indicators that are integrated into the displacement model. These include 120 drivers of displacement, including indicators of economic growth, governance, violence, environment and population.

3.2.1 How big data approaches work

Big data approaches combine algorithms — a set of rules for processing data, often called 'modelling' or an 'equation' — to develop an ensemble. In building this ensemble, modellers develop displacement figures, or point estimates of displacement with confidence intervals. Ensembles are an aggregation of many iterations of models that have been put together due to their predictive power. The software uses the 'training data' (a large database) to iteratively teach itself about what best predicts displacement over space and time. This aggregation of models reduces error associated with relying on a few models from one sample. For example, the boosting technique improves models' predictive power by correcting the errors (poor classification) in their previous iterations, thus increasing the likelihood they will be selected (or the indicator selection weights).

The Foresight Model is a big data approach that uses causal network analysis to investigate in real time the drivers of past displacement as new data are incorporated, such as changing triggers for displacement over time and space. The rounds of analysis are conducted using machine learning and Bayesian network models, which applies a series of analyses under different model specifications — that is, different combinations of predictive indicators — that aggregate to form an ensemble. The idea is that the ensemble improves the predictive power compared to an individual model output.

Vulnerability is integrated through many drivers of displacement, as the model's objective is to predict displacement as an outcome. As such, a much wider account of vulnerability (assuming drivers = vulnerability) is necessary to improve accuracy. For example, Project Jetson (Box 2) uses a series of steps to select relevant indicators that predict displacement risk in Somalia, combining literature reviews of past studies with soliciting expert judgement of operational staff and collecting data through direct consultation with displaced people themselves. This produces socioeconomic vulnerability indicators, simply because many past displacement events were caused by elements of vulnerability. As the data are tested and re-evaluated over time, the dynamic component within the procedure checks and adjusts relational assumptions according to new information, influencing the direction and weight of different factors, which in turn influences displacement risk outputs and predications.

3.2.2 Strengths and weaknesses of big data

Big data offer high accuracy, but are highly complex, have a limited conceptual basis on vulnerability, and are only usable for a limited audience. There are challenges in interpreting results according to the conceptual model and contextual understanding, as well as around data quality, standardisation and management. Big data approaches are in the pilot phase of development, and only a few key stakeholders use them to inform disaster risk assessment. Few people understand the process, which means interpreting results is not easy.

The approaches represent innovation in predictive modelling for displacement risk and can produce country-level estimates of displacement risk for a country up to three years ahead. However, they cannot provide real-time estimates of displacement.

Big data approaches have a conceptual framework for selected drivers of displacement, depending on their ability to predict displacement. In this sense, big data approaches draw on a comprehensive list of indicators that better account for the complexity of displacement settings and provide a more data-rich analysis to accurately model displacement risk and estimate the likely number of people displaced.

In terms of usability, end users often have little to no idea about data collection, data management and the analytical procedure used to generate outputs, such as displacement forecasts. The average decision maker working in policy struggles to understand big data approaches, making the outputs difficult to interpret. However, according to interviews with personnel linked to the Foresight model, the model's ability to produce a number of people likely to be displaced, together with error margins, is a useful product.

Big data approaches provide the best prediction in terms of incorporating and organising the largest range of drivers of displacement and indicators of vulnerability. Their main shortfalls are in terms of data management. Such approaches tend to have some form of standardisation and formatting problems that tend to remain within the database until manual inspection.

BOX 2. BIG DATA RESOURCES

- Project Jetson — UNHCR. https://jetson.unhcr.org/
- Foresight Model — Danish Refugee Council and IBM. https://tinyurl.com/8v64k8s

3.3 System dynamics models

Unlike probabilistic and big data approaches and models, system dynamics models are not designed to calculate displacement risk and number of people at risk of displacement. Instead, modellers use them to explore the drivers of displacement in a deeply contextual way. Disaster settings — what makes disasters happen and crises exacerbate — are inherently dynamic and chaotic, and these models are designed to explore the reality of non-linear relationships in complex systems. Analysts rely on indicators that are constructed through the observable reality of people and places, and some based on perceptions. They use system dynamics models to investigate the ever-changing interconnectivity of indicators that explain displacement, as they differ across contexts and time, and how the causes of displacement are influenced by other preliminary mediating factors.

System dynamics models are based on the belief that displacement outcomes have multiple causes. Not only do causes and effects have different weights; they also change over time, such as when disasters impact stocks of assets and weaken people's ability to produce and generate income (IDMC & NRC, 2014). Effects can also be delayed — for example, it can take 10–18 months for the worse effects of drought to begin to show on households, people and assets, and therefore for future displacement to become more likely, at least in the short to medium term. Indirect effects can last many years in the wider context and influence displacement risk in multiple ways.

3.3.1 How system dynamics models work

These models use literature reviews, fieldwork, interviews and primary data collection to formalise a system-level view of known causal relationships. After collecting data to model the relationships in the system, analysts model a series of interconnected stocks and flows, including key outcomes such as asset levels and displacement. 'Stocks' include any observable component of the system — such as livestock — thought to directly or indirectly impact on displacement, while 'flows' cover changes in stock, using reinforcing or balancing feedback loops. For example, instead of understanding disaster and displacement event onset in terms of a single hazard threshold, system dynamics models enable analysts to explore interactions between drought and livestock, which influence pastoral livelihood incomes, which in turn influence the wider economy and then feed back to pastoral livelihoods and so on.

3.3.2 Strengths and weaknesses of system dynamics models

These models have high accuracy, high complexity and a good conceptual basis on vulnerability, but they are usable for a limited audience.

System dynamics models address some of the shortfalls found in other approaches. They are more inductive than probabilistic models, better accounting for the many causes of displacement. They have more transparent data organisation and management capacity than big data approaches, so their outputs are more reliable in terms of the data used. But despite being more reductionist than big data approaches in terms of data sources incorporated, they still include similar displacement, natural hazard, conflict event and ground-level household and pastoral economy data sources.

The obvious trade-off is with users' ability to understand the methods applied, especially when compared to probabilistic approaches. The more accurate the depiction of a complex reality, the more challenging it is for end users working in policy to understand how model outputs are produced. System dynamics models provide specialists with unparalleled insight into the highly variable drivers of displacement risk over time and space. But for a more practitioner- and policy-based audience, there are barriers to understanding, interpreting — and ultimately using — the outputs of the research. At the same time, users should keep in mind that, unlike probabilistic and big data approaches and models, system dynamics models are not designed to produce numbers of people at risk of displacement. Rather, they are an exploratory exercise into the drivers of displacement.

A conceptual framework from the start of the time series informs the model about the predictors of displacement, structuring the input of socioeconomic vulnerability indicators into the analysis, as these are inevitably key drivers of displacement to varying degrees across contexts. The importance of vulnerability indicators changes over time, and system dynamics models can recognise this evolution and reconfigure assumptions and indicator weights. So, while big data approaches focus on displacement drivers, these models formally integrate vulnerability while also providing indicators of vulnerability that build on more reductive approaches.

BOX 3. SYSTEM DYNAMICS MODEL RESOURCES

- Assessing drought displacement risk for Kenyan, Ethiopian and Somali pastoralists — IDMC and NRC. https://tinyurl.com/3k67cyfv

3.4 Agent-based models

Complementing the system dynamics approach, agent-based models are less widely applied in policy decision making but are often included to develop indicators that substantiate causal pathways in displacement risk assessments. Agent-based models offer a unique micro-level insight around the decisions people make on the ground when experiencing natural and human-induced hazards, often based on people's desires and characteristics (Hébert, Perez & Harati, 2018). Such models can imitate or simulate the decision making of individuals, families and government officials, their perceptions and circumstances when experiencing natural- and human-induced stress.

