Assessing and Addressing Climate Change's Effects on Migration, Displacement and Conflicts

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Many experts argue that climate change is a migration- and conflict-inducing crisis (Burrows and Kinney, 2016). And there are increasing indications that the crisis is already dire, and accelerating, in the present rather than looming in the distant future (Steffen, et al., 2018). In particular, persuasive observational and other evidence suggests that climate change and its impacts are likely to be far worse than the Intergovernmental Panel on Climate Change (IPCC) consensus that frames the debate over what humanity confronts (Brown, 2018; Hansen et al., 2016; Waldman, 2018). If these dire indications are accurate, then it follows that migration and conflict risks probably exceed most forecasts. Yet there is much uncertainty regarding current, let alone projected, numbers of climate-induced migration, both in-country and cross-border, in addition to the links between displacement and conflict (van Schaik and Bakker, 2017). This paper reviews the main evidence, and shows that this uncertainty impedes analyses of current and future conflict. Moreover, generalizing awareness of multifaceted climate risks requires interdisciplinary analyses; yet in some disciplines, such as health, the volume of collaborative research appears to be shrinking. Quality research is also encumbered by uncertain or inadequate data and other hurdles. This paper examines these issues, and then takes up the emergent literature on building "no regrets" resilient infrastructure to mitigate and adapt to these human impacts of climate change. We conclude with a brief summary of what Japanese policymakers are implementing in this regard.

The State of the Field

A large body of articles, reports and studies seeks to assess the relationship between climate impacts, migration and conflict (Burrows and Kinney, 2016). These contributions come from academics, research centres, aid agencies, militaries, and other actors (Schaar, 2017). The analyses differ profoundly in methodology, particularly the

range of independent and intermediate variables covered. They are also based on quite different estimates of the speed and scale of anthropogenic climate change itself, along with its regionally-differentiated impacts on sea-level rise, agricultural productivity, heatwaves, shifting patterns of precipitation, frequency of wildfires, increasing disease vectors, and other phenomena. One consequence of this lack of precision concerning the underlying variable of climate change itself, and its multiple manifestations, is extreme variation in projected numbers of migrants as well as anticipated levels of conflict.

In much of academe, sharply divided opinion on the scale and immediacy of climate change, and its effects on conflict risks and outcomes, fosters a focus on methodological squabbles and a retreat to case studies. This context arguably induces caution in making assertions. One problem is that the bulk of research work on climate change's impacts on migration and conflict has been compelled to examine evidence in the present, using the effects of extreme events (such as drought and flooding) as a proxy to understanding what might happen in the future (Burrows and Kinney, 2016). Looking at the evidence adduced in this research, some meta-studies find that asserted links between climate change and conflict are exaggerated, due to the "streetlight effect[1)]" and other sampling biases (Adams et al., 2018; Forsyth and Schomerus, 2013). To be sure, this critical work is animated by a legitimate concern to avoid stigmatizing particular countries or regions (Nature, 2018). The implication is that assessments of current and projected impacts overstate what is happening in the present and likely to occur in the future. Other meta-studies assert that the causal relationships are complex and mediated by such local factors as climate sensitivity; the relative stability of political institutions; and the availability of water, food and other critical resources. One such meta-study concludes with the hope that "place-based research will proceed that can inform preparedness plans and policy decisions that will be essential to mitigate the potential health impacts of climate change, migration, and conflict" (Burrows and Kinney, 2016). The suggested case-study approach surely has much to recommend it, save for the tendency to overlook the entirety of the forest in favour of a few possibly unrepresentative trees.

One example of the problem is afforded by a recent criticism of Homer-Dixon's

1) The streetlight effect is "the tendency for researchers to focus on particular questions, cases and variables for reasons of convenience or data availability rather than broader relevance, policy import, or construct validity" (Hendrix, 2017).

mid- to late-1990s work on the relationship between environmental scarcities and violent conflict (Homer-Dixon, 1994; 1999). A student of complex systems, Homer-Dixon was careful to argue that climate change and other drivers of environmental scarcity (eg, supply constraints in water, energy, food) must be examined in mutifactor and non-linear terms. His work investigated how complex systems adapt (or fail to adapt) to such stressors as water scarcity and other manifestations of climate change. He was careful to investigate multiple independent, mediating and dependent variables before concluding that there are grave risks that myriad challenges threaten to overwhelm even (and in some respects, especially) the capacity of developed countries to respond. Yet some recent work has come to depict Homer-Dixon's approach as an "environmental conflict model" that—allegedly—almost mechanically links climate change to migration and conflict. This work insists that Homer-Dixon (as well as the IPCC, the OECD, and the World Bank) argue that "migration induced by environmental factors will strain scarce resources in destination countries and become a primary source of instability." The research counters with an empirical survey of 126 countries over the 40-year period between 1960-2000 and finds that migration reduces climate impacts in origin countries and has no statistically significant effect on conflict (Bosetti et al., 2018). This kind of work is richly empirical, and uses regression analysis to test causative relationships; but it fails to grapple with the possibility that the period of study might be exceptional in terms of comparative climate stability and resource availability. It also misrepresents the complexity model that Homer-Dixon painstakingly refined through a protracted period of research and publications. And it overlooks a justly famous 2013 meta-study that found "strong causal evidence linking climatic events to human conflict across a range of spatial and temporal scales and across all major regions of the world" (Hsiang et al., 2013). In this case, the desire for more predictive precision arguably miscalculates risks and, were it to become a mainstream methodology, could gravely impair the design and deployment of comprehensive counter-measures to complex threats.

At the same time, aid agencies have become rather less reticent about escalating risks. For example, in October, 2018, Peter Maurier, the president of the International Committee of the Red Cross (ICRC) warned of a "perfect storm" of climate change and violence. According to Maurier, "[t]here is perfect storm building up between climate change and the development of violence which is of concern to us, and which we in certain respects we find unfolding already in parts of Africa, parts of the Middle

East, and even in the Pacific" (in Sachdeva, 2018). Maurier's warnings preceded the October 30, 2018, release of the ICRC's World Disasters Report. One of the report's key assertions is that global Sustainable Development Goals (SDGs)[2] are challenged by the convergence of stressors coupled with the difficulty of accurately monitoring and addressing them. As the report states, "[m]any countries experience ongoing food insecurity, recurrent disasters and epidemics in the context of long-term complex emergencies including conflict and displacement—but these situations are often prone to funding fatigue. These are classic *out-of-the-head-lines and forgotten crises* [emphasis mine], where high levels of short-term humanitarian financing cannot be sustained in the face of chronic needs, where long-term development donors are ill-adapted to invest and where both are constrained by perceived financial risks" (ICRC, 2018: 131).

In the above, we have seen that much scholarship is hesitant to build on work that has sought to grapple with the big picture, instead opting to engage in distracting methodological disputes. Indeed, the above-noted work on sampling bias in climate-conflict studies has in turn been criticized for actually "looking at publication bias as an independent variable" as well as offering nothing in the way of policy-relevant research to "help a country or region offset climate change" (Meyer, 2018). Hence, divergent assertions on the connections between climate change and conflict suggest that the "streetlight effect" should be viewed from multiple perspectives. It is certainly the case that researchers generally have to work with what they know, or at least what they think they know. Such cognitive bias is a well-recognized problem, in both the social sciences and the natural sciences (Nature, 2015). At the same time, the ICRC and its president rightly draw attention to what we have just begun to see or have reasonable grounds to believe we will see. The streetlight effect to be concerned about may therefore not merely be sampling biases or undue confidence in, and extrapolation from, the "known-knowns" that much of academe is content (or compelled) to examine. Rather, many drivers of climate and conflict threats are "known unknowns" and "unknown unknowns" outside the precisely illuminated area. But excluding these possibilities from risk assessment in an area as profoundly dangerous as climate change seems—to express it in colloquial terms—akin to hazarding being hit

2) An overview of the United Nations 17 Sustainable Development Goals (SDGs) and the 2030 Agenda for Sustainable Development is available at the following URL: https://sustainabledevelopment.un.org/sdgs

by a truck while searching for one's keys in the area lit by the proverbial streetlight.

