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Migration, environment and climate change: Impacts

Second report in the "Migration, environment and climate change" series

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Migration, environment and climate change: Impacts

Second report in the “Migration, environment and climate change” series

by

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Abstract: Migration, Environment and Climate Change: Impacts

This paper explores some of the main ways in which environmental change and migration have been linked to date. Reflecting the complexity and multi-dimensionality of the issue, it seeks to illustrate how environmental changes impact on human mobility in diverse and often subtle ways, reflecting differentiated vulnerabilities, and contexts often characterised by the presence of multiple "migration drivers". Alongside environmental factors, the analysis will consider key economic, political, demographic and social trends and drivers. These include factors such as level of socio-economic development, economic growth, resource scarcity, governance frameworks, population growth, and urbanisation.

The following four "impact types" are considered:

1) Mobility responses to sudden-onset hazards
2) Mobility responses in the context of slow-onset hazards
3) Linkages between environmental change, conflict and mobility
4) Immobile populations

Analysis will include consideration of how these impact types might develop in the future.

Kurzbeschreibung: Migration, Umwelt und Klimawandel: Auswirkungen

In diesem Dokument werden einige der wichtigsten Zusammenhänge, die bisher zwischen Umweltveränderungen und Migration hergestellt wurden, untersucht. Es spiegelt die Komplexität und Vielschichtigkeit des Themas wider und soll veranschaulichen, wie sich Umweltveränderungen auf vielfältige und oft subtile Weise auf die Mobilität von Menschen auswirken. Es spiegelt differenzierte Vulnerabilitäten und Kontexte wider, die häufig durch das Vorhandensein mehrerer „Migrationstreiber" gekennzeichnet sind. Bei der Analyse werden neben Umweltfaktoren wichtige wirtschaftliche, politische, demografische und soziale Trends und Treiber berücksichtigt. Hierzu zählen Faktoren wie das Niveau der sozioökonomischen Entwicklung, das Wirtschaftswachstum, die Ressourcenknappheit, die Rahmenbedingungen der Regierungsführung, das Bevölkerungswachstum und die Urbanisierung.

Die folgenden vier „Wirkungstypen" werden berücksichtigt:

1) Mobilitätsreaktionen bei plötzlich auftretenden Gefahren
2) Mobilitätsreaktionen im Zusammenhang mit langsam einsetzenden Gefahren
3) Zusammenhänge zwischen Umweltveränderungen, Konflikt und Mobilität
4) Immobile Bevölkerungsgruppen

Die Analyse wird in Betracht ziehen, wie sich diese Wirkungstypen in Zukunft entwickeln könnten.

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List of abbreviations

BMU	Federal Ministry for Environment, Nature Conservation and Nuclear Safety
CERA	Canterbury Earthquake Recovery Authority
DRR	Disaster risk reduction
FAO	Food and Agriculture Organization of the UN
GRID	Global Report on Internal Displacement (GRID) – IDMC's annual report
HDI	Human Development Index
IASC	Inter-Agency Standing Committee
IDMC	Internal Displacement Monitoring Centre
IDP	Internally Displaced Person
IOM	International Organization for Migration
IPCC	Intergovernmental Panel on Climate Change
MIC	methyl isocyanide
OECD	Organisation for Economic Cooperation and Development
SIDS	Small Island Developing States
UBA	German Environment Agency
UNEP	United Nations Environment Programme
UNFCCC	UN Framework Convention on Climate Change
UNISDR	UN Office for Disaster Risk Reduction
WGBU	German Advisory Council on Global Change

Summary

As shown in the literature review, global forecasts of the number of future environmental migrants are subject to critical uncertainties and of limited use. Efforts to understand the interplay of different causal factors, including environmental change, on migration in specific contexts (local, national or regional) are far more valuable to policymakers. As migration is a complex, multidimensional issue, it is also important to consider other key drivers like economic, political, demographic and social trends alongside environmental factors[1], when analysing the nexus between migration, environment and climate change. These include factors such as level of socio-economic development, economic growth, resource scarcity, governance frameworks, population growth, and urbanisation.

The second of the three studies therefore focused on the impacts of migration, environment and climate change, and explored four of the main ways in which environmental change and migration have been linked to date. The analysis also included consideration of how these impact types might develop in the future.

Mobility responses to sudden-onset hazards

Displacement risk is based on the hazard itself (type, intensity and frequency), exposure (people located in hazard-prone areas) and vulnerability (sensitivity to hazard impacts). All three components are projected to increase displacement risk in many countries. With regard to the hazard component, climate change is widely expected to increase the frequency and intensity of natural hazards like floods and storms, although not uniformly across continents. In terms of exposure, it is projected to increase in many countries due to population growth in hazard-prone areas – for example, in cities in low-lying coastal areas. In relation to vulnerability, one of the main findings is that disaster-related displacement is more common in countries with a relatively low Human Development Index (HDI), as well as in countries that combine vulnerabilities at multiple levels (individual, community, national). Gender is also often a determinant of vulnerability to sudden-onset hazard events, including through the way gender can condition access to mobility. Gender can also influence levels of vulnerability during disasters and in post-disaster settings. Another key component of vulnerability is capacity to address climate change impacts (often described as “adaptive capacity”).

In the next few decades, the trends towards continued urbanization and population growth mean that displacement risk is likely to continue to increase fastest in urban areas, primarily in low- and middle-income countries. However, public disaster risk reduction (DRR) policies can have a strong influence on mobility outcomes in disaster situations. Early warning systems in combination with clear (and drilled) evacuation plans can go a long way toward reducing fatalities and limiting the impacts of displacement on populations that are often already subject to multiple vulnerabilities. Preparedness measures must take account of specific vulnerabilities within communities, such as education policies and provision, and economic status.

[1] The direct or indirect impact of human activity on the environment and climate through processes such as industrialization and urbanization are among the key drivers of both environmental degradation (such as water or air pollution) and man-made hazards (such as dam failure or nuclear accidents). However, the link between human-induced environmental degradation and hazards and human mobility is beyond the scope of this paper. As a consequence, the paper does not reflect on the linkages between migration and policy issues related to human activities such as environmental legislation or the implementation of health and safety measures.

Mobility responses in the context of slow-onset hazards

Slow-onset events, ranging from drought to sea-level rise, can impact human mobility. Human vulnerability shapes mobility responses and can determine whether moving is even an option. At the same time, mobility responses shape future vulnerability. Two examples illustrate these complex relationships. First, sea-level rise can impact human mobility in different ways. While it is often first associated with permanent inundation of land and settlements, there are in fact a range of ways in which sea-level rise impacts human activities and settlements. These include coastal erosion, the salinization of groundwater in coastal areas, and increased vulnerability to flooding from storm surges and the salinization of agricultural land. Planned relocation may be necessary in cases of irreversible degradation/inundation of land. However, determining the point at which land becomes uninhabitable can be contentious. In many cases, people may choose to migrate well before the stage of inundation, as the severity of these other related impacts increases.

Second, various slow-onset environmental changes are already affecting rural livelihoods. In many regions, smallholder crop-based agriculture is dependent on rainfall, with irrigation being either unavailable as an option or financially out of reach. Thus, these smallholders are often very vulnerable to climate change impacts, notable rainfall variability and temperature rise. Climate change often compounds other human drivers of land degradation, such as overly intensive farming. The impacts can be incremental and take place over long timescales, or more immediate, in the case of drought or erratic rainfall. Taking all these factors together, the choices available to migrate depend on the range of macro-, meso- and micro-level factors described in the literature review.

Alongside environmental drivers, broader contextual factors may also shape mobility in rural areas. Economic 'push' and 'pull' factors, such as stagnating rural incomes, changing market dynamics (low producer prices; changes to demand patterns), and the availability of (higher) paid employment in both urban and rural areas, may have a significant influence on decisions to migrate. Demographic factors can also play role, for example, if youth in rural areas are drawn to urban areas by "social drivers", in particular the prospect of obtaining better education or work opportunities. Political drivers, particularly in relation to governance, are also important to consider. National policies on rural development and climate change adaptation for example could lead to support for rural livelihoods and encourage people to cope or adapt *in situ*. Policies and laws related to land (e.g. land tenure frameworks and land-use policies or building and urban planning policies) can also have major impacts on livelihoods and human mobility.

Linkages between environmental change, conflict and mobility

Regarding the linkages between environmental change, conflict and mobility, the impact paper underlined the findings of the literature review: the linkages are complex and time- and context-specific. The wide array of relevant contextual factors makes it impossible to predict future evolutions of the environment-mobility-conflict nexus with any degree of certainty. Nonetheless, environmental change – through its impact on sudden and slow-onset events – looks set to continue to exacerbate a range of potential conflict drivers. Whether human mobility acts as a "threat multiplier" will depend on many factors, as shown by the analysis of conflicts among pastoralists in Africa.

The effects of in-migration on receiving communities show that tensions are more likely in the case of large-scale influxes taking place over short timeframes, particularly where the influx has

a substantial impact on socio-economic, environmental or cultural systems. Environmental change, conflict and mobility are more likely to be interlinked in complex crises, where climate change can act as a "threat multiplier" to exacerbate the effects of existing conflict drivers.

Immobile populations

The analysis related to the fourth impact type, immobile populations, discussed two forms of immobility in the face of environmental stressors: the choice to and the inability to leave. Across the globe the number of people living in areas exposed to sudden- and slow-onset environmental stressors is growing, with key drivers including population growth, climate change and urbanisation. As such, the prevalence of immobility in vulnerable areas is a growing policy concern. The reasons why people do not move away in the light of environmental stressors are diverse, but broadly speaking can be divided into two overarching categories: voluntary immobility (immobile populations) and involuntary immobility ("trapped populations"). As the impacts of environmental and climate change begin to be felt more strongly, an increasing number of people may be trapped in areas where they are highly vulnerable to environmental stressors. In this regard, the minimization of environmental degradation and of environmental stressors – particularly in rural livelihoods – is an important factor to reduce migration out of necessity.

Zusammenfassung

Wie in der Literaturrecherche dargestellt unterliegen globale Prognosen über das Ausmaß der zukünftigen Umweltmigration großen Unwägbarkeiten und sind von begrenztem Wert. Bemühungen, das Zusammenspiel verschiedener kausaler Faktoren, einschließlich Umweltveränderungen, bei der Migration in bestimmten Kontexten (lokal, national oder regional) zu verstehen, sind für die politischen Entscheidungsträgerinnen und Entscheidungsträger weitaus wertvoller. Da Migration ein komplexes, mehrdimensionales Thema ist, ist es bei der Analyse des Nexus von Migration, Umwelt und Klimawandel außerdem wichtig, andere Schlüsselfaktoren wie wirtschaftliche, politische, demografische und soziale Trends neben Umweltfaktoren zu berücksichtigen. Dazu gehören Faktoren wie der Grad der sozioökonomischen Entwicklung, Wirtschaftswachstum, Ressourcenknappheit, Governance-Richtlinien, Bevölkerungswachstum und Urbanisierung. Die zweite der drei Teilstudien konzentriert sich daher auf die Auswirkungen von Migration, Umwelt und Klimawandel und untersuchte vier der wichtigsten Aspekte, wie Umweltveränderungen und Migration bis dato miteinander zusammenhängen. Die Analyse umfasste auch Überlegungen darüber, wie sich diese Auswirkungen in Zukunft entwickeln könnten.