There is significant variation in the complexity of modelling, ranging from a series of decision tree routes to the application of more complex networks and algorithms. The models have been used for a range of analytical purposes, from predicting refugee destinations in conflict zones (Suleimenova et al., 2017), and migrant numbers (Thober et al., 2018) to supporting decisions around displacement settings (Smajgl & Bohensky, 2013), and tracking complex interactions between migrants and humanitarian actors (Asgary et al., 2016).

3.4.1 How agent-based models work

The main application of an agent-based model is the Groundswell Model, designed by the Center for International Earth Science Information Network (CIESIN) (Sherbinin & Rigaud, 2018). Groundswell incorporates a series of population trajectories, socioeconomic development pathways, and inequality and climate impact scenarios. It adopts the population gravity modelling approach that understands the future based on the observation that people are attracted to economic opportunities and public services in urban areas. The difference between a baseline and endline under various scenarios shows the level of migration and the underlying reasons for movement.

3.4.2 Strengths and weaknesses of agent-based models

Although these models provide unique micro and perception-based insights, policy researchers do not widely apply them as a stand-alone approach.

Stakeholder interviews and thematic group feedback has indicated that the Groundswell Model is alone in adopting agent-based models as its primary methodology to model displacement risk. Bringing a perception-focused approach that works to better understand the drivers of displacement, insights from agent-based models can feed into other modelling approaches or offer a stand-alone approach to displacement risk modelling.

By inputting scenarios for population and socioeconomic development as drivers of displacement risk, the Groundswell Model offers a multidimensional account of vulnerability. However, this does not represent an encompassing inclusion of vulnerability, and is not explained in terms of the broader components of social vulnerability, such as sensitivity, exposure and adaptive capacity.

BOX 4. AGENT-BASED MODEL RESOURCES

Groundswell: Preparing for Internal Climate Migration (infographic) — World Bank. https://tinyurl.com/23tfcvkh

Groundswell: Preparing for Internal Climate Migration — World Bank. https://openknowledge.worldbank.org/handle/10986/29461

3.5 Risk indices

Risk indices are practical tools that inform decision makers on displacement. They provide an aggregation of composite indicators that constitute the main components of the risk equation. Such approaches are designed to be used and applied by practitioners and policymakers without a technical background in displacement risk modelling.

3.5.1 How risk indices work

In the context of the European Commission's Index for Risk Management (INFORM), risk indices adopt straightforward equal weighting procedures for predetermined indicators of displacement risk, which feed into the following formula:

Risk = hazard exposure x vulnerability x lack of coping capacity

Risk indices can provide country profiles, rankings and other comparable risk metrics.

3.5.2 Strengths and weaknesses of risk indices

Risk indices offer an aggregated perspective on risk of disasters and humanitarian crises. Although they have low accuracy, they allow for comprehensive and straightforward incorporation of vulnerability and are easy to use for decision makers.

Risk indices typically adopt a composite indicator approach to vulnerability as an input. For example, the INFORM national-level tool incorporates vulnerability as a component of the standard risk equation and separates coping capacity from vulnerability, despite being connected in policy and academic literature. They also include exposure as a separate category that interacts with physical hazard.

Risk index tools are accessible to a wide audience. Because they are more easily understood, decision makers are more likely to adopt them than more probabilistic approaches and dynamic systems modelling. The methodology is clear, short and easy to understand. Each category of indicators is equally weighted, and the choice of indicators is consistent across contexts. The blocks of indicators are small, and their interactions make intuitive sense to a non-specialist audience. The end users of the interfaces and research outputs have a product that is straightforward to interpret.

With a standard set of indicators that are subjectively weighted, there is little to no account of some indicators being more important than others, and risk indices do not explore the validity of indicators across time and space. Further, there is little consideration of feedback loops and other dynamic elements in the modelling process. The approach assumes that when an indicator rises or falls, there is more or less risk in the units under observation. This suggests a linear relationship between vulnerability, hazard and ultimately risk and does not account for any interaction between the predictive indicators of displacement risk.

BOX 5. RISK INDEX RESOURCES

- INFORM Risk Index — European Commission. https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk
- ReDSS Solutions Framework — Durable Solutions. https://regionaldss.org/index.php/research-and-knowledge-management/solutions-framework/

3.6 Summary

Three of the five approaches we reviewed — probabilistic models, big data approaches and to a lesser extent, agent-based modelling — have predictive power and are currently being used to assess displacement risk. Probabilistic models have the most traction in the policy community.

There is limited input of multidimensional vulnerability data into displacement risk assessment models. The quality of these data and the depth of analysis on vulnerability-displacement interaction vary across the models we reviewed. Probabilistic models rely on a straightforward conception of exposure, which is modelled through a series of hazard thresholds that result in displacement and economic losses. Big data approaches, on the other hand, integrate a comprehensive and complex body of vulnerability data by analysing displacement drivers, but the lack of transparency makes it difficult for end users to use this in policy decision making. Integrating usable information on vulnerability therefore rests on the indicator of exposure used in probabilistic models. Finally, agent-based modelling is useful for simulating urban migration on population, development, inequality and climate impact scenarios.

Table 1: Overview of disaster displacement risk assessment approaches, tools and methodologies

APPROACH	OBJECTIVE/ OUTPUT	METRICS/DATA	FORMULAE	ACCURACY / USABILITY
Probabilistic risk assessment	Prospective risk assessment, usually at national level (can be subnational) with estimate of number of people likely to be displaced	Historical hazard events (slow and rapid onset) Economic losses from hazards Displacement from hazards Calculations conducted at national, region and sector level	*Risk = hazard x exposure* *Capacity or risk = hazard, vulnerability x exposure* Note: It was difficult to glean the broad categories of 'vulnerability' and 'capacity' from documents and stakeholder interviews	Relatively high accuracy Good conceptual basis on and reductive interpretation of vulnerability Usable for a wide audience
Big data approaches	Prospective risk assessment, usually at national level, with estimate of number of people likely to be displaced	Historical displacement at national level All possible predictors of displacement from categories of economic growth, governance, violence, environment and population	Foresight Model example: *Forced displacement risk* = *f* (economic growth, governance, violence, environment and population) + *mediating factors*	High accuracy High complexity Limited conceptual basis on vulnerability Usable for a limited audience only
System dynamics models	A better understanding of displacement drivers Multiple levels, depending on data granularity	Historical displacement All predictors of displacement within a specific context. With the pastoral example, inputs around the pastoral economy and the impact of climate shocks such as drought	Horn of Africa Technical Report example: *Displacement* = *f* (livestock) *as f* (cash and pasture), where *cash f* = markets, cash assistance and remittances, and *pasture f* = land access and pasture rejuvunation	High accuracy High complexity Good conceptual basis on vulnerability Usable for a limited audience only
Agent-based models	Prospective risk assessment, usually at national level, with estimate of number of people likely to be displaced Also used to better understand drivers of displacement	Historical displacement, at multiple (often micro) levels All predictors of displacement within a specific context, with a focus on the desires and characteristics of individuals and their circumstances	Aggregated example: *Displacement* = *f*, where f = environmental and climate hazards, personal preferences, destination choices available, means of movement, or social and political governance	Unique micro and perception-based insights Not applied as a stand-alone approach by policy researchers
Risk indices	Prospective humanitarian crisis and disaster risk assessment National level only	Risk of humanitarian crises and disasters (national-level metrics) Indicators of human and natural hazards, socioeconomic characteristics and vulnerable groups, infrastructure and governance	INFORM example: *Risk f (hazard and exposure (1/3) × vulnerability (1/3) × lack of coping capacity (1/3)*	Aggregated perspective on risk of disasters and humanitarian crises Low accuracy Comprehensive and straightforward incorporation of vulnerability Easy to use for decision makers

4

Good practice review: climate risk analysis

The approaches, tools and methodologies outlined in Chapter 3 all have a strong focus on displacement and disaster risk forecasting. This chapter reviews tools, methods and practices from the climate risk and resilience community, that DRR stakeholders could use to address these limitations and better integrate contextual vulnerability assessments into disaster displacement approaches.