Environmental Migration" and the Numbers Problem

One striking example of these unknowns is the data on current migrants. Comprehensive and reliable data in this domain are crucial, as one of the main factors involved in projections of conflict risks is the number of people displaced by climate change, whether through slow-onset factors or abrupt, extreme-weather events. Perhaps the most authoritative source of migration data, and site for integrating other data, in this regard is the Migration Data Portal (MDP)[3]. This site was first launched in December of 2017, by the International Organization for Migration[4]. The MDP is designed to act as a venue for accurate and timely data in order to underpin a more informed public debate on migration.

The MDP cautions that it is difficult to quantify what it refers to as "environmental migration[5]." It defines "environmental migrants" as "persons or groups of persons who, predominantly for reasons of sudden or progressive changes in the environment that adversely affect their lives or living conditions, are obliged to leave their habitual homes, or choose to do so, either temporarily or permanently, and who move within their country or abroad." These migrants are analytically distinct from "environmentally displaced persons," which the MDP defines as "persons who are displaced within their country of habitual residence or who have crossed an international border and for whom environmental degradation, deterioration or destruction is a major cause of their displacement, although not necessarily the sole one." The MDP adds that disaster displacement "refers to situations, where people are forced or obliged to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of disasters triggered by natural hazards. Such displacement may take the form of spontaneous flight or an evacuation ordered or enforced by authorities. Such displacement can occur within a country, or across international

3) The Migration Data Portal is at the following URL: https://migrationdataportal.org/about

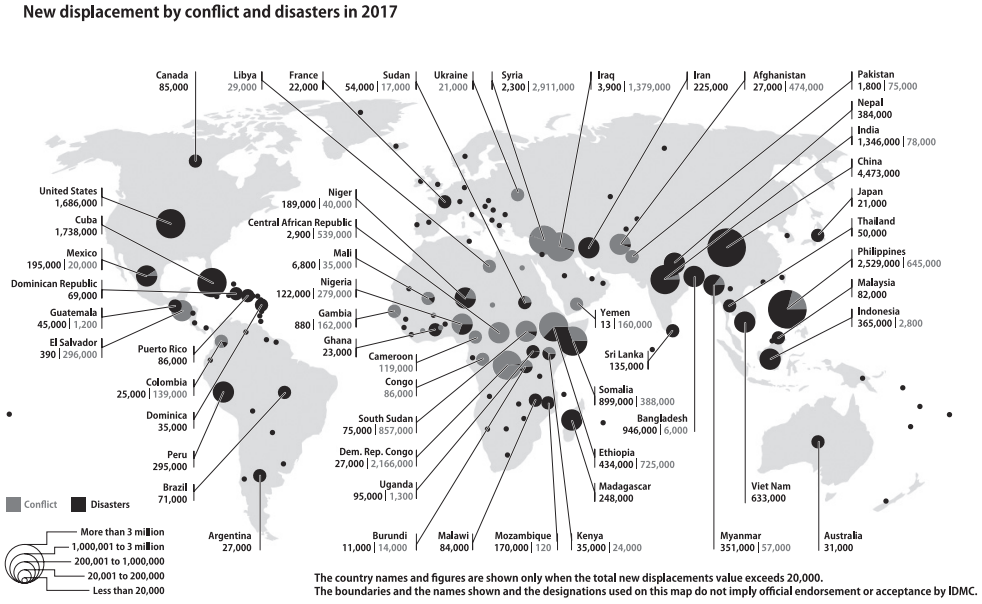
4) The website for the International Organization for Migration is at the following URL: http://gmdac.iom.int

5) The URL for the Migration Data Portal section on environmental migration is as follows: https://migrationdataportal.org/themes/environmental_migration

borders." A third category of environmental migration is "planned relocation," by which the MDP means "persons whose livelihoods have been re-built in another place."

Accurately surveying the number of environmental migrants who cross borders is difficult. The MDP data on the international migrant stock indicate that best estimates for 2017 are 257.7 million international migrants, a 3.4% increase over the previous year. This number of migrants represents 3.4% of the total global population of 7.5 billion. Further, the data indicate that 19.9 million of these migrants are refugees, a striking increase from 17.2 million the previous year. But people migrate for a multiplicity of reasons. Hence, it is unclear to which extent climate change and conflict are implicated in the overall migration as well as the refugee displacement[6].

Internal migration is somewhat easier to track. The MDP's section on environmental migration also links to longer-established agencies such as the Internal Displacement Monitoring Centre (IDMC). The IDMC was established in 1998, in order to provide accurate data as well as analyses based on it. In addition to research pa-



Source: IDMC, 2018

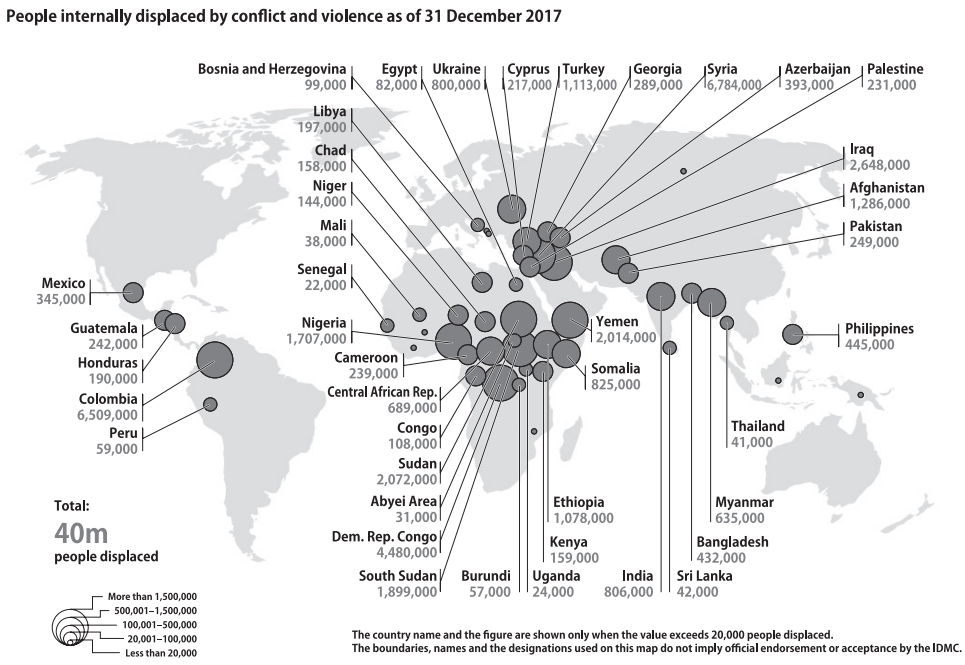
Figure 1 Internal Displacement due to conflict and disaster in 2017

6) These data are available at the following URL and are current to October 5, 2018: https://migrationdataportal.org/data?i=stock_abs_&t=2017

pers and timely information, it publishes an annual global report that synthesizes estimates of displacement due to conflict and disasters[7]. As of this writing, the IDMC's most recent global report is the "Global Report on Internal Displacement 2018" (hereafter, "GRID 2018"), released in May of 2018. The report provides excellent graphical summaries of the scale of displacement and conflict.

Figure 1 shows that in 2017 an additional 30.6 million people were internally displaced by disasters and conflict. Of that total, the number displaced by disasters was 18,780,000, whereas 11,774,000 were displaced by conflict. The data also show that disaster-displacement is largely clustered in the Asia-Pacific while conflict-displacement is centred in Africa and the Middle East.