Mobilitätsmaßnahmen bei plötzlich auftretenden Gefährdungen

Das Vertreibungsrisiko ergibt sich aus der Gefährdung selbst (Art, Intensität und Häufigkeit), der Exponiertheit (Menschen wohnhaft in gefährdeten Bereichen) und der Vulnerabilität (Anfälligkeit für Gefährdungseinflüsse). Alle drei Komponenten dürften das Vertreibungsrisiko in vielen Ländern erhöhen. Was die Gefährdung selbst betrifft, so wird erwartet, dass der Klimawandel die Häufigkeit und Intensität von Naturgefahren wie Überschwemmungen und Stürmen erhöhen wird, wenn auch nicht auf allen Kontinenten gleichmäßig. Hinsichtlich der Exponiertheit wird in vielen Ländern mit einem Anstieg aufgrund des Bevölkerungswachstums in gefährdeten Gebieten gerechnet - zum Beispiel in Städten in tiefliegenden Küstengebieten. Im Hinblick auf die Vulnerabilität ist eine der wichtigsten Ergebnisse, dass katastrophenbedingte Vertreibungen in Ländern mit einem relativ niedrigen Human Development Index (HDI) sowie in Ländern, in denen Vulnerabilitäten auf verschiedenen Ebenen (individuell, gemeinschaftlich, national) gebündelt sind, häufiger. Gender ist oft ein bestimmender Faktor für die Vulnerabilität für plötzlich auftretende gefährliche Ereignisse, auch aufgrund davon, wie das soziale Geschlecht den Zugang zu Mobilität beeinflussen kann. Geschlechtsspezifische Aspekte können ferner die Vulnerabilität bei Katastrophen und nach Katastrophenfällen beeinflussen. Eine weitere Schlüsselkomponente der Vulnerabilität ist die Fähigkeit, die Auswirkungen des Klimawandels zu bekämpfen (oft als „Anpassungsfähigkeit" bezeichnet).

In den nächsten Jahrzehnten dürften die Vertreibungsrisiken aufgrund der fortschreitenden Urbanisierung und des Bevölkerungswachstums in städtischen Gebieten, vor allem in Ländern mit niedrigem und mittlerem Einkommen, am stärksten zunehmen. Maßnahmen der öffentlichen Katastrophenvorsorge können jedoch einen starken Einfluss auf die Mobilität in Katastrophenfällen haben. Frühwarnsysteme in Verbindung mit genauen (und erprobten) Evakuierungsplänen können einen großen Beitrag dazu leisten, die Zahl der Todesopfer zu reduzieren und die Auswirkungen der Vertreibung auf die Bevölkerung zu begrenzen, die oft bereits mehrfach gefährdet ist. Bei den Vorbeugungsmaßnahmen müssen spezifische Schwachstellen innerhalb der Gemeinden, wie Bildungspolitik und -versorgung, sowie der wirtschaftliche Status Berücksichtigung finden.

Mobilitätsmaßnahmen im Kontext von langsam einsetzenden Gefährdungen

Langsam einsetzende Ereignisse, die von Dürre bis zum Anstieg des Meeresspiegels reichen, können Auswirkungen auf menschliche Mobilität haben. Die menschliche Vulnerabilität beeinflusst Migration als Reaktion auf Umweltveränderungen und kann bestimmen, ob Mobilität überhaupt eine Option ist. Gleichzeitig prägen Mobilitätsentscheidungen die zukünftige Vulnerabilität. Zwei Beispiele veranschaulichen diese komplexen Wirkungszusammenhänge. Erstens kann der Anstieg des Meeresspiegels die menschliche Mobilität auf unterschiedliche Weise beeinflussen. Obwohl er oft zuerst mit einer permanenten Überschwemmung von Land und Siedlungen in Verbindung gebracht wird, gibt es in der Tat eine Reihe von Möglichkeiten, wie der Meeresspiegelanstieg die menschlichen Aktivitäten und Siedlungen beeinflusst. Dazu gehören die Küstenerosion, die Versalzung des Grundwassers in den Küstengebieten und die erhöhte Vulnerabilität gegenüber Überschwemmungen durch Sturmfluten sowie die Versalzung von Landwirtschaftsflächen. Geplante Umsiedlungen können im Falle einer irreversiblen Degradierung / Überschwemmung von Land notwendig sein. Die Festlegung des Zeitpunktes, an dem das Land unbewohnbar wird, zu bestimmen, kann allerdings umstritten sein. In vielen Fällen entscheiden sich die Menschen lange vor der Überflutung zu migrieren, da die Auswirkungen der anderen damit verbundenen Probleme immer gravierender werden.

Zweitens wirken sich verschiedene langsam einsetzende Umweltveränderungen bereits auf die Lebensgrundlagen der Landbevölkerung aus. In vielen Regionen ist der kleinbäuerliche Ackerbau von Niederschlägen abhängig, während Bewässerung nicht möglich oder finanziell unerschwinglich ist. Daher sind diese Kleinbäuerinnen und Kleinbauern oft sehr vulnerabel gegenüber den Auswirkungen des Klimawandels, beträchtlichen Niederschlagsschwankungen und Temperaturanstiegen. Der Klimawandel verschärft oft andere menschliche Einflussfaktoren auf die Bodendegradation, wie z.B. eine zu intensive Landwirtschaft. Die Auswirkungen können sich schrittweise ergeben und über einen langen Zeitraum oder unmittelbarer im Falle von Trockenheit oder unregelmäßigen Niederschlägen auftreten. Zusammengenommen hängen die zur Verfügung stehenden Möglichkeiten zu migrieren von den in der Literaturübersicht beschriebenen Faktoren auf Makro-, Meso- und Mikroebene ab.

Neben den Umwelttreibern können auch breitere kontextuale Faktoren die Mobilität in ländlichen Gebieten beeinflussen. Wirtschaftliche „Push"- und „Pull"-Faktoren, wie stagnierende ländliche Einkommen, sich ändernde Marktdynamiken (niedrige Erzeugerpreise; Änderungen der Nachfragemuster) und die Verfügbarkeit von (höher) bezahlten Arbeitsplätzen sowohl in städtischen als auch in ländlichen Gebieten, können einen erheblichen Einfluss auf die Migrationsentscheidungen haben. Demographische Faktoren können auch eine Rolle spielen, wenn beispielsweise Jugendliche in ländlichen Gebieten von „sozialen Treibern", insbesondere die Aussicht auf eine bessere Ausbildung oder bessere Arbeitsmöglichkeiten, in städtische Gebiete gezogen werden. Auch politische Faktoren, vor allem in Bezug auf die Regierungsführung, sind zu berücksichtigen. Nationale Politikmaßnahmen zur ländlichen Entwicklung und Anpassung an den Klimawandel könnten beispielsweise zu einer Unterstützung der Lebensgrundlage im ländlichen Raum führen und die Menschen ermutigen, vor Ort die resultierenden Probleme zu meistern oder sich anzupassen. Politik und Gesetze zum Thema Land (z.B. Bodenbesitzverhältnisse und Landnutzungsrichtlinien oder Gebäude- und Stadtplanungspolitik) können ebenfalls erhebliche Auswirkungen auf die Lebensgrundlagen und die menschliche Mobilität haben.

Zusammenhänge von Umweltveränderungen, Konflikten und Mobilität

Was die Zusammenhänge zwischen Umweltveränderungen, Konflikten und Mobilität betrifft, so unterstreicht die Teilstudie zu Auswirkungen die Ergebnisse der Literaturrecherche: Die Zusammenhänge sind komplex sowie zeit- und kontextbezogen. Die Vielzahl relevanter

kontextualer Faktoren macht es unmöglich, zukünftige Entwicklungen des Nexus von Umwelt, Mobilität und Konflikt zuverlässig vorherzusagen. Dennoch dürften Umweltveränderungen - durch ihre Auswirkungen auf plötzliche und langsam eintretende Ereignisse - eine Reihe potenzieller Konflikttreiber weiter verschärfen. Ob die menschliche Mobilität als „Bedrohungsmultiplikator“ wirkt, hängt von vielen Faktoren ab, wie die Konfliktanalyse unter den Pastoralisten in Afrika zeigt.

Die Folgen der Zuwanderung für aufnehmende Gemeinden verdeutlichen, dass Spannungen wahrscheinlicher sind, wenn massive Zuwanderung in kurzer Zeit stattfindet, insbesondere wenn die Zuwanderung erhebliche Auswirkungen auf sozioökonomische, ökologische oder kulturelle Strukturen hat. Umweltveränderungen, Konflikte und Mobilität sind eher in komplexen Krisen miteinander verknüpft, in denen der Klimawandel als „Bedrohungsmultiplikator" auftritt und die Auswirkungen bestehender Konflikttreiber verschärft.

Immobile Bevölkerungsgruppen und „Festsitzende“

Die Analyse in Bezug auf den vierten Wirkungstyp, immobile Bevölkerungsgruppen, diskutierte zwei Formen der Immobilität hinsichtlich von Umweltstressfaktoren: die Entscheidung zum Verlassen und die Unfähigkeit zum Verlassen. Weltweit wächst die Zahl der Menschen, die in Gebieten leben, die plötzlichen und langsam einsetzenden Umweltstressfaktoren ausgesetzt sind, wobei die Schlüsselfaktoren Bevölkerungswachstum, Klimawandel und Urbanisierung sind. Daher ist die Zunahme der Immobilität in gefährdeten Gebieten eine immer größere politische Herausforderung. Die Gründe, warum Menschen im Hinblick auf Umweltstressfaktoren nicht wegziehen, sind vielfältig, lassen sich aber im Großen und Ganzen in zwei übergreifende Kategorien einteilen: freiwillige Immobilität (immobile Bevölkerungsgruppen) und unfreiwillige Immobilität („Festsitzende“). Da die Auswirkungen von Umwelt und Klimawandel immer deutlicher zu spüren sind, kann es vorkommen, dass eine wachsende Zahl von Menschen in Gebieten gefangen ist, in denen sie sehr anfällig für Umweltstressfaktoren sind. Insofern ist die Minimierung der Umweltzerstörung und der Umweltstressfaktoren - insbesondere im ländlichen Raum - ein wichtiger Faktor, um erzwungene Abwanderung zu begrenzen.

Introduction

This paper is the second of three papers produced under the project "Environmental degradation, climate change and migration: Synopsis of the review and forecasts on migration and flight induced by environmental degradation and climate change" for the German Environment Ministry (BMU) and German Environment Agency (UBA). Drawing on the initial literature review paper (and its accompanying matrix), this paper takes a closer look at a number of key ways in which environmental change and migration have been linked to date. It seeks to provide more detailed analysis of how environmental changes, combined with other drivers and trends, impact migration movements, reflecting the complexity and multi-dimensionality of the issue. The following four 'impact types' will be considered:

1. Mobility responses to sudden-onset hazards
2. Mobility responses in the context of slow-onset hazards
3. Linkages between environmental change, conflict and mobility
4. Immobile populations

These impact types will be analysed separately, aiming to identify the main factors that have influenced each of them to date. Alongside environmental factors, the analysis will consider key economic, political, demographic and social trends and drivers. These include factors such as level of socio-economic development, economic growth, resource scarcity, governance frameworks, population growth, and urbanisation. Analysis will include consideration of how these impact types might develop in the future.