Although many of the methods and approaches for assessing disaster displacement risk assessment factor vulnerability into the risk calculation equation, there are limitations in the way they conceptualise vulnerability and use a set of proxy indicators to analyse it. The resulting assessments often lack accuracy and granularity on the different types of people that are at risk of displacement from a hazard and their underlying vulnerabilities.

In this chapter, we present a second set of approaches, tools and methodologies for assessing vulnerability in the context of escalating climate — rather than displacement — risk. These have a strong emphasis on vulnerability, adaptation and resilience. Developed by stakeholders working in the CRM community of practice, they explore contextual vulnerability to current and future climate hazards and have valuable insights that are directly relevant to the work of DRR stakeholders.

The chapter outlines a range of approaches that CRM stakeholders use to understand climate risk, adaptive capacity and resilience, with an underlying focus on vulnerability. We have grouped these approaches into categories for ease of presentation. It should be noted, however, that this grouping is for illustrative purposes only. It is not meant to reflect a typology or classification that has been developed by CRM stakeholders; rather, it provides a simple way for external audiences to understand a different range of tools and approaches for an external audience.

We outline the broad approaches developed, how they integrate vulnerability assessments, tools or datasets, and their potential application for DRR stakeholders working on displacement risk assessments. At the end of the chapter, we present a synthesis of our findings and a summary table, bringing together the key CRM methodologies and their relevant use for DRR stakeholders and displacement risk analysis.

4.1 Participatory vulnerability analysis at the community level

Participatory vulnerability analysis (PVA) is an umbrella term for a group of approaches that use participatory methodologies led by a trusted facilitator to collect and interpret data at the community level. PVA draws on Robert Chambers' participatory rural appraisal (PRA) methods (Chambers, 1994), developed in the 1980s and 1990s in response to sampling bias in tools used by the development community — such as surveys and field visits — which limited practitioners' ability to generate contextually relevant data to underpin programme design and evaluations. PRA tools were developed to collect more robust, context-specific data on key issues of vulnerability and rural development performance with the input of local people themselves.

With the rise of the sustainable development agenda and efforts to support vulnerable groups to adapt and build resilience to climate change, a second generation of PRA tools has been developed. As climate risks have escalated, the development community has focused on CRM as a key pillar of sustainable development to understand how communities experience climate impacts and the different levels of vulnerability, adaptive capacity and resilience at local level. The new approach — PVA — has been led predominantly by international nongovernmental organisations (NGOs), to inform the design of adaptation interventions and to evaluate their effectiveness.

4.1.1 How does PVA work?

Participatory vulnerability approaches use a suite of facilitation tools and exercises to collect and interpret local-level data with communities. The methods, which are often similar across different NGOs, include hazard mapping, seasonal vulnerability matrices, community mapping, vulnerability analysis and identification of adaptation options. NGOs and UN agencies — including CARE, the United Nations Development Programme (UNDP), the International Federation of Red Cross and Red Crescent Societies (IFRC), Oxfam and ActionAid International — have developed a wide range of how-to handbooks, outlining the participatory tools they use and explaining the role of facilitators in leading community-level data collection activities (Box 6).

4.1.2 Using PVA to analyse displacement risk

DRR stakeholders can use PVA tools to collect context-specific vulnerability data to integrate into disaster risk assessments. However, PVAs are time-consuming exercises that generate data for a small geographical area. One possible application is integrating PVA into local government agencies' formal development planning and/or risk assessment processes, with a focus on gathering displacement risk data for different vulnerable groups. This could be conducted at regular intervals — for example, every five years — or local development agents could update the assessments regularly through spot checks on key indicators in sentinel sites.

From a modelling perspective, the most useful application of these tools would be for collecting data from a variety of locations with a specific set of circumstances — for example, a village, a community, an agricultural zone and so on. Modellers could then use the data to create proxy vulnerability profiles for locations with a specific set of circumstances, such as a specific risk profile, a specific population sample and so on. By collecting different datasets for areas with different circumstances, modellers could generate multiple scenarios for integration into disaster displacement forecast models.

BOX 6. PARTICIPATORY TOOL HANDBOOKS

- Climate Vulnerability and Capacity Analysis Handbook — CARE. https://careclimatechange.org/cvca/
- Community-Based Resilience Analysis (COBRA) implementation guidelines — UNDP. www.undp.org/publications/cobra-implementation-guidelines
- Loss & Damage Handbook — ActionAid, Asia Disaster Risk Reduction Network (ADDRN) and Climate Action Network South Asia (CANSA). https://cansouthasia.net/handbook-for-loss-and-damage-assessment/
- Vulnerability and capacity assessment — IFRC. https://www.ifrc.org/risk-assessment-and-planning
- Enhanced vulnerability and capacity assessment — IFRC. www.ifrcvca.org/what-is-evca
- Participatory Capacity and Vulnerability Analysis: a practitioner's guide — Oxfam. https://tinyurl.com/hufh6n2p
- Participatory Vulnerability Analysis: a step-by-step guide for field staff — ActionAid International. www.livestock-emergency.net/userfiles/file/assessment-review/ActionAid.pdf
- Christian Aid good practice guide: participatory vulnerability and capacity assessments — Christian Aid. https://tinyurl.com/jvuzyvam
- Resilience Assessment Toolkit — Adaptation Consortium www.adaconsortium.org/images/publications/Resilience%20Assessment%20Tool%20Kit.pdf
- Participatory Integrated Climate Services for Agriculture (PICSA) — Research Programme on Climate Change, Agriculture and Food Security (CCAFS). https://ccafs.cgiar.org/resources/tools/participatory-integrated-climate-services-agriculture-picsa

4.2 Approaches for measuring local-level resilience

This section presents a rough grouping of approaches for measuring resilience at the local level. Their common denominator is that data on resilience are collected from local actors — predominantly individuals or households. However, unlike the PVA approaches outlined in the previous section, data collection is not through participatory methods with a facilitator in a group setting. Each tool outlined in this section uses its own methodology or data collection technology to collect local-level resilience data. These are often more agile, less expensive and less time consuming than the participatory methods listed in the Section 4.1.

4.2.1 Tools for measuring local resilience

SHARP+: The FAO's Self-evaluation and Holistic Assessment of Climate Resilience of Farmers and Pastoralists (SHARP+) tool uses tablets to collect data directly from farmers and pastoralists on their levels of resilience. SHARP+ uses a standard resilience framework of resilient agroecosystems across 13 indicators, allowing for comparability of resilience outcomes across groups and geographies. Widely used in Africa and Central Asia, it is a quick and easy way to collect data from local stakeholders (see Box 7).