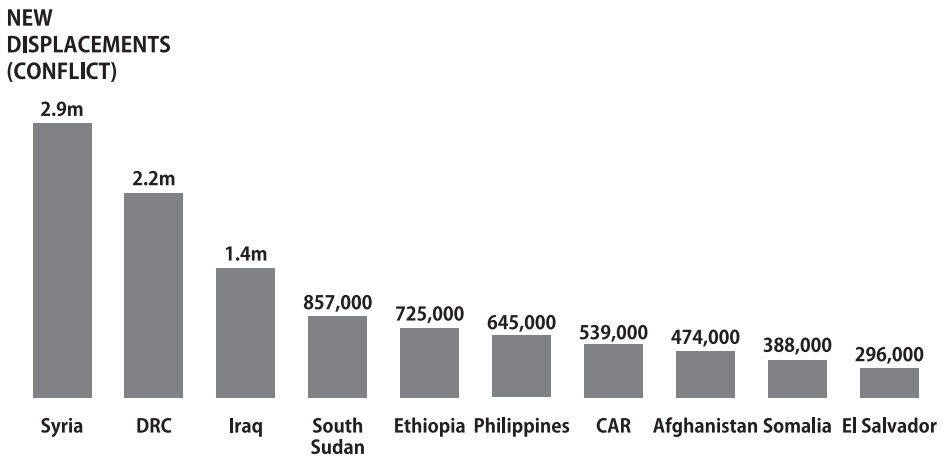
Figure 2 confirms the above clustering of displacement due to conflict. The figure omits the new disaster-driven displacement that was included in **figure 1**, and provides a global perspective on where conflict-driven displacement is concentrated. The IDMC advises that "Sub-Saharan Africa accounts for only 14 per cent of the world's



Source: IDMC, 2018

Figure 2 New Internal Displacement due to conflict in 2017

7) The Internal Displacement Monitoring Centre describes its role at the following URL: http://www.internal-displacement.org/about-us/



Source: IDMC, 2018

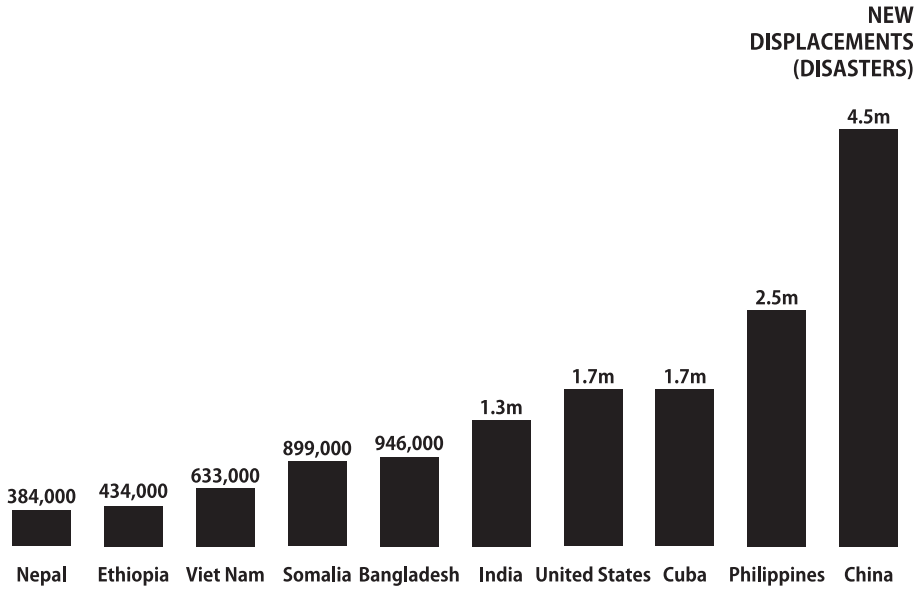
Figure 3 New Internal Displacements due to conflict in 2017

population, but almost half of new conflict displacement took place in the region" (IDMC, 2018).

Figure 3 offers a more focused summary of where new conflict-driven displacement is concentrated. Unsurprisingly, war-torn Syria leads the list, with a staggering 2.9 million. This level of displacement is a significant share of the country's total population of 18.3 million. The next largest number of conflict-displaced people is 2.2 million in the Democratic Republic of Congo (DRC). The DRC's 81.5 million citizens have long been beset by protracted wars, disease outbreaks and climate change (Dargie et al., 2018, Karimi, 2018).

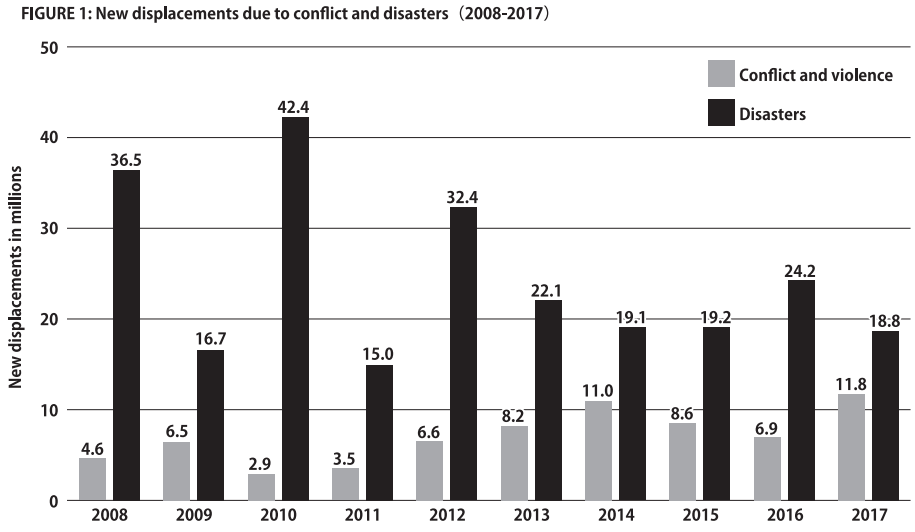
Figure 4 presents the details on new internal displacements due to disasters. China leads the list, at 4.5 million, followed by the Philippines with 2.5 million new internal migrants. The figure confirms that the numbers are clustered in Asia. But the table also shows that the crisis is global. In this respect, it is significant that internal disaster displacements in the Americas (Cuba and the United States) are 3rd and 4th respectively.

Figure 5 provides a listing of new internal displacements due to conflict and disaster between 2008 and 2017. The data indicate that there is no clear trend in disasters and conflict. Yet as we shall see, this apparent result may be due to the limitations of data.



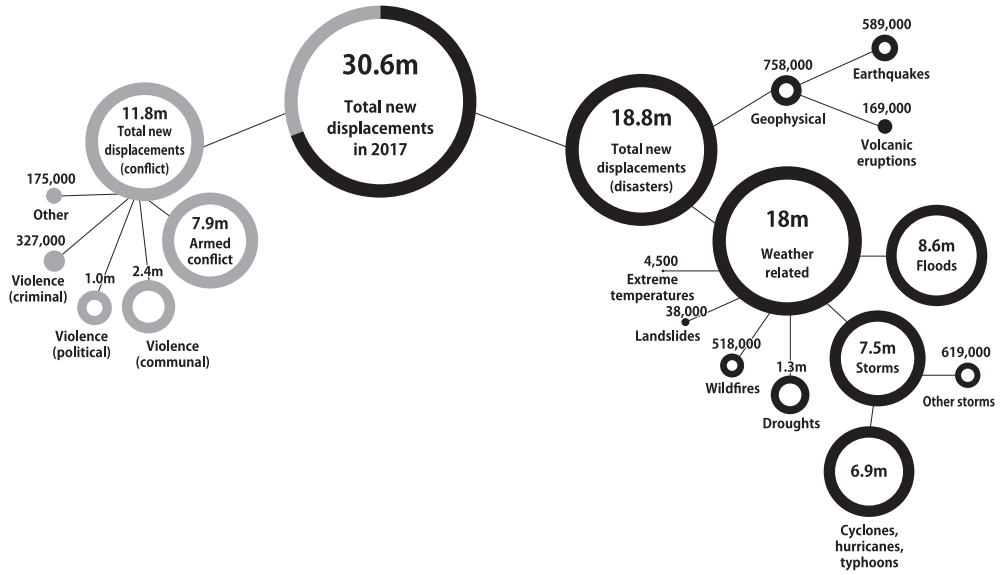
Source: IDMC, 2018

Figure 4 New Internal Displacement due to disaster in 2017



Source: IDMC, 2018

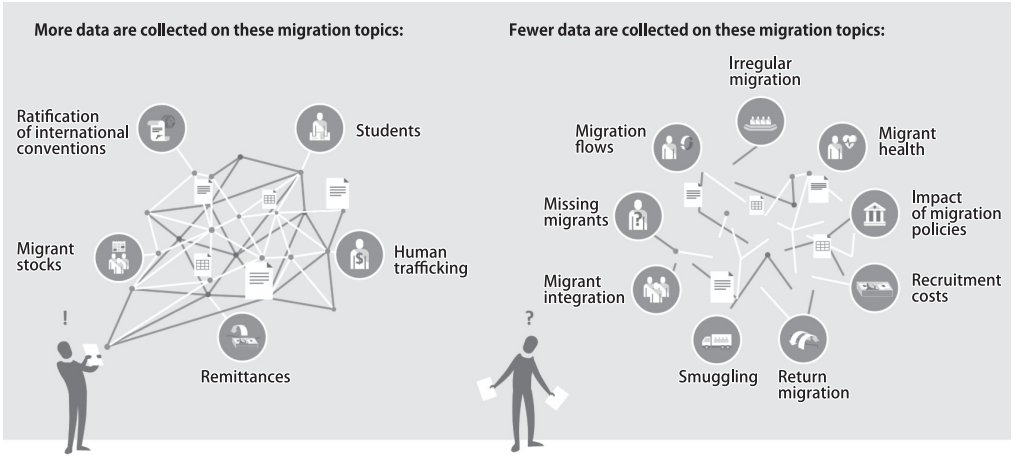
Figure 5 New Internal Displacement due to conflict and disaster, 2008–2017