1 Mobility responses to sudden-onset hazards

Before proceeding with the analysis, it is useful to clarify some key terms:

- Hazards v disasters
  - Hazards are not synonymous with disasters. Hazards become disasters when they impact on exposed and often vulnerable populations, coping capacity is exceeded and external assistance is required.[2]
- Exposure v vulnerability
  - Exposure relates to the presence of people and assets in hazard-prone locations, [3] whereas vulnerability relates to their sensitivity i.e. the extent to which they are likely to suffer harm. [4]
- Displacement risk:
  - Displacement risk is comprised of hazard, exposure and vulnerability. This same trio composes disaster risk more broadly – displacement is one type of disaster impact (Ginnetti, 2015).

The direct or indirect impact of human activity on the environment and climate through processes such as industrialization and urbanization are among the key drivers of both environmental degradation (such as water or air pollution) and man-made hazards (such as dam failure or nuclear accidents). While the link between human-induced environmental degradation and hazards and human mobility is beyond the scope of this paper, a couple of examples below show ways in which human-induced environmental hazards can cause displacement.

The important linkages between migration and policy issues related to human activities such as environmental legislation or the implementation of health and safety measures are also beyond the scope of this paper.

The Fukushima Daiichi nuclear accident (2011)

The Fukushima Daiichi nuclear accident in March 2011, which followed the Great East Japan earthquake and tsunami, displaced more than 150,000 persons as a large amount of radioactive materials were released from crippled reactors into the sea and atmosphere. Four years later, many of these evacuees had remained displaced, unable or hesitant to return home, due to radiological and social consequences caused by the disaster. The Fukushima nuclear disaster triggered two kinds of displacement: (1) mandatory evacuation under the Government's order; and (2) spontaneous evacuation of residents living outside designated evacuation zones who

[2] Disaster: "A serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceeds the ability of the affected community or society to cope using its own resources." (UNISDR, 2009)

[3] Exposure: "The presence of people, livelihoods, species or ecosystems, environmental services and resources, infrastructure, or economic, social, or cultural assets in places that could be adversely affected" (IPCC, 2014b: 12) by environmental and climate change impacts.

[4] Vulnerability: "The propensity or predisposition to be adversely affected. Vulnerability encompasses a variety of concepts including sensitivity or susceptibility to harm and lack of capacity to cope and adapt." (IPCC, 2014b: 28)

decided to flee on their own for fear of radiation effects despite the government's reassurances.
Source: Hasegawa, 2015.

The Christchurch Earthquake (2011)

Christchurch, New Zealand, was struck by a series of earthquake aftershocks between 4 September 2010 to 23 December 2011, causing extensive land and property damage. The Canterbury Earthquake Recovery Authority (CERA), a central government authority created in 2011, assisted people to understand the categorization of their property as high risk "red zones" and evaluate the Government's offer to buy red zoned properties.

Source: Mitchelle, 2015.

1.1 Vulnerability-resilience

Displacement risk is closely related to human and economic development. In a related report, IDMC showed that absolute and relative displacement risk is concentrated in countries in the third and fourth quintiles of the Human Development Index (HDI) where "exposure has increased more quickly than vulnerability has decreased, largely due to rapid population growth in hazard-prone areas such as coastal cities" (Ginnetti, 2015: 22).

While the geographic distribution of hazards varies by type of hazard, disasters are more common in countries that combine vulnerabilities at multiple levels (individual, community, national). Thus, while the Gulf Coast of the USA is highly exposed to extreme weather hazards (high numbers of people and assets in at-risk coastal zone), disasters are relatively rare, thanks to a range of disaster-preparedness measures, modern infrastructure and a population which is relatively resilient. On the contrary, countries in Asia have the highest risk of being displaced because they have a large number of vulnerable people exposed to multiple natural hazards. When population size is accounted for small island states face disproportionately high levels of displacement risk (Ginnetti, 2015: 8). There are of course exceptions, such as when Hurricane Katrina morphed into a disaster for the people of New Orleans and surrounding parts of the coast, but on the whole disasters are less likely to occur in developed countries.

Anybody who is forced to move away from a (sudden-onset) hazard for their safety is displaced, but the linkages between vulnerability and hazard-induced displacement are complex. People following evacuation orders to safety are displaced, yet they may be able to move quickly to safety and – where needed - benefit from organized public assistance (shelter, food and so on). People who have to flee spontaneously and make their own arrangements for shelter are displaced in ways which are likely to result in heightened levels of vulnerability. People unable to follow an evacuation order (due to *inter alia*: physical constraints, lack of education/awareness on hazard threats or evacuation routes) are even more vulnerable than those fleeing spontaneously under conditions of distress (see final section 'Immobile populations').

Studies of displacement patterns relating to Hurricane Katrina showed that poorer, more vulnerable sections of the population were far more likely to be displaced in conditions of vulnerability or be unable to flee, particularly in deprived areas of inner-city New Orleans (Laska and Morrow [2007]; Li et al. [2010]). Wealthier households were more likely to be able to follow evacuation orders and reach safety quickly, often using their private vehicles (many poorer residents did not have access to private transport). They were also more likely to have private insurance to cover disaster-related damage. One study revealed how low-income groups (often following ethnic lines) were also much more likely to be involved in 'secondary movements', as

they sought more adequate solutions (Li et al., 2010). Katrina showed that even in a developed country, differences in vulnerability within populations can result in drastically different outcomes, with mobility presenting one of the clearest manifestations in this regard. Vulnerability shapes mobility, and in turn mobility shapes vulnerability.

Gender is not just an important element to understand the diverse facets of environmental degradation and related migration; it is an organizing principle of human mobility (Fitzpatrick, 1997: 23). Gender is often a determinant of vulnerability to sudden-onset hazard events, including through the way gender can condition access to mobility. Gender can also influence levels of vulnerability during disasters and in post-disaster settings. A study of gender's influence on vulnerability to flood disasters in Bangladesh found that women were far more likely to suffer severe impacts than men, for a number of reasons linked primarily to cultural differences and gendered power relations (Ikeda, 1995). Women were found to be far more likely to have drowned, which can be linked to cultural restrictions on swimming lessons for women, have low access to information on disaster warnings and evacuation plans (low literacy levels, low access to information generally) and their culturally assigned role as caregivers (more likely to be trying to assist the evacuation of children and elderly family members). Women are also more likely to be exposed to risks of gender-based violence in post-disaster situations (Felten-Biermann, 2006; Anastario et al, 2009).

1.2 Public policies on disaster preparedness

How do public policies on disaster preparedness influence mobility outcomes?

Public disaster risk reduction (DRR) policies have a strong influence on mobility outcomes in disaster situations. Early warning systems in combination with clear (and drilled) evacuation plans can go a long way toward reducing fatalities and limiting the impacts of displacement on populations which are often already subject to multiple vulnerabilities. Contingency planning - such as stockpiling of emergency supplies at strategic locations, or the construction of storm shelters and evacuation routes – can further limit the impacts of disasters on exposed populations. Where such measures are in place, there are far less likely to be high numbers of people displaced in distress conditions to disparate locations where they are unable to access assistance.

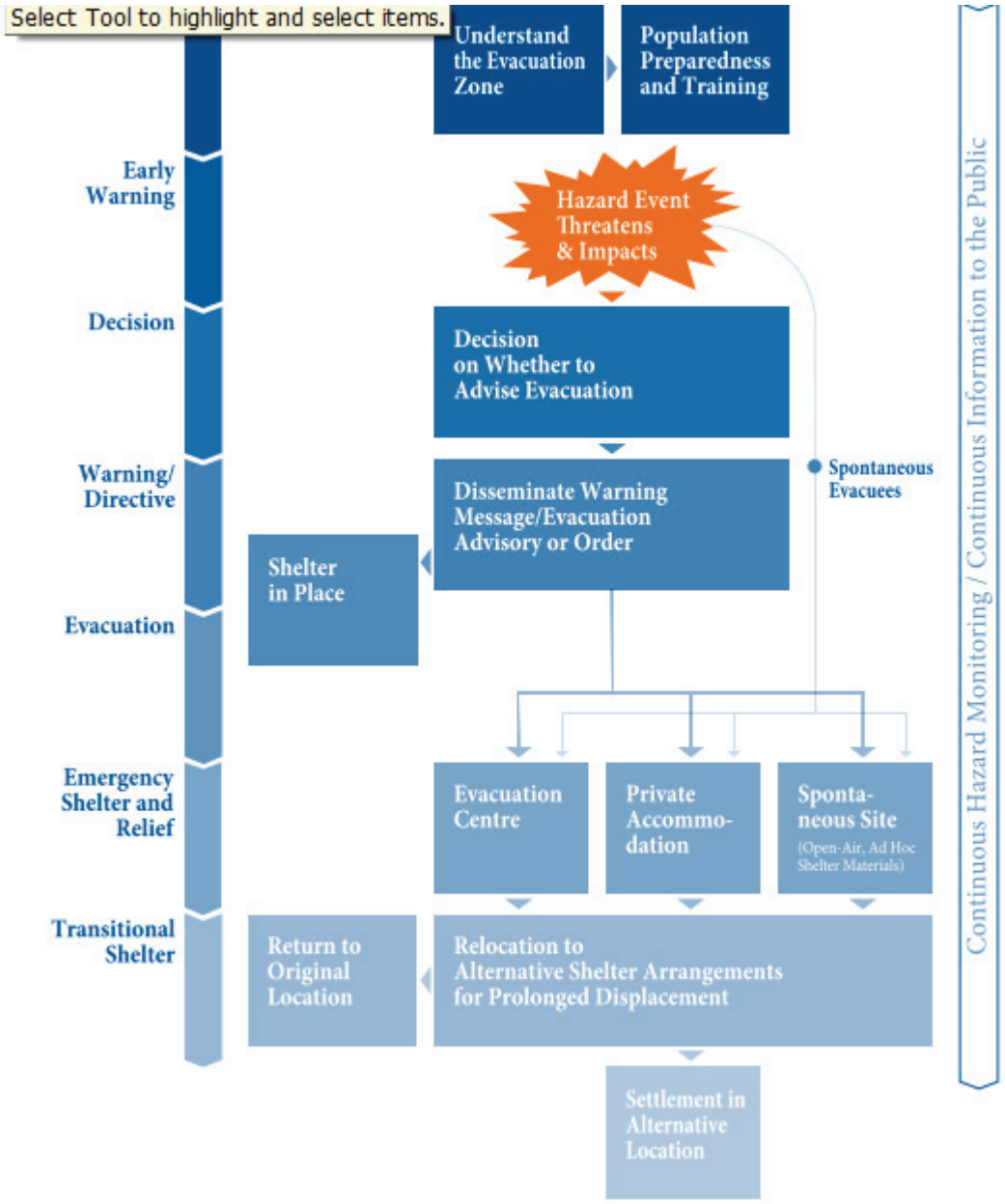
Preparedness measures must take account of specific vulnerabilities within communities, such as education policies and provision, and economic status. For example, levels of education and cultural factors (such as gender roles) can determine access to and understanding of crucial information (such as local evacuation plans).