Subjective resilience approach: The Overseas Development Institute (ODI) takes a different approach to collecting local-level resilience data. Rather than use a pre-existing framework with specific resilience indicators, ODI has pioneered the subjective resilience approach, which allows local actors to self-report on their resilience. The idea behind this approach is that because local people have a stronger understanding of the livelihoods, resources, networks and systems that make them resilient, they can estimate their own ability to cope or recover from a hazard without the need for proxy indicators on resilience. Proxy indicators are the basis of most bottom-up and top-down approaches, including the tools outlined under Sections 4.4 and 4.5). The approach has been trialled in Myanmar, using mobile phones to collect monthly data from stakeholders to understand their subjective resilience to disaster risk over a 12-month time horizon (see Box 7).

4.2.2 Using local-level resilience measuring methods to analyse displacement risk

The tools and methodologies presented in this section have three main applications for DRR stakeholders.

First, they can be used to collect localised, contextually relevant data on adaptation and resilience that can be used in risk forecasts. For example, DRR stakeholders can extrapolate data from a subjective resilience assessment conducted in a particular community or region and integrate it into risk models. They can then forecast the likely impact of a disaster on displacement in that region by specifically factoring in the adaptive capacity and resilience of people in the region. As well as using subjective resilience assessments to collect large-scale datasets for models, they could apply a sampling approach, using smaller datasets as proxies for communities with specific types of circumstances, much like the approach proposed in Section 4.1.

Second, DRR stakeholders can use subjective resilience assessments on an operational level as a useful approach to generating data on specific perceptions of resilience at a moment in time. For example, if an early warning system triggers a call to conduct a subjective resilience assessment, DRR stakeholders could then use these data to identify potential displacement hotspots within a broader area considered vulnerable on higher-level proxy data. Such assessments would enable more rapid support to be deployed to displacement hotspots, preventing displacement altogether or providing appropriate support and resources to help displaced people to relocate.

Third, DRR stakeholders can use subjective resilience assessments to evaluate the effectiveness of DRR responses on reducing vulnerability and building resilience at the local level. They could collect data via tablets or mobile phones, as shown in the SHARP+ and Myanmar case studies, on the effect of specific projects or programmes that have delivered pre- or post-disaster support on levels of resilience in targeted locations.

BOX 7. RESOURCES FOR MEASURING LOCAL-LEVEL RESILIENCE

- SHARP+ — FAO. www.fao.org/in-action/sharp/en/
- Subjective resilience measurement — ODI. https://tinyurl.com/3uetcbmk
- Rapid Response Research project in Myanmar — ODI. http://livedata.vonengelhardt.net/rrr-dashboard/
- Tracking Adaptation and Measuring Development (TAMD) — International Institute for Environment and Development (IIED). https://pubs.iied.org/10100iied

4.3 Approaches for measuring macro-level resilience

Several global climate change funds have taken a macro-level approach to estimating resilience with programmes that aim to aggregate results from individual projects supporting adaptation and resilience building into a programmatic estimate of resilience outcomes across their project portfolio. There is significant overlap between these frameworks, which are among the largest public funders of climate action in the world, including the World Bank, Adaptation Fund, Green Climate Fund (GCF) and Climate Investment Funds (CIFs).

4.3.1 Tools for measuring local resilience

The World Bank's *Operational Guidance* document (Box 8) provides a detailed overview of relevant indicators that have been used to measure resilience from across its portfolio of climate change investments. The sheer breadth of these indicators shows that there is no 'one-size-fits-all' approach and indicators need to be tailored to the context and intervention in question.

The Adaptation Fund, GCF and the CIFs' Pilot Programme for Climate Resilience (PPCR) results frameworks (Box 8) also have high-level indicators to calculate the number of people with improved climate resilience from project interventions.

4.3.2 Using macro-level resilience measuring tools to analyse displacement risk

Because there are no universally agreed indicators for measuring improved climate adaptation or resilience, each funder has developed its own macro-level indicator framework. DRR stakeholders could use these in scenario planning exercises, as they have some utility in conceptualising resilience at a high level. Specifically, they could use the indicators from these frameworks to generate generalisable disaster resilience profiles in certain regions, with scenarios where early, late and no action would lead to different resilience outcomes. They could then use these scenarios to forecast the most effective DRR responses to specific risks.

These frameworks could also provide DRR stakeholders with metrics that they could use to evaluate the effectiveness of DRR interventions from a climate resilience perspective. For example, if DRR actions helped reduce the physical loss and damage to infrastructure and/or livelihoods, stakeholders could report to their funders the number of people they had helped build resilience to disasters.

The shortcoming of these frameworks is that they are relatively blunt planning tools that do not allow for granularity of data collection for different vulnerable groups across different contexts, including countries, regions, landscapes, climate risks or vulnerability drivers. So, although they can help DRR stakeholders create generalisable resilience metrics for their models, planning approaches and evaluations, they must be supplemented with more granular vulnerability data obtained through other tools, such as those outlined highlighted in Sections 4.1 and 4.2.

BOX 8. RESOURCES FOR MEASURING MACRO-LEVEL RESILIENCE

- Strategic Results Framework — Adaptation Fund. https://tinyurl.com/7fjdxr43
- PPCR Results Framework — CIFs. https://tinyurl.com/vsaca4zr
- Adaptation performance measurement framework — GCF. https://tinyurl.com/yk3avr75
- Operational guidance for M&E in climate and disaster resilience-building operations — World Bank. https://tinyurl.com/snm5em6n

4.4 Climate risk indices

This section showcases macro-level risk indices that policymakers can use as decision support tools. These include the Notre Dame Global Adaptation Initiative's (ND-GAIN) Global Adaptation Index, the Global Climate Risk Index, Maplecroft's Climate Change Vulnerability Index and the Disaster Risk-Integrated Operational Risk (DRIOR) model developed by the Economist Intelligence Unit (Box 9).

4.4.1 Macro-level indices

These indices compile data at the national level using a series of proxy indicators to rank countries by level of vulnerability or adaptive capacity. Some of the indices are relatively concise — for example, the Germanwatch Global Climate Risk Index uses four indicators to rank countries by level of vulnerability (in this case to rapid-onset climate-related disasters). Others are more complex, such as the DRIOR framework, which categorises risk under five pillars comprising 23 indicators and 82 subindicators to provide a holistic assessment of country operational risk levels (focusing on disaster risk). Similarly, ND-GAIN is based on 36 vulnerability indicators and 9 adaptation readiness indicators drawn from a total of 74 data sources.

4.4.2 Using macro-level risk indices to analyse displacement risk

These macro-level risk indices provide several important uses for DRR stakeholders.

First, they provide a decision-making framework to help stakeholders understand the areas that are most at risk to climate disasters, which they can use to target DRR support. They can also use them to identify specific sectors, institutions or contextual factors in a country that need DRR actions and disaster resilience strengthening, based on the severity of climate change risk.

Second, displacement risk models and assessment tools do not forecast displacement resilience. DRR stakeholders can use macro-level risk indices to develop risk assessments that identify suitable proxy indicators or groups of indicators to integrate into disaster forecasts and models to better forecast vulnerability, climate risk and adaptive capacity. DRR stakeholders can learn from these CRM approaches and use them to improve displacement risk models to showcase where vulnerable groups are resilient to displacement.