Source: IDMC, 2018

Figure 6 New Internal Displacement Drivers, 2017

Figure 6 is one indicator of the data limitations. The figure categorizes the drivers of internal displacement in 2017, showing the types of conflict and disaster implicated. The limitations of the data are apparent, for example, in the 1.3 million listed as displaced by drought. The IDMC itself points out that these are very conservative estimates, hampered by data collection as well as the complexity of climate phenomena. They advise that "[m]ore than 686 million people across Africa and Asia have been affected by drought since 2008, more than earthquakes, storms and floods combined. We have not, however, been able to obtain verified data on more than a handful of displacement situations associated with the phenomenon." They point out that estimates are encumbered by a lack of consistent definitions of drought and consequent displacement, the problem of teasing out displacement from other migration, and the issue of multi-factor causality. One example of the latter would be when drought is accompanied by food insecurity and conflict (IDMC, 2018). These difficulties are of great concern to the IDMC, as in many regions drought is the most potent cause of crises. The IDMC indeed lament the difficulties of accurately assessing the true scale of drought-driven displacement, as it hinders their capacity to help target attention and resources to where need is greatest.



Source: MDP, 2018

Figure 7 Migration Data Gaps

Figure 7 offers an additional insight into data limitations. The subject is migration overall, as opposed to internal displacement alone. But the figure shows that a variant of the streetlight effect is as work in this respect: the data are better in areas where there is considerable monitoring. The figure's left-hand side shows that these include remittances and student flows. These items require visas and other permissions and procedures that leave quantifiable evidence.

However, the right-hand side of **figure 7** shows there are many areas where data are at best "guesstimates."

The result of the data gaps and uncertainty over how climate change will unfold results in undue variability in estimates of migrant numbers, let alone how much conflict is likely to be generated.

Migration and Climate Change

The International Organization for Migration (IOM) suggests that there are no reliable estimates of climate change induced migration. Indeed, the IOM warn that future forecasts vary from 25 million to 1 billion environmental migrants by 2050. These migrants are both internal and international, moving either within their home countries or across international borders, and on a permanent or temporary basis. The IOM advise that the most generally cited estimate is 200 million, which is itself equivalent to the current estimate of international migrants worldwide (IOM, 2018).

The difference between 25 million and I billion exceeds an order of magnitude, and lends little confidence in the projections.

Another problem is the paucity of multidisciplinary analyses that connect the environmental and social sciences. Even as the climate crisis worsens, in many areas the volume of interdisciplinary research is actually shrinking as scholars retreat to the certainty of disciplinary boundaries. The Migration Data Portal's most recent survey of the literature suggests that the number of publications on migration and the environment peaked at 154 in 2011 and then declined to 100 in 2016 (MDP, 2018).

The MDP lament this disturbing ebb in interdisciplinary work. They warn that the phenomenon is in itself an additional hindrance to making more accurate assessments and predictions: "When it comes to predicting future trends, the disconnection between the environmental sciences and social sciences communities constitutes an additional challenge, in a context where environmental migration research would greatly benefit from multidisciplinary research and better integration of climate and population data" (MPD, 2018).

The IDMC's 2018 report on internal displacement deploys a similar language in its quest for improved accuracy. It notes that "existing displacement and future risk need to be better understood through comprehensive assessments of their scale and nature...Complex and interdependent risk drivers, including poverty and inequality, political instability and state fragility, water stress and food insecurity, climate change and environmental degradation, unsustainable development and poor urban planning combine in different ways in different countries to increase people's exposure and vulnerability to displacement...A solid evidence base is vital to make the case for the significant investments that will be required in future action to address these issues" (IDMC, 2018).

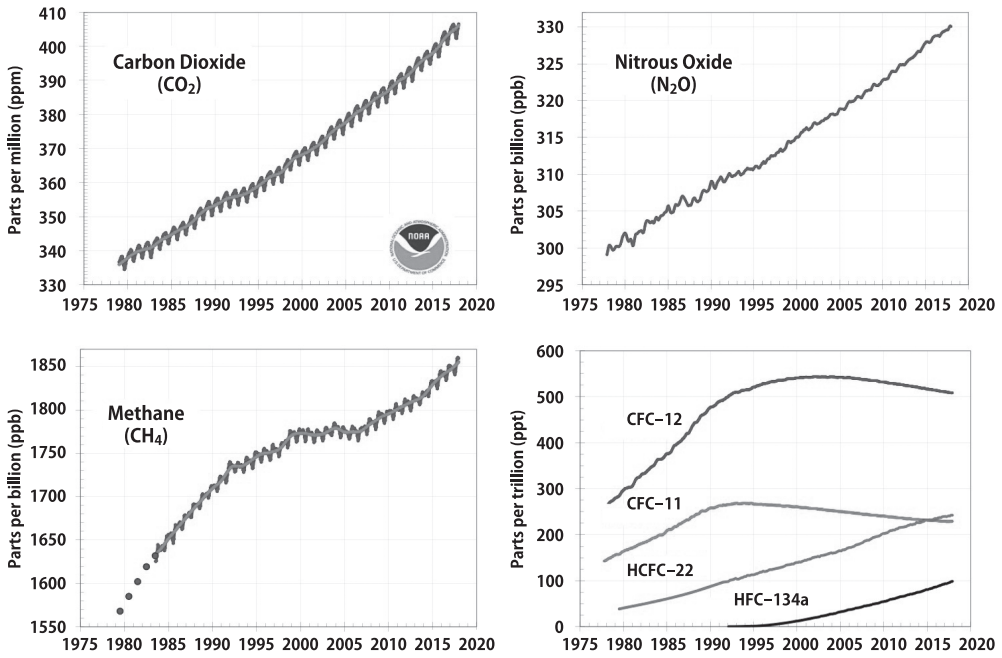
Indeed, as we shall see below, there is a larger problem of undue emphasis on scientific certainty and the maintenance of public optimism, at the expense of a comprehensive approach to risk management.

Climate Data and the IPCC's 2018 Special Report, IPCC SR15

As is indisputable, the primary drivers of climate change are anthropogenic releases of greenhouse gases into the atmosphere (IPCC, 2014). These gases consist primarily of carbon dioxide, nitrous oxide, methane, and chlorofluorocarbons. Once

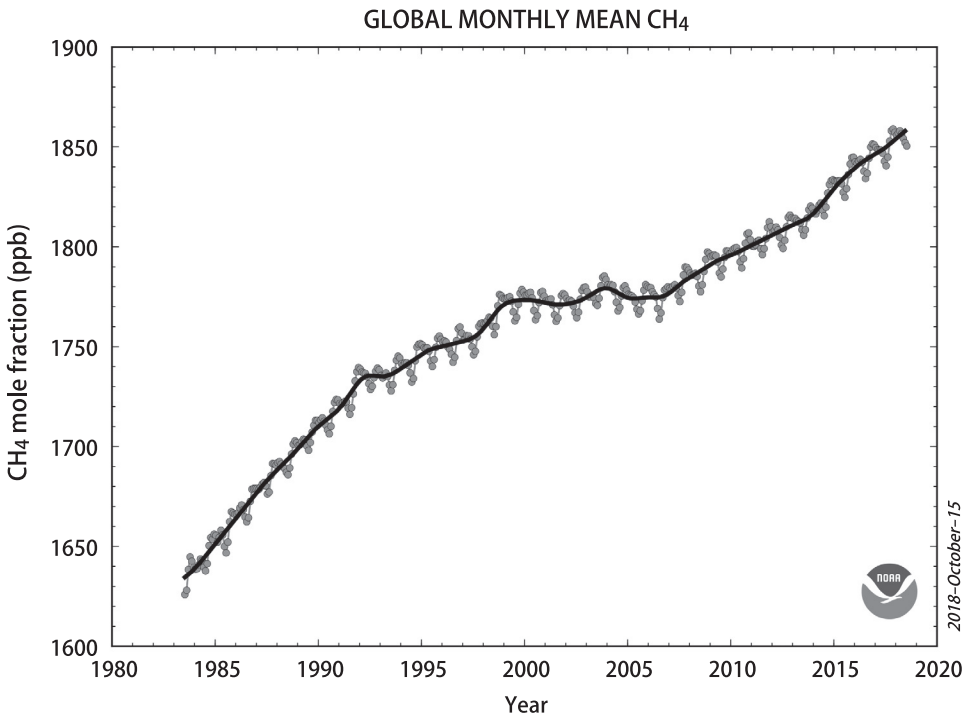
emitted, carbon dioxide remains in the atmosphere for about one hundred years, trapping additional heat from the sun, whereas the other gases are short-lived. The overall increase of all these gases between 1975 and 2017 is displayed in **figure 8**, in units of parts per million (ppm), billion (ppb) and trillion (ppt), respectively. **Figure 8** indicates that increases in these gases are significant and sustained, and the scientific consensus is that they account for approximately 96% of total human-caused warming since 1750, the beginning of the industrial revolution (NOAA, 2018).