Cuba's example in resilience to disasters

"Cuba, however, offers a lesson in resilience. All Cubans are taught what to do when hurricanes approach from an early age. Disaster preparedness, prevention and response are part of the national curriculum, and people of all ages take part in drills, simulation exercises and other training. The island's civil defence system and meteorological institute are pillars of its disaster risk management system, and every individual has a role to play at the community level as a storm bears down. Schools and hospitals are converted into shelters and transport is quickly organised. Around 1.7 million people were evacuated before and during Irma, keeping them safe from its destructive power and demonstrating that, when managed as a resilience measure, displacement need not always be a negative outcome."

Source: IDMC (2018:44) *Global Report on Internal Displacement (GRID)*

Figure 1: The evacuation process



Source: Camp Coordination and Camp Management (CCCM) Cluster, 2014: 22.

1.3 Drivers shaping disaster displacement at the macro-level

Displacement risk is based on the hazard itself (type, intensity and frequency), exposure (people located in hazard-prone areas) and vulnerability (sensitivity to hazard impacts). Displacement risk is projected to increase in many countries (Ginnetti/IDMC, 2015), driven by each of these three components.

Hazard

In regard to the hazard component, climate change is widely expected to increase the frequency and intensity of natural hazards like floods and storms, although not uniformly across continents (IPCC, 2012:10-13).

Exposure

Exposure is currently increasing, driven by population growth in hazard-prone areas, a trend which looks likely to increase into the future (Ginnetti/IDMC, 2015). Using their own data and a modelling of disaster displacement since 1970, IDMC has been able to develop estimates of those at risk of being displaced in the future by such hazards, using Probabilistic Risk Assessment methodology (Ginnetti, 2015). IDMC's projections show a clear upward trend over a 10-year timeframe.

Figure 2: IDMC's Disaster-Displacement Risk Index (10-year projection)

Focus Region	Population	Average Annual Displacement Risk	Relative Annual Displacement (per 1 million people)	Annual change in displacement risk
S Asia	1,730,000,000	9,200,000	5,300	3.7%
SE Asia	1,990,000,000	30,000,000	15,100	2.4%
S Pacific	10,800,000	45,600	4,200	2.4%
LAC	186,000,000	809,000	4,300	2.5%

Source: Ginnetti, 2015: 23[5]

Population growth is driven by two main factors: natural growth (fertility rates) and net migration. Growth driven by both of these elements is occurring rapidly in hazard-prone areas across the globe, notably cities in low-lying coastal areas, and is an important driver of displacement risk, particularly in coastal mega-cities in Asia which are already exposed to severe tropical cyclone events such as floods and storms (Foresight, 2011). Migration into exposed locations looks set to continue, notably in the context of urbanisation. Many of the countries most exposed to natural hazards are low- or middle-income countries with levels of urbanisation which are still relatively low but increasing fast. Paradoxically, many people are leaving rural areas partly as a result of negative environmental pressures but are moving to urban areas in which hazard risk can be just as high or potentially higher (Foresight, 2011).

Vulnerability

At the macro-level, vulnerability often reflects low levels of socio-economic development. Low literacy rates, for example, can make it more difficult for public authorities to ensure effective communication of disaster risk, including in regard to early warning systems and evacuation plans. Poor housing in disadvantaged areas (where inhabitants are unable to afford houses made of sturdy, more hazard-resistant materials) can leave inhabitants more vulnerable to storms. Lack of access to a privately-owned motor vehicle can be a concrete example of how low income can impact vulnerability to hazards. This was documented as a factor explaining why some disadvantaged residents of New Orleans were unable to flee Hurricane Katrina in 2005.

Populations of fragile States are particularly vulnerable to natural hazards. The Organisation for Economic Cooperation and Development (OECD) defines fragility as "is the combination of exposure to risk and insufficient coping capacity of the state, system and/or communities to manage, absorb or mitigate those risks. Fragility can lead to negative outcomes including violence, the breakdown of institutions, displacement, humanitarian crises or other

[5] LAC = Latin America and the Caribbean.

emergencies" (2016: 22). Populations of fragile States are unlikely to benefit from disaster preparedness or relief measures (unless provided by external actors) and are likely to be particularly reliant on social support networks when disaster strikes.

Unmanaged or poorly managed urbanisation linked to development levels - but also to governance / capacity – can also drive vulnerability to hazards. It can result in economically disadvantaged groups (including migrants from rural areas) settling in urban peripheries subject to higher hazard-risk (such as flooding and landslides) and without access to key infrastructure and services (which may affect their ability to receive warnings of imminent hazards, and ability to evacuate, for example if there are no tarmac roads, or inadequate drainage systems).

Cultural norms such as gender roles can also drive vulnerability, for example by imposing constraints on women's mobility. These are just some among many possible examples of vulnerability embedded in socio-economic conditions.

Another key component of vulnerability is capacity (often described as 'adaptive capacity' in regard to capacity to address climate change impacts). Developing countries often lack the financial and technical capacity to manage risk through disaster risk reduction infrastructure. For example, complex sea defence systems may require finance, technology and engineering expertise unavailable in most developing countries. However, capacity may also take other forms. Adaptive capacity also has a social dimension, in which strong 'social capital' (networks, institutions etc.) facilitates adaptive response.

Many developing countries lack financial and technical capacity, and it is crucial for them to build and develop social capital to reduce vulnerability and increase resilience. Nevertheless, some developing countries already have strong informal community networks and norms which can provide crucial support in the event of a disaster, also in regard to preparedness and recovery (Aldrich et al., 2018). Even for technical infrastructure projects, the social dimension often plays an important role.

It is hard to assess how these drivers of displacement risk will evolve into the future, and of course much will depend on contextual factors specific to a given location. However, it seems likely that – due to continued urbanisation and population growth, risk will continue to increase fastest in urban areas, primarily in low- and middle-income countries.

2 Mobility in the context of slow-onset events

Slow-onset events, ranging from drought to sea-level rise, impact human mobility in complex ways. Human vulnerability shapes mobility responses and indeed can determine whether moving is even an option. At the same time, mobility responses shape future vulnerability. The degree to which alternative options are available is a key factor in analyzing vulnerability and mobility in these contexts – the degree to which mobility (or immobility) is a choice, or is the result of the absence of alternatives. Two examples will be considered in order to illustrate these complex relationships. The first part of this section will analyse the impacts of sea-level rise, while the second part will examine the impacts of environmental change on agricultural livelihoods, focusing on smallholders.

2.1 Sea-level rise

Predictions of future sea-level rise vary widely according to different scenarios for carbon emissions and temperature rise (IPCC, 2014). There are also high levels of uncertainty as regards certain future tipping points, such as the melting of major ice sheets, which would produce non-linear increases with potentially massive impacts on human settlements and systems (IPCC, 2014). However, sea-level rise is already happening gradually, and there is high agreement among scientists that even if action is taken now to cut or prevent the emission of greenhouse gases - limiting the magnitude of future warming – sea-level rise will continue, due to the time-lag between current and past emissions and their future effects (climate scientists talk of 'locked-in' impacts – see University of Exeter, 2017). Sea-level rise has major human mobility implications for the populations of low-lying coastal areas. The exposure of vulnerable populations in Small Island Developing States (SIDS) has been well documented (IPCC, 2014), but there is also an increasing awareness of the growing exposure of often vulnerable populations in large coastal cities, particularly in Asia where a number of rapidly growing 'mega-cities' are situated only a few metres above sea-level (Foresight, 2011).

Sea-level rise impacts human mobility in different ways. While permanent inundation of land and settlements is often the image conjured up by the concept of sea-level rise, there are in fact a range of ways in which sea-level rise impacts human activities and settlements. In many cases, people will use mobility as a response well before the stage of inundation, as the severity of other related impacts increases.

Sea-level rise produces the following main impacts for humans:

- Salinization of groundwater in coastal areas
- Increased vulnerability of coastal areas (settlements and land) to flooding from storm surge and related salinization of agricultural land
- Coastal erosion
- Permanent inundation of coastal land and settlements. This can lead to rapid-onset floods for coastal areas situated beneath sea-level (there are large parts of the Netherlands situated below sea-level for example).

Salinization of groundwater and agricultural land can gradually erode the livelihoods of people in rural coastal areas, and lead to the use of temporary or seasonal migration as a livelihood diversification strategy, with permanent out-migration (or planned relocation) becoming more likely as crop yields decrease over time. In water-stressed coastal urban settlements the reduced

availability of fresh groundwater could potentially contribute to out-migration, particularly in developing countries lacking the capacity to implement alternative water-supply solutions (desalination plants, or diversion of rivers for instance).

Increased vulnerability to storm surge flooding could lead to increased displacement, depending on capacities to implement disaster preparedness measures. This is a particular concern for low-lying coastal cities, particularly in Asia, where small increases in sea-level can translate into significantly more destructive tropical cyclone impacts.

In the longer term[6], inundation (and recurrent storm-induced flooding) is likely to lead to permanent out-migration and planned relocation, though the scale of the challenge would be daunting in terms of relocating entire city populations. The most exposed will often be the poorest and most vulnerable. In coastal cities for example, pressure on land for urban expansion (fueled in part by in-migration from rural areas) often results in slum-type development on urban peripheries in low-lying flood-prone land lacking basic infrastructure. In some cases, this type of expansion is not even on land, with cities such as Lagos seeing slum expansion in the form of flimsy housing raised on stilts in the water (Douglas et al., 2008; Baker [ed.], 2012).

The issue of capacity – a component of vulnerability – is an important one in this example. The Netherlands for example has the technological and financial capacity to implement large-scale sea-defence systems to protect land and settlements; many exposed countries in Africa, Asia, the Pacific and the Caribbean lack the capacity and resources to protect coastal settlements from sea-level rise impacts. As referred to above, the social dimension of adaptive capacity should also be taken into account. Many developing countries affected by sea-level rise might lack financial and technical capacity for large-scale sea-defence infrastructure projects, but the social dimension nonetheless often plays an important role in shaping the resilience of affected populations.

Due to the continued growth of large urban settlements in low-lying coastal areas, the threat posed by sea-level rise looks set to increase progressively into the future.

2.1.1 Planned relocation

Planned relocation may be necessary in cases of irreversible degradation/inundation of land. Determining the point at which land becomes uninhabitable can be contentious, with differing definitions and perceptions of habitability. For example, inhabitants' views may not coincide with government views on the fertility of land. Relocation should generally be considered a last resort, due to the sizeable challenges it poses, both for the population to be moved and the population at the destination. Relocation needs to be carried out in an inclusive way, involving the participation and consent of the community to be relocated and the destination community.[7] Providing sustainable livelihoods at destination is a particular challenge.