One limitation of these approaches is that they use data collected and aggregated at national level. And, although such macro-level data can be useful for national-level risk assessment tools, if the goal of DRR stakeholders is to develop localised displacement risk and resilience models, then the data sources might not be relevant. Of course, modellers should look at the source data for each indicator. If subnational data are not available, the main utility of these approaches is showing DRR stakeholders what relevant subnational data they need to collect or source from existing databases to enable them to model adaptation and resilience in a specific geography.

BOX 9. CLIMATE RISK INDICES

- ND-GAIN – University of Notre Dame. https://gain.nd.edu/our-work/country-index/
- Global Climate Risk Index – Germanwatch. https://germanwatch.org/en/cri
- Climate Change Vulnerability Index – Maplecroft. www.maplecroft.com/risk-indices/climate-change-vulnerability-index/
- DRIOR – Economist Intelligence Unit. www.preventionweb.net/files/51068_eiutowardsdisasterrisksensitiveinve.pdf

4.5 Social protection approaches

Social protection programmes play an important role in reducing poverty and vulnerability in countries around the globe (World Bank 2018). Over the past decade, there has been significant investment in social protection programmes in low- and middle-income countries to support the twin goals of poverty alleviation and climate resilience. Policymakers, funders and development actors recognise that there is substantial overlap between social protection and climate adaptation interventions. Both aim to improve wellbeing, reduce risks that stem from acute vulnerability and promote equity for the poor (Agarwal et al., 2019; Tenzing, 2019).

4.5.1 Social protection programmes

There have been several notable large-scale social protection programmes in sub-Saharan Africa and south Asia that have emerged as particularly good case studies for studying the effectiveness of social protection and climate resilience. These include Ethiopia's Productive Safety Net Programme (PSNP), Kenya's Hunger Safety Net Programme (HSNP) and India's Mahatma Gandhi Rural Employment Guarantee Scheme (MGNREGS) (Box 10).

Climate-resilient social protection systems use climate forecasts to scale up support to vulnerable groups before or in the immediate aftermath of a shock. Two examples of this approach are forecast-based financing (FbF) (Wilkinson et al., 2018) and shock-responsive social protection (SRSP) (O'Brien et al., 2018).

FbF aims to minimise the impact of disasters by establishing a financing mechanism that disburses funding when a climate shock occurs. FbF works by integrating observed or projected climate information data, using standard rules and procedures to govern when emergency payouts are triggered with social protection delivery, and using a registry of vulnerable beneficiaries the programme will support when a disaster occurs.

SRSP scales up and scales out social protection payments to beneficiaries after a disaster hits. Like FbF, SRSP works with observed impact data to trigger payments to beneficiaries. Payments can be either expanded vertically, to top up benefits for existing beneficiaries, or horizontally to reach new beneficiaries who need support after a shock.

4.5.2 Using climate-resilient social protection programmes to analyse displacement risk

There are two ways in which social protection programmes are relevant to DRR stakeholders.

First, these large-scale schemes are built on large-scale data registries that are available at national level and used as the basis for targeting eligible recipients of social protection support. Many of these databases hold advanced data on household composition by age, sex, income levels and poverty level, among other indicators. They can be valuable sources of disaggregated data that capture important metrics on vulnerability at individual or household levels. DRR stakeholders could integrate such data into risk assessments and forecasts to more accurately predict the effects of disasters on vulnerable groups. In particular, some of these datasets could provide valuable sources of household-level data for displacement models in countries where national-level statistical data are scarce.

Second, climate-resilient social protection systems such as FbF and SRSP can guide DRR stakeholders on how to integrate hazard data or forecasts and beneficiary databases with vulnerability indicators to provide rapid support to people who are exposed to disasters.

BOX 10. NATIONAL SOCIAL PROTECTION PROGRAMMES

- PSNP woreda risk profiles — Ethiopia. https://tinyurl.com/3zrw4dxw
- FbF — Mongolia. www.preventionweb.net/files/62643_casestudy16mongoliafbffinal.pdf
- HSNP — Kenya. www.hsnp.or.ke/
- MGNREGS — India. https://nrega.nic.in/netnrega/mgnrega_new/Nrega_home.aspx
- Northern Uganda Social Assistance Fund (NUSAF) — Uganda (SRSP). https://documents1.worldbank.org/curated/en/209591512051473006/pdf/121786-replacement.pdf

4.6 Summary

This chapter has provided an overview of approaches, methods and tools used by CRM stakeholders to understand climate risk and vulnerability, and to deliver responses that reduce vulnerability and build resilience. DRR stakeholders can apply similar approaches in data collection, risk forecasting, scenario planning, evaluating the effectiveness of DRR interventions, and when creating datasets and indicators that can be used in risk models for measuring vulnerability and resilience. Table 2 provides a summary of the relevance of the broad CRM approaches outlined in this chapter to DRR stakeholders' work on developing disaster risk assessments.

Table 2: Summary of CRM approaches and their application for displacement risk assessments

CRM APPROACH	RELEVANT USE	APPLICATION FOR DRR STAKEHOLDERS
PVA	Data collection method Data source for forecasts	Collecting bottom-up data on locally contextualised vulnerability to be integrated into risk assessments
Approaches for measuring local-level resilience	Data collection method Data source for forecasts Evaluating effectiveness of DRR actions	Collecting bottom-up data on locally contextualised vulnerability to be integrated into risk assessments Evaluating the effectiveness of local-level DRR actions that were implemented as a result of risk forecasts
Approaches for measuring macro-level resilience	Scenario planning Evaluating effectiveness of DRR actions	Developing DRR scenario planning options using high-level indicators for adaptation and resilience Evaluating the effectiveness of interventions implemented based on risk forecasts
Climate risk indices	Risk forecasts Indicator development for resilience and vulnerability	Assessing which countries, regions or sectors are vulnerable to climate disasters The indicators that form the backbone of these indices can also provide useful lessons on how to develop proxy indicators in DRR resilience and adaptation models
Social protection approaches	Databases with datasets for forecasts Risk forecast methodologies	Social protection registries can provide datasets for displacement risk models FbF and SRSP models can provide examples of how to forecast/respond to disasters and deliver early action to reduce shock impact and build resilience

5

Main findings

This chapter presents the main findings from our review of the approaches, tools, methods and practices that DRR stakeholders use to develop displacement and disaster risk assessments, and those used by the climate risk and resilience community that could help DRR stakeholders better integrate contextual vulnerability assessments into their work.

Our detailed analysis of displacement risk assessment tools and methodologies used by DRR practitioners (Chapter 3) assesses their strengths and limitations in the way they **integrate vulnerability data** as an input into their methodologies and **provide outputs with disaggregated vulnerability data** that DRR practitioners can use to better prepare for and respond to displacement events. Based on some of the limitations we identified in this analysis, we also analysed several tools, methodologies and approaches used by CRM practitioners (Chapter 4) to understand vulnerability, adaptive capacity and resilience in the context of climate risk. Our key findings are as follows.

A limited number of displacement forecast models predict the numbers of people likely to be displaced by a disaster. Of those reviewed, only three of the five main categories of displacement model have predictive power. **Probabilistic approaches** model the linkage between probability of hazard occurrence, the exposure of the context in relation to the hazard, and the number of people at risk of being displaced or incurring economic losses. Stakeholders can use them to generate broad estimates of the number of people likely to be displaced by a disaster at national or regional levels. Their main limitation is that, being based on a relatively simplistic model, they are useful for broad trends but not for more accurate estimates or subnational analysis. **Big data approaches** use advanced data analytics methodologies to predict displacement outcomes, creating algorithms with a wide range of large datasets to analyse the drivers of displacement. They can increasingly generate accurate displacement forecasts, but their highly technical nature means that end users have few means to understand and use the models in policy decision making. Finally, **agency-based models** use population trajectories, socioeconomic development pathways, economic opportunities and inequality as drivers of movement from rural to urban areas.