Though not shown in the figure, the 2017 global average of 405.0 parts per million of carbon dioxide was higher than at any time over the past 800,000 years and in fact was only last matched 3 million years ago. At that time, average temperatures were 2°-3°C higher than at present, and sea levels were 15-25 meters greater. Over the past 6 decades, the rate of anthropogenic release of carbon dioxide has been 100 times faster than previous natural rates of increase, including rapid warming event that marked the end of the last ice age (Lindsey, 2018). In this regard, no one knows the lag effect: how rapidly the biosphere, cryosphere, hydrosphere and other elements of the climate system will change, and be changed by, this unprecedented pace of increase in atmospheric greenhouse gases and their absorption by the world



Source: NOAA, 2018

Figure 8 Primary Greenhouse Gas Levels, 1975-2017



Source: Dlugokencky, 2018

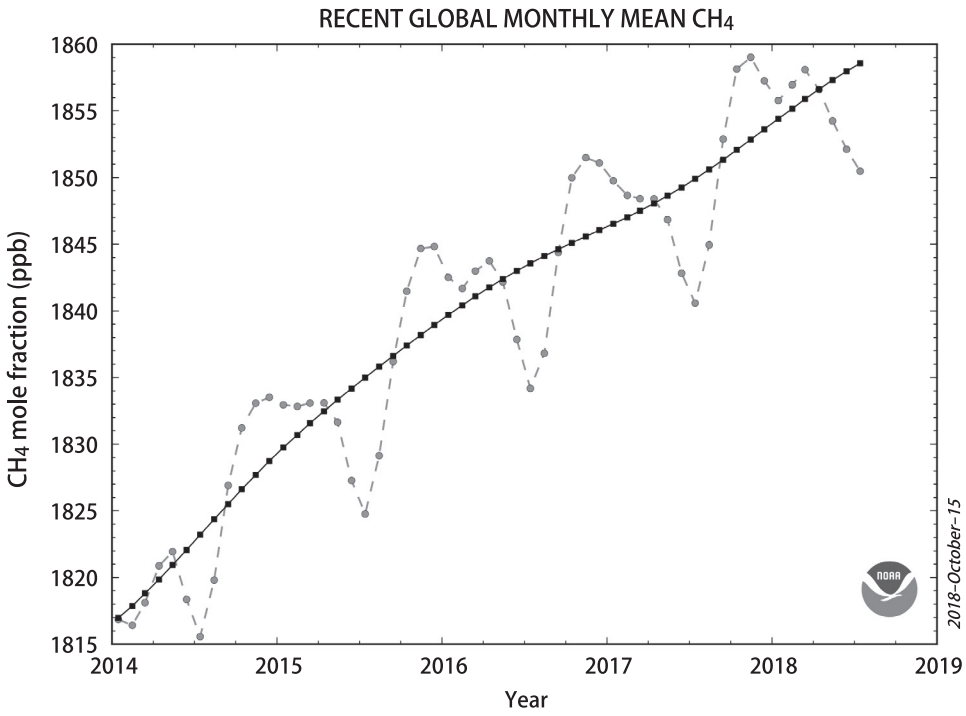
Figure 9 Methane Levels, 1983–2018

ocean.

The total greenhouse-gas effect of the other gases portrayed in **figure 8** varies considerably, but their relative effect vis-à-vis carbon dioxide is generally many multiples over short periods of time. Hence, the increasing concentrations of methane, nitrous oxide and some of the chlorofluorocarbons are of great concern. **Figures 9 and 10** offer additional detail on the increase in methane. Methane's greenhouse-gas effect (or "global warming potential") has been assessed at 86 times that of carbon dioxide, over a period of 20 years, and the gas accounts for roughly 9 of total anthropogenic greenhouse gases (Johnson, 2018).

Figure 9 confirms that methane levels have increased at a rapid pace since reaching a comparative plateau between 2000 and 2007.

Figure 10 provides more granular detail on methane levels, showing their global fluctuations due to human and natural processes. The figure also confirms that concentrations continue to increase dramatically, rising from 1840.6 ppb in July 17 to 1850.5 ppb in July 2018 (Dlugokencky, 2018). Prior to the Industrial Revolution dated



Source: Dlugokencky, 2018

Figure 10 Averaged Monthly Mean Methane Levels, 2014–2018

to roughly 1750, atmospheric levels of methane fluctuated between 300 ppb to 800 ppb. Moreover, though "concentrations of methane in the atmosphere are about 200 times lower than carbon dioxide, methane was responsible for 60% of the equivalent radiative forcing caused by carbon dioxide since the onset of the Industrial Revolution" (Dean, 2018).

The reasons for this accelerated rate of methane release are the subject of much debate. Current assessments suggest that the majority of methane release is due to agriculture, landfills, and the production and distribution of fossil fuels (ECJCR, 2018). Yet there are also increasing indications that the increases are harbingers of "tipping points[8)]" in warming. The idea of tipping point refers to a sufficient degree

8) On the diversity of "tipping points," or "tipping elements," including ice-mass melt, altered marine and atmospheric circulation systems, forest die-back, see the concise summary at "Tipping Elements—the Achilles Heels of the Earth System," Potsdam Institute for Climate Impact Research, nd: https://www.pik-potsdam.de/services/infodesk/tipping-elements/kippelemente

of shift in a system that it is driven to a different state. One particular item of concern is that methane increases are linked to Arctic amplification, wherein the rate of temperature increase in that region is twice to triple the global average. The amount of methane contained in permafrost and clathrates is much greater than the amount in the atmosphere, and these stores of methane are clearly sensitive to warming. That sensitivity is a "known unknown" about which emerging evidence is very disturbing (Beitler, 2012; Ekin, 2018; Gray, 2018).

The primary drivers of climate change, greenhouse-gas emissions, are clearly increasing, and are imposing grave effects on ecosystems, changes which may not be reversible. A growing consensus among climate scientists thus already recognizes present climate change to be a crisis (Black et al. 2018; Harris et al., 2018; Mora et al., 2018). Yet an array of data-aggregation and methodological problems hinder coping with this crisis. One major issue is the difficulty in understanding the scope and speed of climate change itself. The conventional wisdom relies on a linear model of climate change, wherein additional flows of greenhouse gases from human activity lead to commensurate changes in climate, particularly the global average temperature (Steffen, et al., 2018).

Even milestone efforts to depart from this consensus become mired in gradualism. For example, the Intergovernmental Panel on Climate Change (IPCC) published its Special Report on Global Warming of 1.5°C (hereafter, "IPCC SR15") on 8 October 2018[9]. This report is a milestone document for the IPCC, as it has emphatically shifted the focus away from the previous emphasis on limiting global warming to 2°C, a level that had come to be seen as entailing quite severe climate impacts. The report's 91 authors warn that the current stock of greenhouse gases (notably carbon dioxide) "will persist for centuries to millennia." Hence the authors built on over 6,000 scientific papers to depict the difference between 1.5°C and 2°C (IPCC, 2018)[10].