As stated above, many people will not wait for the situation to deteriorate to this point, and will move away autonomously (permanent out-migration). However, in some cases people will not move. These 'immobile' populations are of increasing concern, as they are often the most vulnerable members of society. Immobility may either be the result of not having sufficient resources to move (unable to move, or 'trapped') or of a decision not to move, for a range of reasons, such as cultural ties to the land they inhabit. The latter may be a particularly important

[6] The timeframes here can range from years to decades or potentially even longer.

[7] International guidelines for relocation have been developed. Specific guidelines for relocation in the context of environmental change and disasters were recently developed by a consortium of agencies and academic institutions, following consultations with states (see Brookings Institution et al, 2015).

issue in Pacific island states threatened by sea-level rise, where ancestral and spiritual ties to the land can be extremely strong.

There are already a number of examples of relocations linked to sea-level rise, such as in Fiji (see Gharbaoui and Blocher, in Milan et al [eds], 2016; Tronquet, in Gemenne et al [eds], 2015) or the Gunayala islanders in Panama (Displacement Solutions, 2014). These have so far been limited to internal relocations (usually to nearby islands with higher elevation), but international relocation could potentially be needed in the future if worst case scenarios become reality. International relocation poses a whole range of operational and cultural challenges and raises some highly complex and controversial questions about the continuation of national sovereignty if a State's territory has disappeared.

High exposure to sea-level rise and extreme events in Vunidogoloa (located on the second largest island of Fiji,) led to a relocation process that was begun in 2006, with assistance from the government and international organisations. The selection of the destination site was made by the people being relocated, a factor that was deemed critical to the relocation's success (Tronquet, in Gemenne et al [eds], 2015). Similarly, faced with sea-level rise, São Tomé & Príncipe is assisting communities in low-lying coastal areas to move to safer locations nearby (Koskinen-Lewis et al, 2016). Confronted with thawing permafrost and loss of sea ice, the Alaskan village of Newtok is poised to begin relocation to a nearby site (Bronen, 2011).

2.2 Environmental change and agricultural livelihoods

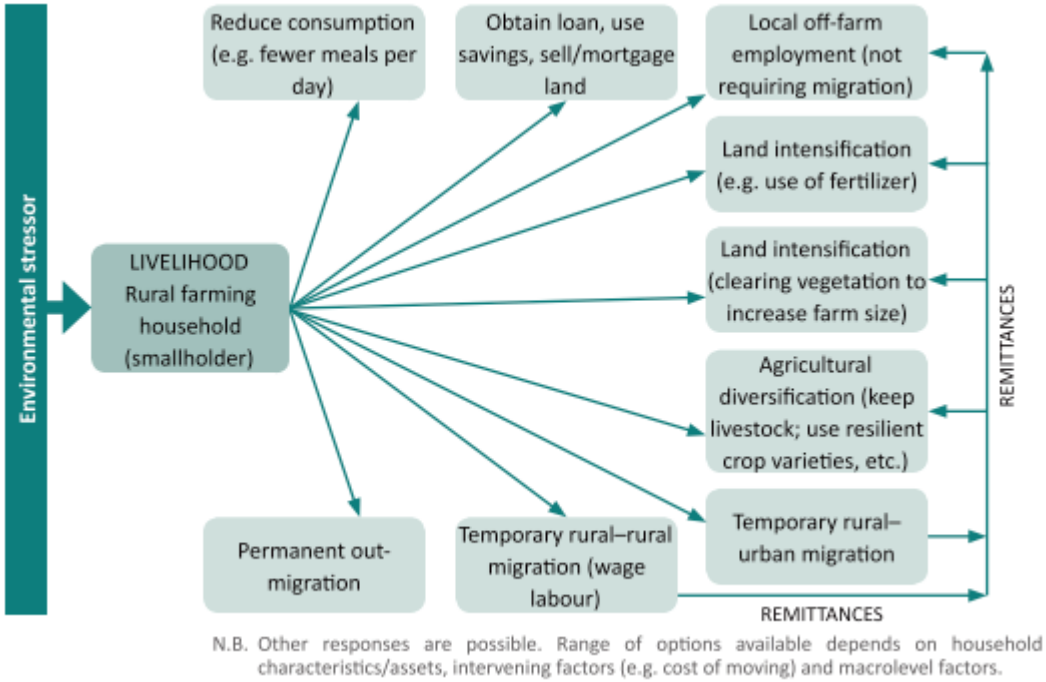
Rural livelihoods are already being impacted by various slow-onset environmental phenomena (FAO et al, 2018), notably climate change and land degradation. This section will take the example of smallholder crop-based agriculture, to illustrate the main transmission mechanisms linking slow-onset environmental phenomena with human mobility.

2.2.1 Smallholder crop-based agriculture

Smallholder crop-based agriculture is prevalent in many of the global regions affected by severe and/or recurrent drought, which include the global 'drylands' and many mountain regions (Foresight, 2011). In many cases, this type of agriculture is dependent on rainfall, with irrigation being either unavailable as an option or financially out of reach (Warner et al, 2012). Smallholders are often extremely vulnerable to climate change impacts, notably rainfall variability (including more frequent or intense droughts) and temperature rise (Foresight, 2011). Climate change often compounds man-made drivers of land degradation such as overly intensive farming. The impacts can be incremental and take place over long timescales, or more immediate, in the case of drought or erratic rainfall. Soil desiccation and erosion gradually render agricultural land less fertile, and crop yields decrease. Combined with other pressures such as population growth, smallholder households are faced with the need to respond. The choices available to them depend on the range of macro-, meso- and micro-level factors described in Paper 1 ("Migration, environment and climate change: Literature Review"). Smallholders engaged in subsistence agriculture, in which everything produced is consumed, are likely to have few response choices, and are therefore highly vulnerable to continued environmental stress (Warner et al, 2012).

The diagram below draws on the sustainable livelihood approach, and looks at how migration is one of several different response strategies which may be available at times of environmental stress, and which can be said to constitute a coping or adaptation strategy.

Figure 3: Possible responses to impacts of environmental stress on livelihoods in farming areas



Source: author's own elaboration, based on Bilsborrow (2009: 135).

The diagram also shows that remittances from migration can potentially be used to invest in longer-term strategies to increase future resilience to environmental stress, such as land intensification or agricultural diversification. The investment potential of remittances varies widely, based on factors such as level of remittances, availability of investment opportunities, level of stability and policy framework (quality of governance, policy incentives).

It is important to clarify the usage of the terms coping and adaptation in this context. The IPCC's definition of climate change adaptation comprises two aspects: moderating harm and exploiting beneficial opportunities. 'Coping' is about meeting basic needs, and therefore corresponds more to the first aspect of adaptation. The second aspect could be seen to fit with the concept of "transformative adaptation", i.e. changing the status quo (building resilience) to no longer be impacted in the same way (Foresight, 2011). In this context, is migration's role limited to a coping strategy, or can it also be a transformative adaptation strategy?

The evidence is mixed. While most studies find that remittances – generally considered the primary mechanism via which positive adaptation effects in areas of origin are obtained from migration – contribute to household resilience, several studies have found that financial remittances have limited *transformative* adaptation potential, since a large proportion of the money sent home is spent on meeting basic household needs such as food and fuel.

Scheffran et al (2012) – looking at remittances from West African diaspora groups in Europe - found remittances being used to invest in community water-supply projects. They also found positive adaptation effects from social remittances[8] in a range of countries - young, professionally trained returnees contributing to environmental initiatives by bringing

[8] Social remittances have been defined as "the ideas, behaviours, identities and social capital that flow from receiving- to sending-country communities" (Levitt, 1998: 927).

knowledge and skills in fields such as the natural resource management, disaster management, technology and agricultural techniques. Such examples indicate the transformational potential of migration in the context of environmental change.

In some cases however, remittances can have negative effects at the community level, for example by exacerbating inequalities between households with a migrant and households with no migrant. Household- and community-level impacts of migration on vulnerability vary greatly according to local contexts.

The multi-country Where the Rain Falls study (Warner et al, 2012) identified different household mobility profiles within communities facing rainfall variability and related livelihood insecurity, which demonstrate the complexity and context-specific nature of the relationship between mobility and vulnerability. Better-off, land-owning households were found to be using temporary labour migration of a family member as a strategy to build their resilience, investing remittances in education, health, climate-resilient livelihood opportunities and risk diversification, while poorer households were resorting to temporary labour migration as a survival strategy, in many cases with incremental, negative effects, such as the effects of whole-household temporary migration in disrupting children's education ('erosion' of human capital). The most vulnerable were the households that struggled to survive in their areas of origin but were not easily able to use migration to adapt (see the final section 'Immobile populations' for analysis of this dimension).

While temporary labour migration of a family member generally helps households to cope with environmental stressors, the 'social costs' of temporary migration are not always adequately taken into account in discussions of the benefits of migration in this context. The 'Where The Rain Falls' project report highlights this aspect, for example the vulnerability of female household members left behind:

> *"adolescent girls and young women also face sexual harassment in the absence of male household members, leading to social stigma and even early marriage, which has long-term negative social and demographic implications."* (Warner, 2012: 75)

Women staying behind may also suffer from an increased workload, especially in rural areas, where a woman may find herself responsible for performing work hitherto undertaken by the man in addition to her existing responsibilities. The hardship often endured by migrants in destination areas also needs to be taken into account. Migration can also increase the vulnerability of men who are separated from their families and often exposed to harsh work conditions.

Permanent out-migration, usually of the whole household, is unlikely until land has become severely and permanently degraded. The slow-onset nature of the environmental change impacts outlined in this section usually allows households to cope for years or decades before coping thresholds are passed, and there is a risk that some households may not move until it is too late, meaning they no longer have the resources required to move away – "trapped populations". This is a major policy concern that was highlighted by the Foresight study's findings (Foresight, 2011). Immobility (including trapped populations), will be considered in more detail in the final section of this paper.

Drought and mobility

Drought is in itself a complex phenomenon, with differing conceptual definitions (hydrological drought, agricultural drought, for instance) and different physical manifestations (duration,

intensity).[9] A drought might be the result of a relatively short period in which crucial seasonal rains did not occur, or a period of several years of below-average rainfall. In terms of human mobility, the crucial aspect here is not the absolute level of rainfall, but the impacts droughts have on human livelihoods.

Drought has major impacts on crop yield, and can result in total crop failure. Although figures are lacking, migration as a response to drought has been widely documented. Findley (1994) documented 'long cycle' labour migration (multiple years) of a household member as a pre-emptive risk management strategy in Mali, with migrants sometimes travelling internationally and sending home significant remittances. However, faced with the recurrent droughts of 1983-1985, this type of 'expensive migration' (in regard to initial outlay) decreased, while short-term migration increased, to local destinations (labour migration, extended family visits, among others). The level of household resources is a key determinant not only of whether migration is necessary or available as an option, but also in regard to the type of migration undertaken (distance, duration). It is also important to consider what other livelihood options are available to the household (see the diagram above).