Probabilistic forecasts are the most widely used predictive model for displacement, but they integrate vulnerability data only in terms of exposure. Probabilistic models use the standard risk equation *Displacement = risk x exposure x vulnerability,* but only measure vulnerability data as a function of building damage. This means that these models use a single indicator of structural damage as a proxy to capture all dimensions of vulnerability. **Multidimensional vulnerability datasets** with disaggregated indicators on sex, age, ability/disability, wealth, ethnicity, marginalised group and so on are not integrated as inputs into these models, seriously limiting their accuracy. So, while these models are very useful for predicting displacement that may occur due to hazards that cause significant structural damage, such as floods or tropical storms, their utility is more limited when it comes to predicting the impacts of slow-onset or complex hazards — such as drought, heatwave or conflict — where structural damage is not the main impact. This is important for understanding the relevance of these models for the operating context in the Horn of Africa, where drought is a common hazard.

Several other types of disaster displacement assessment better integrate vulnerability data as inputs, but they do not have predictive capacity. Risk indices and system dynamics models both use more detailed vulnerability data to understand displacement. **Risk indices** provide country profiles, ranking and other comparable risk metrics based on large-scale, national-level datasets of economic, social and political indicators. They outline the vulnerabilities inherent to a specific country or region to provide nontechnical audiences with a framework for decision making around disasters. **System dynamics models** map the web of interconnected causal pathways in a system to understand the drivers of displacement and the effects of disasters once they occur. This causal mapping is derived from a wide range of data sources, including literature reviews, fieldwork, interviews and primary datasets on key socioeconomic data. However, neither model has predictive capacity to estimate the number of people that will be displaced when a disaster occurs. Risk indices can predict the likelihood of an event occurring, or the sectors and systems that are vulnerable, but not how many people will be displaced. System dynamics models can also explain the types of impact that a disaster will generate, such as loss of livestock, market prices for commodities and crop failure, and are particularly robust in outlining the causal linkages and feedback loops that will occur in a system — that is, in a community, region or similar — due to disasters. But, like risk indices, they cannot predict the number of people that will be displaced.

Displacement forecasts do not provide disaggregated vulnerability data for people who are forecast to be displaced, and displacement risk models provide little to no vulnerability data as an output. Specifically, probabilistic displacement forecasts are designed to predict the number of people who will be displaced within a country or region due to a particular type of hazard. The emphasis for DRR stakeholders has been to develop global models that can generate high-level figures for top-line decision making, using simplistic formulae that can be broadly applied across different geographies and hazard types. As a result, the models' vulnerability component has been reduced to exposure framed in terms of building damage, with no further data on multidimensional vulnerability as inputs. Without such data as inputs, probabilistic models cannot deliver predictive outputs that present data on the number of people likely to be displaced with further disaggregation by vulnerable group such as age, sex, ability/disability wealth, ethnicity and marginalisation as a key output to guide decision making.

Resilience and adaptive capacity are not integrated into displacement risk forecasts. There has been over a decade of applied learning on approaches that can be used to measure and assess the resilience or adaptive capacity of vulnerable groups to a wide variety of shocks. The DRR community can use many of these data collection methodologies — including PVA and subjective resilience assessments — to generate localised, granular datasets on vulnerability, adaptive capacity and resilience for more nuanced displacement models. Although these approaches offer the potential to integrate complex, disaggregated micro-level data on the different dimensions of vulnerability that can be extremely useful for planning and delivering tailored interventions to address the displacement risks of the most vulnerable, the datasets they generate may be unsuitable for integrating into existing displacement forecasting models. Their use therefore requires the establishment of institutional systems or frameworks to triangulate data from different sources to inform decision making. This suggests that stakeholders should avoid relying on a single methodology for conducting displacement forecasts and should instead consider probabilistic or other models alongside more detailed local-level vulnerability data that is regularly updated at sentinel sites.

There is demand from DRR stakeholders for more operational knowledge products that include displacement estimates or forecasts with locally disaggregated vulnerability data. Despite the lack of displacement forecast outputs with granular predictive data by category of vulnerable group, there is clear interest within the DRR community in having access to these types of output to inform disaster risk planning, disaster risk management activities and disaster response. Given the global scope of predictive models, DRR stakeholders are prospectively demanding the development of new modelling approaches able to identify context-specific, national, or subnational characteristics using datasets sources from governments or specialised agencies.

Further work is needed to understand how to integrate quantitative and qualitative approaches to displacement risk analysis to generate more accurate, vulnerability-informed, contextually relevant displacement forecasts**.** This report has focused primarily on reviewing quantitative — rather than qualitative — displacement modelling approaches. Some of these, including agent-based modelling, system dynamics and big data approaches, integrate expert analysis and stakeholder interviews into their tools to ensure greater accuracy. More detailed and nuanced assessments of displacement risk require a systematic integration of qualitative stakeholder insight into the design and interpretation of quantitative models and their outputs. Such analysis could inform the development of more robust vulnerability-informed forecasting approaches that are both accurate in their predictive power and responsive to DRR stakeholders' needs for disaggregated vulnerability data.

6

Recommendations

The purpose of this report is to provide evidence on how DRR stakeholders can strengthen disaster displacement risk assessments by integrating more detailed, contextually relevant data on vulnerability and resilience. Based on the findings outlined in Chapter 5, we make the following recommendations to achieve this objective:

DRR stakeholders should integrate more detailed, context-specific vulnerability data as an input into disaster displacement forecasting methodologies. Current probabilistic disaster displacement forecasts use housing damage as a proxy for vulnerability and have neither granular datasets on other components of vulnerability nor methodologies that provide more accurate understandings of how multidimensional vulnerability affects displacement. To improve the capacity of models to predict displacement, a multi-dimensional framing of social vulnerability should be used to complement the reliance on exposure. Stakeholders can source granular datasets from national and local governments, UN agencies, international NGOs, community-based organisations, social protection agencies or programmes, and through some of the innovative data collection methods used by the CRM community such as PVA or subjective resilience assessments. The trade-off is that such models may need to be downscaled to regional or national level to find suitable data on vulnerability.

DRR stakeholders working on predictive models should work to develop a next generation of probabilistic forecasts that provide outputs with granular predictions on the socioeconomic categorisation of the people likely to be displaced. There is high demand from strategic and operational-level DRR stakeholders for displacement analysis methods that go beyond the main metric of number of people displaced to include data disaggregated by key metrics such as age, sex, ability/disability, ethnicity, wealth and marginalisation among others. Having a better understanding of who is displaced will support the development of bespoke operational decisions and ultimately benefit displaced people.

DRR stakeholders should shift their emphasis from global displacement models towards regional, national or subnational models that can generate more accurate data to inform operational decision making. The emphasis on generating a global displacement model that can provide strategic policymakers with a high-level estimate of future displacement has been useful at the macro level. But it has limited utility for operational DRR stakeholders at subnational levels. The global focus has meant that the model used has an underlying methodology that requires indicators to be sufficiently simplistic and have broad enough datasets to ensure all countries are represented. As a result, the methodology limits the concept of vulnerability to building damage and allows for neither vulnerability datasets as an input nor disaggregated vulnerability forecasts as an output. A switch of focus to national or subnational models would have four main benefits:

- It would allow modellers to focus on context-specific indicators for vulnerability and exposure that are much more relevant to the risk profile of the country or region.
- It would also allow for data to be sourced at national, subnational or regional levels where additional datasets on vulnerability might be available.