The IPCC SR15 notes that anthropogenic warming effects include global average temperature increases of roughly 0.2°C per decade. It also points out that these average temperature increases have already led to "profound alterations to human and

9) The IPCC Special Report can be accessed at the following URL: http://www.ipcc.ch/report/sr15/

10) For these details, see the United Nations Climate Change website of the IPCC Special Report: https://unfccc.int/topics/science/workstreams/cooperation-with-the-ipcc/ipcc-special-report-on-global-warming-of-15-degc#eq-2

natural systems, bringing increases in some types of extreme weather, droughts, floods, sea level rise and biodiversity loss, and causing unprecedented risks to vulnerable persons and populations[11]." Particularly germane to this paper, they add that current warming has led to a "decline in food security, linked in turn to rising migration and poverty." The report reveals that the bulk of scientific work suggests that the even the differences between 1.5°C and 2°C are striking, particularly on biodiversity, hydrologic cycles, ocean acidification, food security, and a range of other areas[12].

Certainly, the IPCC SR15 deserves praise as an effort to understand the risks of not aiming for a lower target than the long-agreed 2°C. But many critics point out that the IPCC may have underestimated the risks and impacts. One question is why the authors of IPCC SR15 chose to move the baseline period for measuring warming from 1750 to 1850–1900. During these years, global temperatures are estimated to have increased by approximately 0.2°C–0.3°C, which means that the IPCC estimate that current temperature increases of 1.0°C (±0.2°C). Other criticisms highlight the continued failure to incorporate a number of additional drivers for climate change, including permafrost melt and other carbon-cycle feedbacks. Some research suggests that these feedbacks pose a 5% "fat-tail" risk of producing a "runaway global warming through tipping points that interact and cascade (Molina et al., 2018; Xu and Ramanathan, 2017). Indeed, the overall approach of the IPCC has long been questioned due to its concern for scientific certainty rather than risk-based assessments (Spratt and Dunlop, 2018).

These critics do not aim to undermine the IPCC, and its IPCC SR15, unlike the vested fossil-fuel interests who routinely accuse the IPCC of alarmism. Rather, climate scientists' criticisms address the IPCC's underestimate of risk, especially the omission of fat-tail risks. They point out that the IPCC SR15 analysis, while more aggressive than previous reports, still holds back from contending with quite dire scenarios, in part due to inherent conservatism in science as well as the need to run the gauntlet of political interference in compiling the ever-important "Summary for Policymakers." Many observers are concerned that the IPCC SR15 scenarios are more op-

11) See chapter 1 of the IPCC Special Report at the following URL: http://www.ipcc.ch/report/sr15/

12) A summary of the differential effects projected by the Special Report can be found at the flowing URL: https://report.ipcc.ch/sr15/pdf/sr15_headline_statements.pdf

timistic than the evidence warrants, and "may mislead world leaders into thinking they have more time to address the climate crisis, when in fact immediate actions are needed" (Molina et al., 2018).

A similar argument has been made by Peacock (2018), a philosopher who highlights the fact that there are non-trivial risks of abrupt climate change, such as a rapid 3-meter increase in global sea levels due to shattering of highly vulnerable ice concentrations in West Antarctica. Peacock assets that "the need for the highest possible epistemic certainty must sometimes be counterbalanced by the need for the best possible decisions to be made in finite time, with less-than-perfect resources of information. This is the rigor that professionals in fields such as medicine and engineering have been required to aim at for centuries, and it can be very difficult to achieve. It is far easier to withhold assent until one's result is confirmed to seven standard deviations (Peacock, 2018).

There is merit to these arguments for a most robust application of the "precautionary principle[13]" and more forceful communication of risks. A multitude of distracting events and issues intrude on contemporary party politics in the developed countries. And there is limited public engagement with climate change, which is a "wicked problem[14]" whose alleviation requires a myriad of changes in lifestyle. Underestimating the scope of the crisis hazards continued complacency that risks remain almost wholly concentrated in foreign lands and the distant future[15]. But inadequate re-

13) On the "precautionary principle," see the IPCC definition: "the precautionary principle is considered when possibly dangerous, irreversible, or catastrophic effects are identified, but scientific evaluation of the potential damage is not sufficiently certain, and actions to prevent these potential adverse effects need to be justified... uncertainty about the damage to be incurred does not serve as an argument to delay action. In the face of great uncertainty, a precautionary approach might even result in a more stringent emission-reductions target and/or adaptational response." The IPCC definition is available at the following URL: http://www.ipcc.ch/ipccreports/tar/wg3/index.php?idp=437

14) One useful definition is that wicked problems "are multidimensional challenges that are difficult to resolve due to incomplete or contradictory information, differing views on the nature of the problem, or complex interactions with other issues. Wicked problems often blend into other issues and only become visible when their serious effects are felt. One such problem is climate change: a long-term issue for which the urgency of immediate action is increasingly evident" (Stang and Ujvari, 2015).

15) Of course, here we mean "distant" on party-political and human timescales, not ecosystems and geology. As we have seen, anthropogenic carbon emissions and other drivers of climate change appear to be increasing at rates unprecedented over the past 3 million years.

sponses to climate change almost certainly means that it will be out of control and irreversible once the effects are so evident that there is no scope for disagreement left. These and other factors give cause for concern that the IPCC's cautious approach could foster a continuation of inadequate efforts to mitigate and adapt to potential extremes in the comparatively near future. This possibility clearly has enormous import when it comes to coping with the drivers of displacement and conflict.

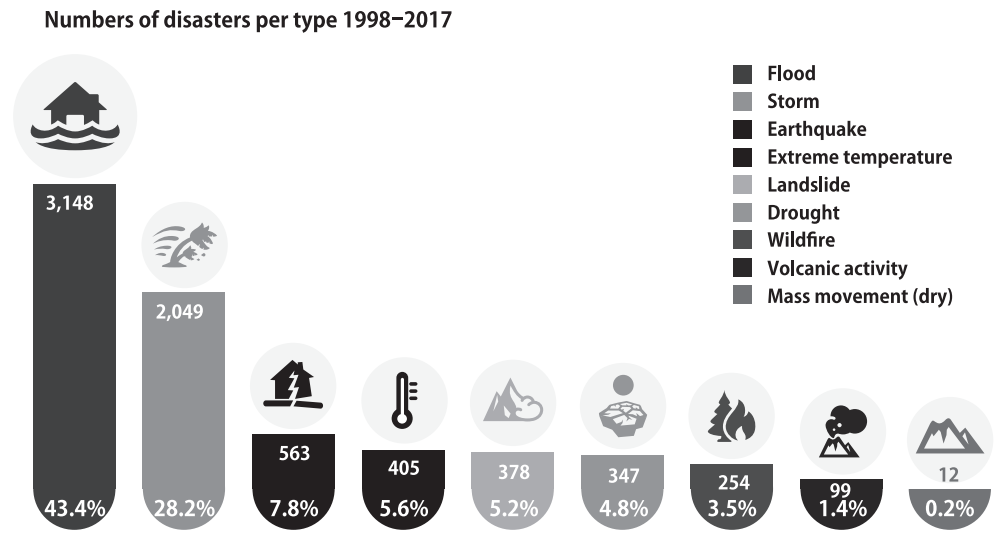
Risk-Management and Multi-Factor Analyses

The burgeoning evidence of rising disaster risks and costs may help shift attention towards increased interdisciplinary analyses and action. Though the link between disaster, migration and conflict is difficult to quantify to the satisfaction of many experts and lay persons, the increasing scale and cost of disasters has ample empirical evidence. More accurate reporting on these costs could help galvanize constructive action on combined adaptation and mitigation.

Comprehensive global summaries of disasters and their costs are available from the United Nations Office for Disaster Risk Reduction (UNISDR). As of this writing, their most recent work is a report on "Economic Losses, Poverty and Disasters, 1998–2017" (Wallemacq and House, 2018). The report summarizes total reported disaster losses, assessing their direct economic affect during the 1998–2017 period as in excess of USD 2.9 trillion, with climate-related disasters representing 77% of the total, or roughly USD 2.25 trillion. The report compares these aggregate figures with the 1978–1997 period, when total reported losses were far less, at just over USD 1.3 trillion with climate-related disasters accounting for 68%, or USD 895 billion. The report also points out that there is serious under-reporting of economic costs. Over the 1998–2017 period, high-income countries reported economic costs for 53% of disasters, while low-income countries reported assessments for only 13% of disasters.