The severity of the drought can also be an important factor for analyzing drought-induced migration. The combined effects of ongoing conflict and repeated drought years led to a very different form of migration during the Horn of Africa a drought crisis in 2010-2011.[10] The severity of impacts on rural livelihoods led to distress migration[11] of whole households over long distances, including to neighbouring countries. More than 1.3 million Somalis were displaced internally, while an estimated 290,000 Somalis were displaced to neighbouring countries. The conditions in transit and at destination were often characterised by acute and multiple vulnerabilities, with reliance on international aid (camps, food aid and so on).

In the Horn of Africa drought crisis context, migration was clearly 'forced', due to the severity of the drought and the resultant lack of alternative choices available, in a situation of acute food insecurity. However, in less severe cases of drought, households tend to have a degree of choice with regards to how they respond, including whether or not they use mobility as a coping strategy and how they use it (whole household or just one member? Male or female? To a local rural destination or a more distant urban area?).

2.3 Drivers shaping mobility at the macro-level

Sea-level rise

Growing exposure to sea-level rise is being driven largely by population growth in large, low-lying cities, particularly in Asia, a trend which seems likely to continue (Foresight, 2011). In Asia and Africa, the number of people living on flood plains is projected to rise from 114 million in 2000 to 192 million in 2060 (Foresight, 2011).

Rural-urban migration is contributing to urban population growth, particularly in Asia. The potential for rural-urban migration to continue to be an important factor varies by region according to the extent of existing urbanisation (highly urbanised regions -including South

[9] "Drought: A deficiency of precipitation over an extended period of time, usually a season or more, which results in a water shortage for some activity, group, or environmental sectors." (UNISDR, 2009: 8)

[10] For more detailed information see Schrepfer and Caterina (2014).

[11] FAO defines distress migration as "all migratory movements made in conditions where the individual and/or the household perceive that the only viable livelihood option for moving out of poverty is to migrate. Such distress is usually associated with lack of livelihood options, given the limited economic and employment opportunities, as well as drought, crop failure and food insecurity.(FAO, 2016)

America – would be less affected). There is high uncertainty in regard to how this increased exposure will influence human mobility, with much depending on capacities and governance.

Some of the at-risk cities or areas are located in middle-income countries in Asia or small island states may have the capacity to address sea-level rise through expensive sea-defence measures or planned relocation, although there is uncertainty as to whether (and when) effective policies will be implemented in light of vulnerability and for instance lack of social capital to mitigate effects. In low-income countries which lack such capacities - including several small island states – sea-level rise could result in significant levels of displacement, migration and planned relocation even if appropriate policies are put in place and financed. In some cases, a combination of mitigation measures and planned movements may occur. An often-studied case of an at-risk city is Jakarta (Indonesia), where several human-made problems, in combination with sea-level rise, led to the decision of the government to relocate the capital to Borneo within the next ten years (see for instance Abidin et al., 2011; Takagi et al., 2016). However, in Jakarta as in other at-risk cities, assessments of climate change-related vulnerabilities tend to focus on the physical aspects of climate-change impacts; the impacts on local socio-economic conditions as well as an assessment of specific intervening factors that determine local exposure to sea-level rise (such as building on sand and clay; enormous illegal groundwater extraction leading to a sinking of the groundwater level and thus the city, in turn increasing exposure to the impact of sea-level rise; population growth faster than infrastructure and so on in case of Jakarta) tend to be neglected (Firman et al., 2011). Thus, different cases need to be studied in detail to draw out the continuum of (in)habitability and resource endowments in each context.

Rural areas are more likely to be affected by the impacts of sea-level rise on crop-based agricultural livelihoods (and also coastal aquaculture in a number of regions). Temporary and permanent migration to nearby urban areas are likely responses, which may paradoxically result in increased exposure to risks if moving to coastal settlements.

Smallholder crop-based agriculture

The preceding section highlighted the influence of slow-onset environmental drivers on mobility, noting that temporary/seasonal/circular migration – usually internal (within country) and involving one or more household members – is a common response, but that the impacts on vulnerability are not always positive. This section will now consider some of the broader contextual factors which shape mobility in this context.

The economic context is likely to be a strong 'push' factor in shaping mobility decisions. Stagnating rural incomes are a challenge for many smallholders, which may be linked to environmental factors (failed crops or low crop yields), but may also be explained by other factors such as changing market dynamics (low producer prices; changes to demand patterns). Pressure on producer prices is likely where smallholders are in direct competition with large, commercial farms using advanced mechanisation, fertilisers/pesticides/seed varieties and benefiting from economies of scale. The availability of (higher) paid employment –in both urban and rural areas - can also constitute a strong 'pull' factor, particularly where distances are not great, and social networks can facilitate the migration process.

Demographics may also drive out-migration of smallholders, such as when high birth rates translate into land fragmentation (inheriting ever-smaller parcels of land), or pressure on water resources (groundwater, lakes, rivers).

Youth in rural areas facing the kinds of challenges described above (environmental, economic, demographic) may also be drawn to urban areas by 'social drivers', in particular the prospect of obtaining better education or work opportunities.

Political drivers can also play an important role, notably in relation to governance. Inadequate governance or indeed situations of prolonged conflict or persecution can be important drivers of migration, and are often interwoven with environmental drivers, leading to prolonged 'complex crises' (see section 3.4 below). Policy and legal frameworks are other poltical drivers which can also strongly influence migration.

National policies on rural development or climate change adaptation for example could lead to support for rural livelihoods and encourage people to cope or adapt in situ. However, the impacts on migration can be diverse, depending on the emphasis of support strategies. Where support focuses on livelihood diversification (including off-farm employment opportunities), the likely effect would be to reduce migration. Where support focuses on improving agricultural productivity (mechanisation and access to modern inputs), the need for labour is reduced and may result in higher migration.

The strong global trend toward continued urbanisation may limit the impact of policies aiming to reduce rural out-migration but does not necessarily invalidate them. Much will depend on contextual factors – for example, birth rates in rural areas, or the capacity of urban areas to accommodate in-migration (employment opportunities, access to housing and essential services). Growing exposure to hazard risk in many urban areas (particularly mega-cities in low-lying coastal areas) could also contribute to slowed rural-urban migration in the future, but this remains uncertain at present. Improvements in energy supply, access to essential services such as health and education as well as improvements in land productivity and agro-forestry systems can allow more people to live sustainably in rural areas. Policies and laws relating to land can also have major impacts on rural livelihoods and human mobility. Informal and insecure land tenure frameworks for example may discourage temporary migration due to the fear of one's land being taken during a period of absence (de Brauw and Giles, 2008) and limit the potential for permanent out-migration (unable to sell one's land). Land-use policies can also affect smallholders – particularly in contexts of insecure land tenure – when smallholders' land is requisitioned for large projects or other purposes, often without compensation. Examples include large infrastructure projects, commercial farms and ranches, and development of extractive industries. There is a risk that policies designed to address climate change can also result in the relocation of smallholders, such as hydropower projects as part of adaptation strategies or reforestation projects under mitigation plans (Mcdowell, 2011).

3 Linkages between environmental change, conflict and mobility

The linkages between environmental change, conflict[12] and mobility are complex. However, there is a tendency in international climate diplomacy for example to assume that climate change will cause migration and that this migration will translate into conflicts in receiving areas. This linear, deterministic analysis is based on a number of assumptions which need to be challenged. We have seen in preceding sections of this paper that the cause-effect chain between environmental change and migration is often hard to establish, acting through diverse mechanisms, often in indirect ways, and in conjunction with a range of contextual factors. This complexity is equally present in regard to the migration-conflict linkage, which is the focus of the following analysis.

Firstly, it is important to distinguish between different types of environmental migration. As we have seen in preceding sections, disasters create very different patterns of movement in relation to slow-onset processes such as sea-level rise or desertification. Vulnerabilities are also very different. Why does this matter? Perhaps unsurprisingly, studies of the effects of in-migration on receiving communities have found that tensions are more likely in the case of large-scale influxes taking place over short timeframes, particularly where the influx modifies existing socio-economic, environmental or cultural balances (IOM, 2013).

3.1 Climate change-related displacement and conflict

There is a lack of evidence regarding conflict potential resulting from large-scale disaster-induced displacement. However, studies of large refugee influxes to camp settings have found evidence of conflict with local communities over access to natural resources such as timber, and environmental degradation in areas around camps (Berry, 2008). So, can it therefore be expected that, since climate change is predicted to contribute to increased disaster displacement risk,[13] that climate change will drive conflict in receiving communities? There are good reasons to suppose that disaster-induced displacement is in fact less likely to result in conflict in receiving areas compared to conflict-induced displacement. Unlike displacement resulting from conflict which often generates refugee flows to neighboring countries, people displaced by disasters are usually displaced within their own country, and therefore less likely to be perceived as a threat. Refugees are more likely to be of different ethnic origin, not speak the local language, and may potentially be targeted by warring parties from the origin state (e.g. recruitment of fighters, usage of refugee camps as safe retreat zones), representing therefore a threat of conflict spillover.

It is also widely recognized that people displaced by disasters are likely to return relatively quickly to their homes compared to those displaced by conflict, though protracted displacement can occur in both scenarios. People displaced by disasters are in fact more likely to be met with solidarity than hostility. Nonetheless, there is more scope for tensions where the displacement is large-scale and protracted, where local capacity to integrate newcomers is limited, and where external assistance is inadequate. There are different contexts in which this can play out, urban and rural, camp and non-camp settings.[14] The presence of large populations of people in camps

[12] In this paper, conflict is used broadly to describe competition over for instance scarce resources, tensions, and armed conflict.

[13] See Ginnetti, 2015.

[14] In the same way as for conflict-induced displacement.

can lead to significant pressure on natural resources in the surrounding area (Naser, 2015), such as when as camp inhabitants compete with locals for timber for charcoal fires.

3.2 Climate-change related migration and conflict

As we have seen in preceding sections, people move in diverse ways in response to slow-onset environmental stressors. At the earlier stages of stressors like land degradation, mobility is more likely to be in the form of temporary labour migration of a household member(s), and movements will be to a range of (usually internal) destinations, both rural and urban. Migration of this kind can actually reduce the likelihood of conflict in the origin area, through reduced population pressure on resources, and decreased reliance on the environment for livelihood of those left behind, such as when remittances are received from migrants in urban areas.

Impacts on receiving areas are likely to be diffuse, and the potential for conflict is low (Kita and Raleigh, in McLeman and Gemenne [eds], 2018). In a similar vein, autonomous permanent out-migration of whole households is likely to occur internally and incrementally, and therefore the impacts in receiving areas are unlikely to exceed coping capacity. When tipping points are reached, there is more potential for tensions if large numbers of people are moving over relatively short timeframes, to destinations already straining to cope with existing challenges. Planned relocations of whole communities may also pose more conflict risk than incremental in-migration, particularly when receiving communities are not adequately involved in the planning and implementation stages.

3.3 Conflicts involving pastoralists

The case of pastoralists is a particular one,[15] as their livelihoods are based around mobility, moving herds in line with seasonal changes along established routes (often across international borders) to ensure adequate access to water and pasture (IOM, 2010).