- It would provide the space to generate forecasts that include disaggregated vulnerability data.
- It would be highly relevant for operational DRR stakeholders in the country or region to be used before or in the immediate aftermath of a disaster.

DRR stakeholders would also benefit from better integrating resilience and adaptive capacity considerations into displacement forecasting methodologies. Adaptive capacity and resilience are largely missing from the disaster risk equation used in most displacement risk models. A wide range of factors contribute to resilience and adaptive capacity, affecting the likelihood of an individual or household moving when a disaster occurs. Approaches like the system dynamics model might already account for resilience by testing causal linkages between pathways that lead to a decision to move when a disaster occurs. But the complexity of adaptive capacity and resilience must be better integrated into probabilistic models on displacement. Chapter 4 sets out methodologies and indicators that DRR stakeholders can learn from the CRM community of practice as they think through their own models.

Further research is needed to understand how DRR stakeholders can use qualitative and quantitative approaches to disaster displacement analysis to generate more accurate disaster displacement forecasts. This good practice review has focused primarily on understanding how to better integrate vulnerability data into quantitative disaster displacement modelling approaches. However, DRR stakeholders working on the ground in an operational capacity have a wealth of knowledge and data — both quantitative and qualitative — that could be integrated into more formal modelling approaches to increase their accuracy. A further area of study to build on the research in this report would be to catalogue the different types of qualitative and quantitative approaches used by DRR stakeholders at an operational level. This could help stakeholders understand whether there are additional tools, methods or approaches that could strengthen both the way they integrate vulnerability into models and the outputs that models provide, to make them more accurate, disaggregated with vulnerability data, and more useful for operational DRR stakeholders.

Annexes

Annex 1. Displacement models and approaches reviewed

Assessing drought displacement risk for Kenyan, Ethiopian and Somali pastoralists — IDMC and NRC. https://tinyurl.com/3k67cyfv

Assessing the impacts of climate change on flood displacement risk — IDMC. https://tinyurl.com/5hx4d7rk

Famine Early Warning Systems Network — FEWS NET. https://fews.net/

Foresight Model — Danish Refugee Council and IBM. https://tinyurl.com/8v64k8s

Global disaster displacement risk — a baseline for future work — IDMC. https://tinyurl.com/5vtu8464

Global Displacement Risk Model — IDMC. www.internal-displacement.org/database/global-displacement-risk-model

Global Flood Forecasting Information System (GLOFIS) — Deltares

Groundswell: preparing for internal climate migration — World Bank. https://openknowledge.worldbank.org/handle/10986/29461

Groundswell: preparing for internal climate migration (infographic) — World Bank. https://tinyurl.com/23tfcvkh

INFORM Risk Index — European Commission. https://drmkc.jrc.ec.europa.eu/inform-index/INFORM-Risk

Probabilistic country risk profiles for disaster risk management — UNDRR and CIMA Foundation. https://tinyurl.com/satvyydk

Project Jetson — UNHCR. https://jetson.unhcr.org/

ReDSS Solutions Framework — Durable Solutions. https://regionaldss.org/index.php/research-and-knowledge-management/solutions-framework/

Reducing displacement risk in the Greater Horn of Africa: a baseline for future work — UNISDR and IDMC. https://tinyurl.com/3crz9jf6

Annex 2. CRM tools and approaches reviewed

Adaptation Performance Measurement Framework — GCF. https://tinyurl.com/yk3avr75

Climate Change Vulnerability Index — Maplecroft. www.maplecroft.com/risk-indices/climate-change-vulnerability-index/

Climate Vulnerability and Capacity Analysis — CARE. https://careclimatechange.org/cvca/

Community-Based Resilience Analysis (COBRA) — UNDP. www.undp.org/publications/cobra-implementation-guidelines

DRIOR — Economist Intelligence Unit. www.preventionweb.net/files/51068_eiutowardsdisasterrisksensitiveinve.pdf

Enhanced Vulnerability and Capacity Assessment — IFRC. www.ifrcvca.org/what-is-evca

FbF — IFRC (Mongolia). www.preventionweb.net/files/62643_casestudy16mongoliafbffinal.pdf

Global Climate Risk Index — Germanwatch. https://germanwatch.org/en/cri

Hunger Safety Net Programme — Government of Kenya. www.hsnp.or.ke/

Loss and damage assessment — ActionAid, ADDRN and CANSA. https://cansouthasia.net/handbook-for-loss-and-damage-assessment/

MGNREGS — Government of India. https://nrega.nic.in/netnrega/mgnrega_new/Nrega_home.aspx

Monitoring and evaluation (M&E) in climate and disaster resilience-building operations — World Bank. https://tinyurl.com/snm5em6n

ND-GAIN — University of Notre Dame. https://gain.nd.edu/our-work/country-index/

Participatory Capacity and Vulnerability Analysis — Oxfam. https://tinyurl.com/hufh6n2p

PICSA — CCAFS. https://ccafs.cgiar.org/resources/tools/participatory-integrated-climate-services-agriculture-picsa

PVA — ActionAid International. www.livestock-emergency.net/userfiles/file/assessment-review/ActionAid.pdf

Participatory Vulnerability and Capacity Assessments — Christian Aid. https://tinyurl.com/jvuzyvam

PPCR Results Framework — CIFs. https://tinyurl.com/vsaca4zr

PSNP woreda risk profiles — (Ethiopia). https://tinyurl.com/3zrw4dxw

Rapid Response Research — ODI. http://livedata.vonengelhardt.net/rrr-dashboard/

Resilience Assessment Toolkit — Adaptation Consortium. www.adaconsortium.org/images/publications/Resilience%20Assessment%20Tool%20Kit.pdf

SHARP+ — FAO. www.fao.org/in-action/sharp/en/

Shock-responsive social protection (NUSAF) — Government of Uganda. https://documents1.worldbank.org/curated/en/209591512051473006/pdf/121786-replacement.pdf

Strategic Results Framework — Adaptation Fund. https://tinyurl.com/7fjdxr43

Subjective resilience measurement — ODI. https://tinyurl.com/3uetcbmk

TAMD — IIED. https://pubs.iied.org/10100iied

Annex 3. Thematic workshops

We developed and refined the recommendations in this report through a series of roundtable thematic discussion groups with key DRR stakeholders in the Horn of Africa region in September and October 2021.

Thematic discussion 1: Improving the integration of socioeconomic vulnerability indicators to model displacement risk

This thematic group addressed the needs of the displacement risk modelling stakeholders and others, focusing on digital interface tools for decision makers. It provided a space for discussion that took stock of where the data and science are around integrating vulnerability into displacement risk assessments, where there are gaps in the field of practice, and pathways forward for improving the way vulnerability is included.

Thematic discussion 2: Triangulation of quantitative analysis of hazard and displacement risk with qualitative insights of socioeconomically vulnerable populations

This thematic group was of interest to displacement risk modellers, knowledge product developers more broadly, end users of knowledge products and decision makers. It focused on state-of-the-art methods for integrating qualitative socioeconomic vulnerability data (narrative, expert judgement, among other forms) into quantitative data and models. For example, modellers often make decisions on the thresholds between normal climate variability and hazards. In terms of post-modelling practical decision making, multistakeholder forums can be used to discuss ways to harmonise information sources that support decision making around displacement as either a risk or an event. The group discussion was a forum for discussing these examples and/or any others that participants considered relevant.