It is also important to note that the report aggregates reported disaster losses of all types. These disasters include seismic events that cannot be attributable to climate change, at least in the present[16]. These latter were responsible for only 9% of

16) Note, however, that a significant scientific literature explores the relationship between seismic events and ice-mass loss, methane-hydrate melt and other phenomena. The researchers study such changes in the past in part to investigate whether current climate processes may induce seismic activity (Brandes, 2018; McGuire, 2012).



Source: Wallemacq and House, 2018

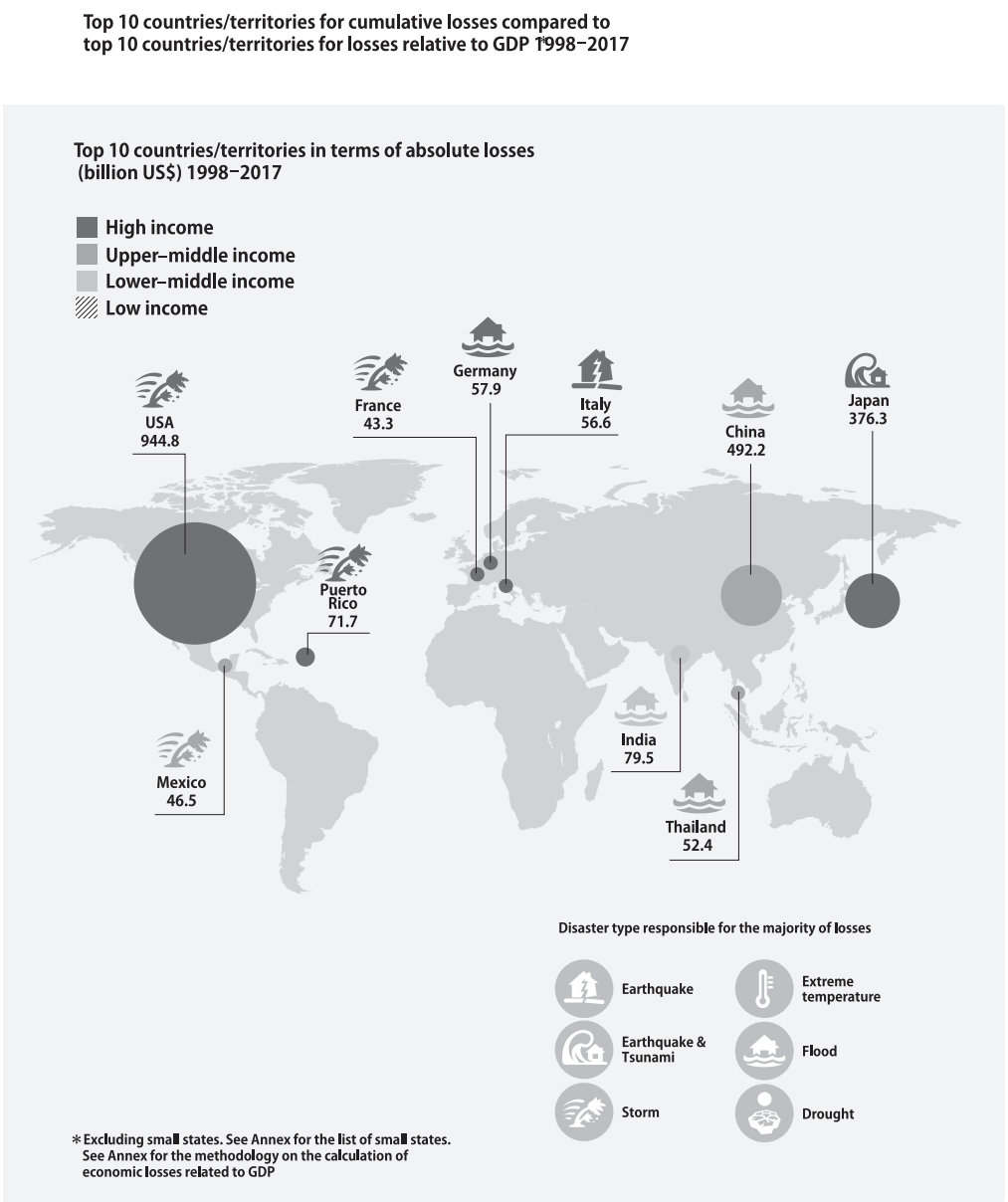
Figure 11 Disasters by Type, 1998–2017

disasters. But including them is key to formulating an all-hazard approach to enhancing public safety. The report shows that during the 1998–2017 period, reported deaths total 1.3 million, with 4.4 billion people having been injured, made homeless, displaced or requiring emergency assistance. Seismic events led to the greatest loss of lives, as a total of 563 earthquakes, including the tsunamis they generated, caused 56% of total deaths, representing 747,234 lives lost.

Figure 11 provides a summary view of reported disasters over the 1998–2017 period. It shows that the most frequent disaster was floods, at 43.4% of reported events, followed by storms, at 28.2%.

Figure 12 displays the top ten countries/regions in terms of absolute, direct economic losses, dividing these countries/regions into high-income, upper-middle income, lower-middle income, and low income. As is indicated, the greatest absolute economic losses afflict the United States, with storm damage ranking highest in USD 944.8 billion in damages over the 1998–2017 period. This amount is followed by China, where flood damages cost a cumulative total of USD 492.2 billion.

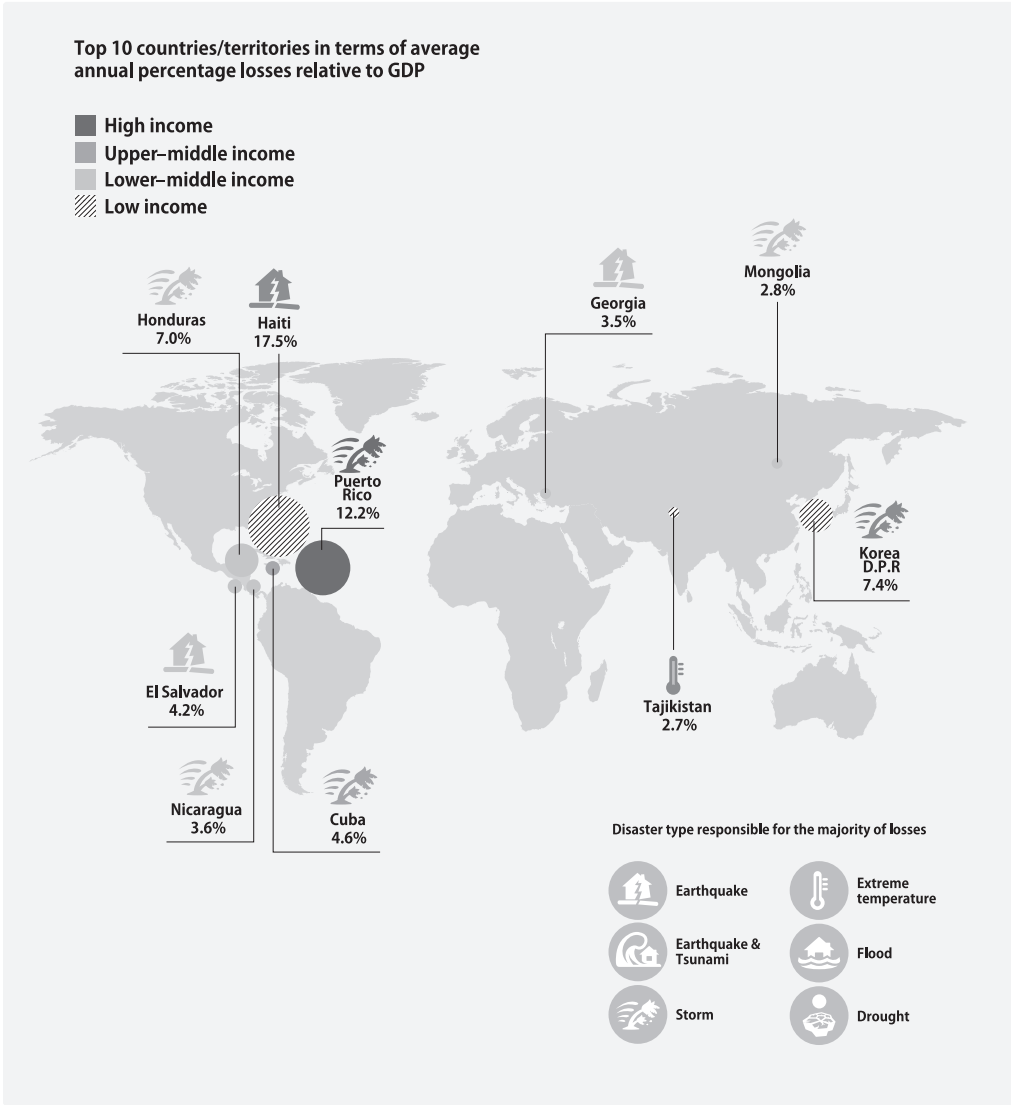
Figure 13 adopts a different perspective, examining the cost of disasters as a share of GDP. The high-income countries largely disappear from the list, with the exception of the US territory of Puerto Rico, whose disaster burdens are a prodigious 12.2% of GDP. The highest, however, is Haiti, where assessed and reported disasters