3.3.1 Pastoralist livelihoods under pressure

Pastoralism takes different forms (seasonal, nomadic, semi-nomadic), but the implications of increasingly recurrent drought for pastoralist livelihoods are common to all forms. Increasingly recurrent drought and other climate change impacts, in conjunction with diverse political and demographic factors (political marginalisation, land-use restrictions, land grabbing, population growth, etc.) are leading to pressure on pastoralist livelihoods, as they struggle to adapt to less predictable weather cycles and longer journeys to get to water points and grazing pasture for their herds (IOM et al, 2010).

In Tanzania, Maasai herders working as security guards have become a common sight in towns and cities, usually in the form of temporary labour migration to supplement income through remittances (Munishi, 2013). Tacoli (2011) questions the extent to which this fits with the 'migration as positive adaptation thesis', noting the often precarious conditions of work and accommodation, low pay and cultural dislocation.

Schrepfer and Caterina (2014) point out that pastoralists can also be displaced. They define pastoralist displacement thus:

"Internally displaced pastoralists are persons or communities who have lost access to their habitual pastoral living space as a result of or in order to avoid the impacts of conflict, violence, human rights violations, cattle rustling, natural or human-made disasters, or similar sudden onset events, as a result of drought, environmental degradation or similar slow onset processes, due to direct

[15] For a more detailed discussion of these issues, see IOM (2010)

intervention by state or private actors, or due to a combination, sequence or accumulation of any of the aforementioned causes, and who have not crossed an internationally recognised state border" (Schrepfer and Caterina, 2014:20).

3.3.2 Conflicts

Conflicts between pastoralist groups and sedentary farmers are reported to be on the increase in some areas (notably in the African Sahel) and climate change is often cited as a factor (FAO, 2018; IOM, 2010, UNEP et al, 2011). Climate change, through its effects on drought and rainfall variability, is disturbing traditional pastoralist migration routes, often forcing them to travel greater distances in search of water and pasture. Conflicts arise when pastoralists graze their herds on agricultural lands, though this may in some cases be due to farmers having cultivated land that was previously pastoralist rangeland (IOM, 2010; UNEP et al, 2011).

Conflict is also reportedly on the increase *among* pastoralist groups in the Greater Horn of Africa (IOM, 2010. While conflict between groups is not new (cattle rustling has a long history in the region), climate change impacts on pastoralists' traditional migration routes is a contributory factor for conflicts which are increasingly of an armed nature due to the prevalence of light weapons in the region (recent and ongoing inter-state and intra-state conflicts).

However, the importance of climate change as a driver of conflict in these two scenarios must be nuanced. It is more likely to exacerbate the impacts of other conflict drivers than to be a trigger of conflict (IOM, 2010). The significance of pre-existing conflict as a conflict facilitator (availability of light weapons) has already been noted above, but drawn-out conflicts of the kind experienced in many countries in the region also contribute by destabilizing governance mechanisms and impacting on levels of development/resilience among affected populations (IOM, 2010).

Other contextual factors include demographics, and rising pastoralist populations potentially contributing to over-grazing via increased herd size (UNEP et al, 2011), although statistics on these elements are lacking (pastoralist groups are not easily pinned down for census exercises for example, and births and deaths are not necessarily registered).

Governance is possibly the most important factor, with pastoralist groups often marginalized from decision-making. Pastoralists' rangelands usually have no legally protected status, and are therefore vulnerable to land-grabbing or land-use policies which restrict access, such as conservation areas in the border areas between northern Tanzania and southern Kenya (Mbonile, 2006). The restrictions imposed by such measures go beyond access to the land in question, as they can result in pastoralists having to travel greater than usual distances to reach alternative pasture and water points. It is these kinds of disruptions to traditional migration routes (exacerbated by environmental factors) which drive conflict risk. This can result in grazing herds on farmland, provoking conflict with farmers, or encroachment on other groups' rangelands/routes (UNEP et al, 2011; IOM, 2010).

Looking to the future, it seems likely that climate change will further exacerbate existing environmental challenges for traditional pastoralist livelihoods. However, it would seem that there is significant potential to counter the conflict potential of such a trend, notably through more accommodating governance frameworks which bring pastoralist groups into decision-making processes, facilitate their mobility, and promote peaceful conflict resolution mechanisms (IOM, 2010).

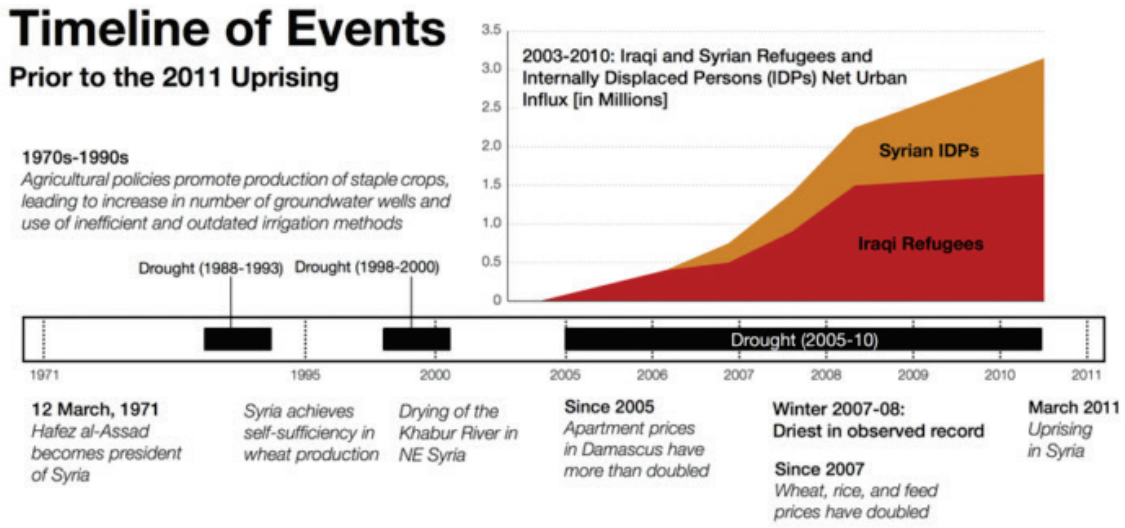
3.4 Complex crises

Climate change, (forced) migration and conflict are more likely to be interlinked in complex crises, where climate change exacerbates the effects of existing conflict drivers (threat multiplier) (WBGU, 2008). These often relate to governance (weak or oppressive), demography (population growth), poverty/pressure on livelihoods, resource scarcity and man-made environmental degradation. States affected by fragility and conflict are particularly susceptible to the effects of climate change on conflict, as they often combine many of these factors.

While it is important to avoid overstating the supposed influence of climate change in relation to other factors, there are some examples which would seem to indicate climate change-conflict-migration linkages.

A 2015 study of the Syria crisis[16] attracted widespread attention for the prominent role it attributed to climate change in igniting the ongoing crisis. The study found that climate change had contributed to the recurrent droughts (2005-2010) in the years leading up to the outbreak of the war in 2011, and by pushing large numbers of farming families off the land and into urban areas – combined with other factors such as rising food prices – it contributed to political instability and the subsequent conflict. The study's 'climate change link' has been criticized by several scholars who prefer to underline the importance of governance failings in explaining the genesis of the conflict. However, this example shows the potential for environmental migration to exacerbate existing instabilities, even if the exact role of climate change or the relative importance of different factors are contested. It is important to note in the Syria example the scale and rapidity of net migration to urban zones during the extended drought period from 2005-2010, which also included conflict refugees from neighbouring Iraq as an additional destabilizing factor. This is presented in the figure below.

Figure 4: Timeline of events prior to the 2011 uprising in Syria



Source: Kelley et al (2015)

[16] Kelley (2015)

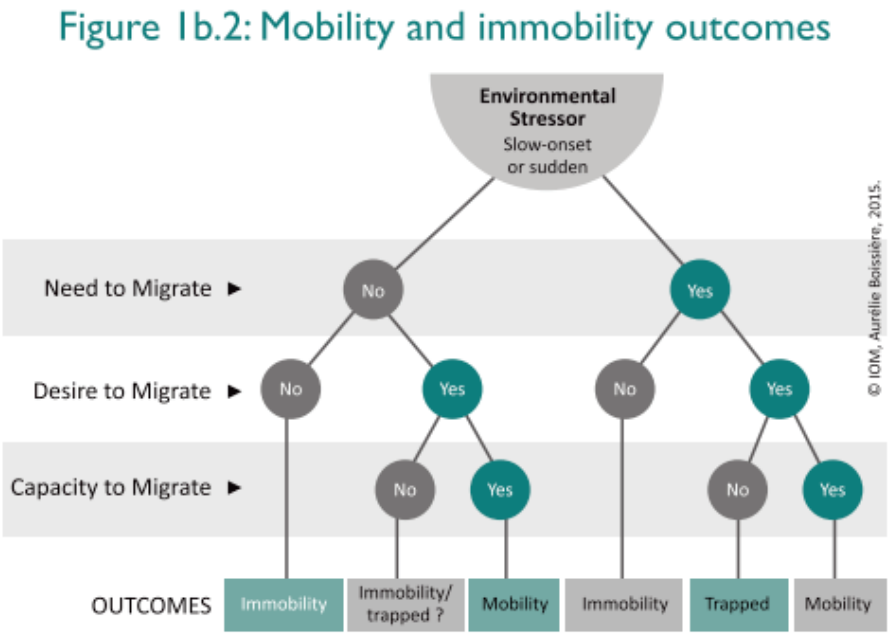
3.5 Drivers shaping the environment-mobility-conflict nexus at the macro-level

The wide array of contextual factors described above makes it impossible to predict future evolutions of the environment-mobility-conflict nexus with any degree of certainty. Nonetheless, environmental change – through its impact on sudden and slow-onset events – looks set to continue to exacerbate a range of potential conflict drivers. Whether human mobility acts as a threat multiplier will depend on many factors, but as we have seen in the context of restrictions on the mobility of pastoralists, the relationship is a complex one.

4 Immobile populations

Many people do not move away from areas exposed to environmental stressors. Across the globe the number of people living in areas exposed to sudden- and slow-onset environmental stressors is growing, with key drivers being population growth, climate change and urbanisation.[17] As such, the prevalence of immobility in vulnerable areas is a growing policy concern. The reasons why people do not move away from environmental stressors are diverse, but broadly speaking can be divided into two overarching categories. Non-migration in the face of environmental stressors can be the result of choosing to stay (voluntarily immobile), or being unable to leave (involuntarily immobile, or "trapped") (Zickgraf in Mcleman and Gemenne [eds], 2018; Adams, 2016).

Figure 5: Mobility and immobility outcomes



Source: Ionesco, Mokhnacheva and Gemenne, 2016.
Note: Conceptualized by Caroline Zickgraf and Nathalie Perrin.