Thematic discussion 3: Using vulnerability-informed knowledge products for displacement programming – getting the scale, data disaggregation and temporality right

This thematic group was directed to those working as practitioners in programme planning and implementation, especially UN agencies and NGOs involved in operational work. It discussed and proposed ways to improve how practitioners working on programmes currently use vulnerability, given the complexity around informing decisions on the ground in specific contexts and at particular times.

Thematic discussion 4: Using vulnerability indicators to characterise those at risk of displacement

This thematic group was directed to all producers and users of displacement risk models and broader assessments. After stakeholder interviews revealed the challenge of understanding the socioeconomic characteristics of those either displaced or at risk of displacement, we discussed that developing this nuance would greatly improve decision making. To address this point, this thematic group discussion outlined the state of the art in terms of characterising who is affected by or at risk of displacement. It then proposed ways to improve the level of detail available to those receiving modelling and/or assessment outputs.

Annex 4. Disaster-related data sources and displacement databases

This annex provides an outline of data available within Ethiopia to conduct a disaggregated analysis of social vulnerability. Please note that the list is not exhaustive, but provides examples.

Table A1. Disaster-related data sources with socioeconomic vulnerability

NAME	COUNTRY	TIMEFRAME	VARIABLES
DesInventar	Multiple	Historical data	Type of disaster Effects on human life Effects on property Effects on infrastructure
Disaster risk profiles	Ethiopia	Data collected at one point in time (462 woredas over seven years)	Type of hazard Socioeconomic characteristics Geography Topography
OCHA — severity of needs analysis	Ethiopia	Multiple, iterative	Needs of the woreda, with severity score indicating how compounded humanitarian needs are in a woreda
Ethiopian Rural Household Survey Dataset	Ethiopia	Multiple iterations (1989–2009)	Household characteristics, agriculture and livestock, consumption, health, women's activities, public services, NGO activity, migration, production and wages
Ethiopia Socioeconomic Survey Data	Ethiopia	Three iterations (2012, 2016, 2019)	Full range of household characteristics, community characteristics, individual characteristics, planting, agricultural production, post-harvest, livestock
Ethiopia Population and Housing Census	Ethiopia	Taken at three time periods over past 27 years (1994, 2007, 2017)	Literacy, population density, fertility rates, infant mortality rates, disabilities, employment, service provision, housing and local amenities
EM-DAT	Global	Covers 121 years	Hazard type Economic losses Number of people displaced
PREVIEW Global Risk Data	Global	21 years (2000–2021)	Spatial data on global risk from natural hazards Hazardous events, such as tropical cyclones, drought, earthquakes, biomass fires, floods, landslides, tsunamis and volcanic eruptions Human and economic hazard exposure

Table A2. Displacement databases

NAME	COUNTRY	TIMEFRAME	VARIABLES
Displacement Tracking Matrix (DTM)	Ethiopia	Real time and past displacement	Number of individuals Age and sex of individuals Reasons and date of displacement Location of displacement from/to Shelter arrangements/needs Multisectoral needs (water, sanitation and hygiene, food, health, electricity, protection, education, communications, transport and so on)
Global Internal Displacement Database (GIDD)	Global (IDMC countries)	Real time and past displacement	Internal displacement associated with conflict and generalised violence (2003–2020) Displacement associated with hazard-related disasters (2008–2020) Modelled disaster-related displacement risk metrics for more than 200 countries and territories
EM-DAT	Global	Covers 121 years	Hazard type Economic losses Number of people displaced
DesInventar	Multiple	Historical data	Type of disaster Effects on human life Effects on property Effects on infrastructure

Acronyms

ADDRN	Asia Disaster Risk Reduction Network
CANSA	Climate Action Network South Asia
CCAFS	Research Programme on Climate Change, Agriculture and Food Security
CIESIN	Center for International Earth Science Information Network
CIFs	Climate Investment Funds
CRM	Climate risk management
DRIOR	Disaster Risk-Integrated Operational Risk model
DRR	Disaster risk reduction
EM-DAT	Center for Research on the Epidemiology of Disasters' Emergency Events Database
FAO	Food and Agriculture Organization of the United Nations
FbF	Forecast-based financing
GCF	Green Climate Fund
GLOFIS	Global Flood Forecasting Information System
HSNP	Hunger Safety Net Programme (Kenya)
IDMC	Internal Displacement Monitoring Centre
IFRC	International Federation of the Red Cross
IGAD	Intergovernmental Authority on Development
IIED	International Institute for Environment and Development
INFORM	Index for Risk Management
LDCs	Least developed countries
M&E	Monitoring and evaluation
MGNREGS	Mahatma Gandhi Rural Employment Guarantee Scheme (India)
ND-GAIN	Notre Dame Global Adaptation Initiative
NGO	Nongovernmental organisations
NRC	Norwegian Refugee Council
NUSAF	Northern Uganda Social Assistance Fund
ODI	Overseas Development Institute
PICSA	Participatory Integrated Climate Services for Agriculture
PPCR	Pilot Programme for Climate Resilience
PRA	Participatory rural appraisal
PSNP	Productive Safety Net Programme (Ethiopia)
PVA	Participatory vulnerability analysis
SHARP+	Self-evaluation and Holistic Assessment of Climate Resilience of Farmers and Pastoralists
SIDS	Small island developing states
SRSP	Shock-responsive social protection
TAMD	Tracking Adaptation and Measuring Development
UNDP	United Nations Development Programme
UNDRR	United Nations Office for Disaster Risk Reduction
UNDRR	United Nations Office for Disaster Risk
UNHCR	United Nations High Commissioner for Refugees
WFP	World Food Programme

Related reading

Addison, S, Bharadwaj, R and Carthy, A. (2021) Tackling loss and damage: lessons from vulnerable countries. IIED Briefing. IIED London. https://pubs.iied.org/20546iied

Bermudez, LG (2017) Integrating livelihoods and protection for displaced persons in urban humanitarian response. Guidance note for Humanitarian Practitioners. IIED, London. https://pubs.iied.org/10829iied

Bharadwaj, R and Shakya, C (2021) Loss and damage case studies from the frontline: a resource to support practice and policy. IIED Toolkit. IIED, London. https://pubs.iied.org/20551iied

Bharadwaj, R, Gallagher, C, Carthy, A, Nisi, N, Shakya, C and Addison, S (2021) Climate change loss and damage: 1st deliberative dialogue report. IIED Event/workshop report. IIED, London. https://pubs.iied.org/20346iied

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Earle, L and Ward, C (2021) The case for treating long-term urban IDPs as city residents. IIED Briefing. IIED, London. https://pubs.iied.org/20431iied

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Climate-related disasters put millions of people at risk of displacement. To effectively plan and deliver disaster risk reduction and response plans in contexts at risk of disaster displacement, governments and humanitarian agencies require good quality assessments of displacement risk. Social vulnerability is a key displacement risk factor that needs to be well integrated into assessment tools. In this good practice review, the International Institute for Environment and Development takes stock of how social vulnerability is integrated into displacement risk assessments. Finding that prominent risk assessment methodologies offer a limited account of social vulnerability, we propose a series of practical solutions.

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