4.1 Choosing to stay

People may choose to stay for a wide variety of reasons. These 'immobile' populations are not necessarily characterised by high levels of vulnerability in terms of capital (financial, social, among others). Reasons for staying may be based on perceptions of risks[18] and opportunities, or the strength of social or spiritual ties to home (e.g. ancestral ties to land). They nevertheless constitute a category of people which is vulnerable to the impacts of environmental change (Zickgraf, 2018).

[17] In the case of rural-urban migration to low-lying coastal cities in Asia and some parts of Africa, people are often moving away from certain types of environmental risk towards new ones (Foresight, 2011).
[18] Risk perception can relate to both sudden- and slow-onset stressors.

The importance of perception is clear among the reasons listed below by Hunter (2005: 281-282, based on Kates, 1962; expanded by Fordham, 1992) to explain why people exposed to environmental hazards or change may opt not to move. "Residents may:

1. not be aware of the hazard;

2. be aware, but do not expect a disaster;

3. expect a disaster, but do not anticipate loss;

4. expect loss, but not serious loss;

5. expect serious loss and have undertaken, or are planning to undertake, loss reduction actions;

6. expect loss, but have accepted [it] as costs of gaining locational benefits.

7. have no choice in location."

Perception is also "very important in determining whether or not people undertake adaptive measures – perception of risk, perceived efficacy of adaptation, perceived cost of adaptation" (Kniveton, 2009:62). This includes decisions on whether to undertake migration as an adaptive measure.

Wealth is an unreliable determinant of (im)mobility. For example, wealth can make it easier for people to move (private transport, costs of settling elsewhere), but can also mean people choose to stay where they are.

> *"When relatively wealthy people decide to remain in an area impacted by environmental change, it may be a reflection of capacity to cope, the result of a cost–benefit analysis (locational amenity) or, conversely, could reflect constraints on mobility (investment in property or business which cannot be left behind without incurring serious financial loss)." (IOM, 2016)*

Financial loss in this context could be exacerbated by informal tenure (legal ownership) frameworks which make it difficult to sell. In the case of planned relocation schemes, insufficient compensation could be an important consideration in the decision to stay.

Cultural and social ties to place can also be important determinants of immobility. This may be a particularly important issue in Pacific island states threatened by sea-level rise, where ancestral and spiritual ties to the land can be extremely strong. In the Pacific island state of Kiribati for example, which is already experiencing an array of climate change impacts, there is very strong attachment to the land inherited from ancestors, "which is often considered as an extension of the self and on which their identity, traditions, myths and knowledge are strongly dependent" (Ionesco et al, 2017). As a result, many are unwilling to leave, fearing the loss of traditions, but are increasingly vulnerable to climate change impacts.

4.2 Unable to leave: Trapped populations

People may be unable to leave ('trapped') if they lack the requisite 'capital' needed to move. Key types of capital needed are financial (wealth, access to credit), social (networks in potential destinations), and human (skills, knowledge). These people may be among the most vulnerable to the impacts of environmental stressors, combining multiple vulnerabilities (Milan and Ruano, 2014; Warner et al. 2012). Their physical exposure to risk is also likely to be higher, as many are

forced to live in some of the most exposed areas, such as urban peripheries or flood-prone areas, where land and houses are more affordable (Foresight, 2011).

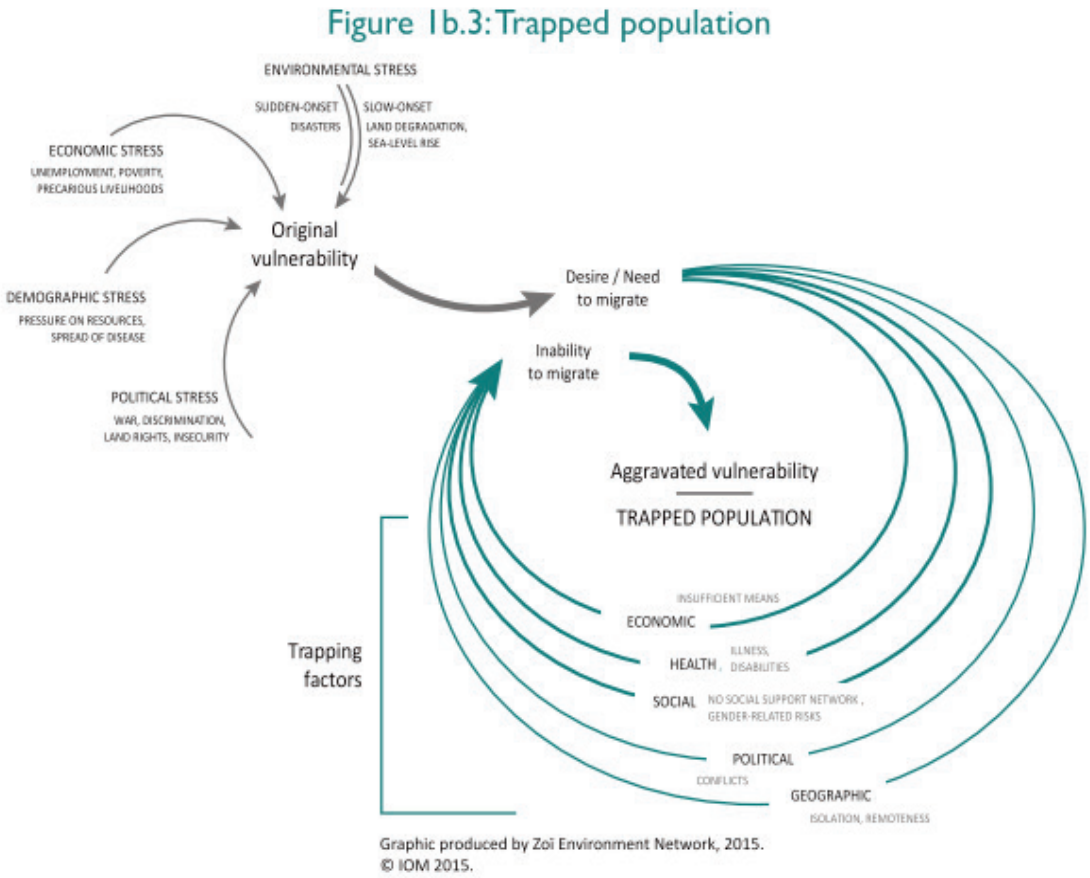
> *Poor health, limited access to information, belonging to marginalized groups, and isolation can all be factors undermining the ability to leave hazard-prone or gradually degrading environments (…) When disasters strike, they may be unable to gain access to help and critical services. When Hurricane Katrina struck the Gulf Coast of the United States in 2005, about 15 per cent of the residents of New Orleans (60,000 people) found themselves trapped in the flooded city, because they had been unable to evacuate prior to the disaster. Many of them resided in poor and marginalised neighbourhoods." (Ionesco et al, 2017)*

Another problem related to trapped populations is that they are sometimes not fully aware of the environmental stressors they are exposed to. The Bhopal Gas Tragedy occurred in India in 1984 and began with the leakage of methyl isocyanide (MIC), a colorless gas used in pesticides, from the Union Carbide of India Ltd. Since the factory was established in Bhopal, people had migrated from surrounding villages in search of work and the shantytowns which had developed around the factory were the first to be affected during the tragedy. The majority of the people affected by the catastrophe were poor, uneducated and unaware of the problems caused by exposure to toxic remains on the site as well as the contamination of ground water in the area. Others, even though aware of the contamination, continued to consume it because they did not have any alternative sources of potable water (Nair, 2005).

4.3 Drivers shaping immobility at the macro-level

Climate/environmental change is likely to increase the prevalence of 'trapped' populations, through erosion of livelihoods (falling crop yields for instance) resulting in depletion of the capital needed for migration (Foresight, 2011). This process could affect many of those for whom immobility is currently a choice. The UK's Foresight project estimated that over the coming decades, millions of people in low-income countries could be "trapped" in environmentally exposed areas and unable to move, lacking the resources or opportunities for migration (Foresight, 2011:119). This is an important point – environmental factors may actually have more impact in terms of non-migration than migration.

Figure 6: Trapped population



5 Conclusions

The preceding analysis has sought to shed light on the ways in which environmental factors (sudden- and slow-onset hazards) impact human mobility, in conjunction with various other macro-level trends and drivers. The linkages are complex and in some cases are tightly interwoven, such as environmental change impacts on the productivity of rural livelihoods (environmental combining with economic drivers). In the case of linkages between environmental migration and conflict, migration is unlikely to play more than a contributing role through effects on key conflict drivers, and only in certain conditions. Macro-level factors alone are unable to explain the complexity of the environment-human mobility nexus. Individual and household characteristics are also key in determining the ability to move, whether it be moving away from a sudden-onset hazard or migration as a response to long-term environmental stress, or not moving at all.

Differences in vulnerability between and within households shape the conditions under which people move. In the case of sudden-onset hazards, people living in conditions of vulnerablility are far more likely to be displaced in ways which exacerbate their vulnerability. In the case of slow processes of (negative) environmental change, vulnerable households (which are able to have recourse to migration) are less likely to benefit from the resilience-building potential of migration, with migration's role limited to that of a coping strategy. And yet the most vulnerable are likely to be those who are unable or unwilling to move. The number of 'immobile' and trapped populations is predicted to increase as the impacts of environmental change erode rural incomes, reducing the resources available for migration.

The first section of this paper (mobility responses to sudden-onset hazards) showed that disaster-related displacement is more common in countries with a relatively lower Human Development Index (HDI) as well as in countries that combine vulnerabilities at multiple levels (individual, community, national). However, overall almost all countries around the world are affected, making this an enormous challenge worldwide. Vulnerability and hazard-induced displacement are interlinked: vulnerability shapes mobility, and in turn mobility shapes vulnerability. In the next few decades, the world is expected to be characterized by continued urbanization and population growth, and displacement risk is likely to continue to increase fastest in urban areas, primarily in low- and middle-income countries.

The second section looked at mobility responses in the context of slow-onset hazards. The degree to which alternative options are available in the context of slow-onset hazards is a key factor in analyzing vulnerability and mobility in these contexts, and environmental degradation risks making migration a matter of necessity (rather than a matter of choice) for an increasing number of people. Human vulnerability shapes mobility responses too and indeed can determine whether moving is even an option.

The linkages between environmental change, conflict and mobility are highly complex and time- and context-specific. The third section presented key studies on the effects of in-migration on receiving communities that show that tensions are more likely in the case of large-scale influxes taking place over short timeframes, particularly where the influx has a substantial impact on socio-economic, environmental or cultural systems. Environmental change, conflict and mobility are more likely to be interlinked in complex crises, where climate change can exacerbate the effects of existing conflict drivers (threat multiplier).

Finally, the analysis related to the fourth impact type (immobile populations) discusses two forms of non-migration in the face of environmental stressors: the choice to stay (immobile populations) and the inability to leave (trapped populations). As the impacts of environmental

and climate change begin to be felt more strongly, an increasing number of people may be trapped in areas where they are highly vulnerable to environmental stressors. In this regard, the minimization of environmental degradation and of environmental stressors – particularly in rural livelihoods - is an important factor to reduce migration out of necessity. These and other factors are taken up in the response paper of this series.

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