Source: Wallemacq and House, 2018

Figure 12 Disasters and Absolute Cumulative Losses, 1998–2017

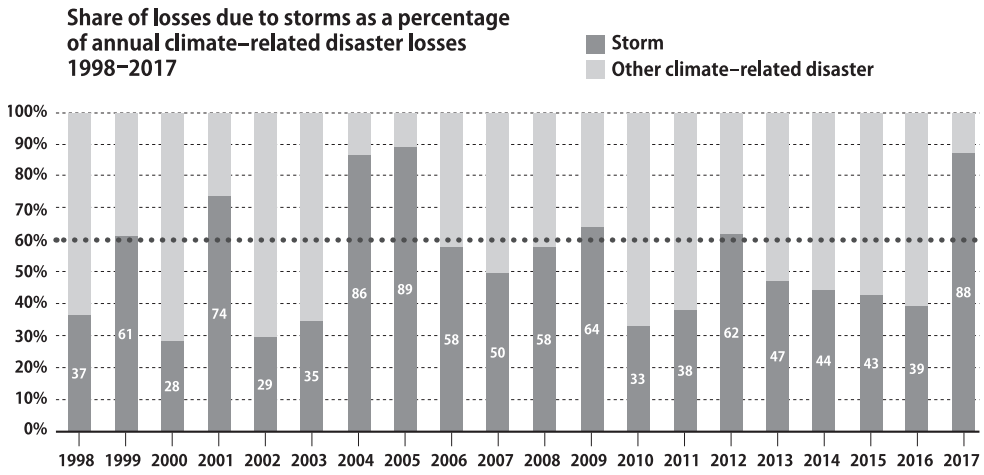
impose a crushing burden of 17.5% of GDP. Hence, with the exception of Puerto Rico, the countries/regions with the highest relative disaster costs are lower-middle and low-income. And though the majority of the disasters are floods and storms, seismic events also play a large role.



Source: Wallemacq and House, 2018

Figure 13 Disasters and Relative Cumulative Losses, 1998–2017

Figure 14 shows that over the period surveyed, storm damages made up a rough average of 60% of climate-related disaster losses. The definition of storms includes tropical cyclones and hurricanes. Not only was the economic damage significant, but the death toll was as well. The report finds that storms were the second-leading cause of



Source: Wallemacq and House, 2018

Figure 14 Storms as a Share of Climate-Related Disasters, 1998-2017

Table 1 Reporting of Economic Losses, 1998-2017

Reporting of economic losses per disaster type (climate-related)

	% reported
Storm	55
Wildfire	41
Flood	32
Drought	29
Landslide	13
Extreme temperature	11

Source: Wallemacq and House, 2018

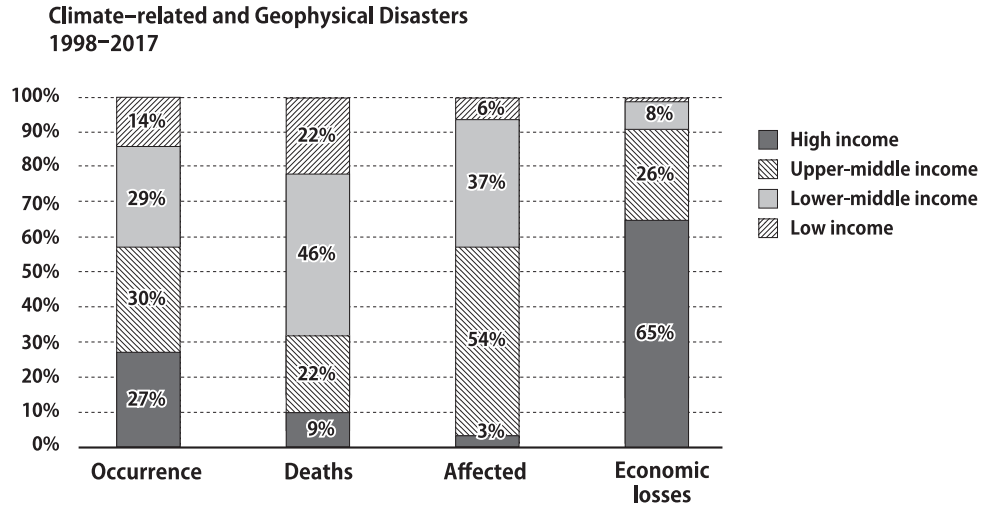
death over the period, costing 233,000 lives.

Table 1 is one indicator of how much the aggregate losses from disasters are under-ported. It shows that economic costs for storms were reported in just over half of all cases. It also reveals that the direct economic costs of other climate-related phenomena (such as wildfires, floods, and droughts) were reported in far less than half of all cases. Indeed, the costs of extreme temperatures were assessed and reported in only 11% of such incidents. One can infer that total economic losses from disasters would be considerably higher if there were more accurate assessment (particularly the

Table 2 Reporting of Economic Losses, by Income Level, 1998–2017

Reporting of economic losses per income group (%)	ALL	Climate-related	Geophysical
High income	53	52	61
Upper-middle income	40	40	37
Lower-middle income	31	30	31
Low income	13	13	20

Source: Wallemacq and House, 2018



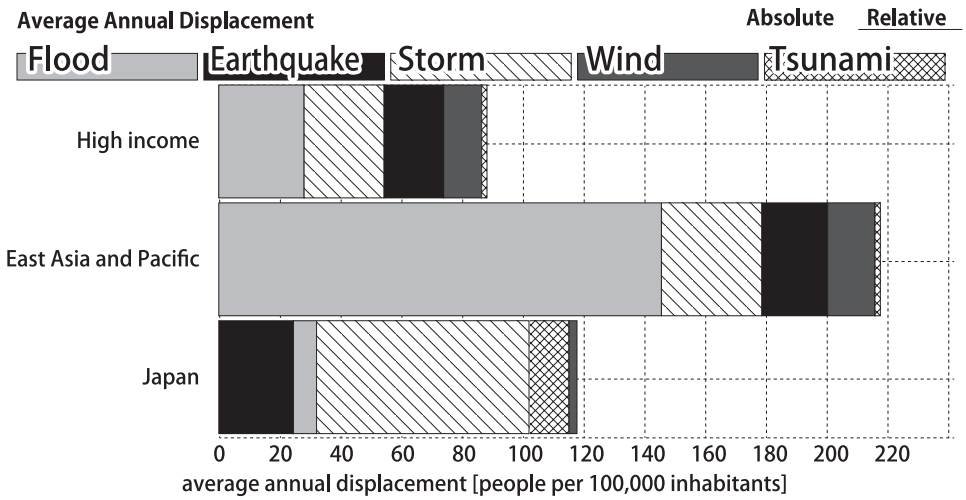
Source: Wallemacq and House, 2018

Figure 15 Disaster Type and Costs, by Income Level, 1998–2017

inclusion of indirect economic costs, such as long-term impacts on human health).

Table 2 provides additional evidence of this under-reporting, in this case breaking it down by country/region income level. The discrepancy between high-come and low-income reporting of losses is striking, with the former being 53% whereas the latter are only 11%.

Figure 15 provides more detail on the differential impact of disasters by country/region income level. It shows that the frequency of reported occurrence is well over half (57%) for high-income and upper-middle income countries and regions. At the same time, the number of deaths due to disasters is conspicuously clustered in lower-middle income countries and regions, which account for nearly half (46%) of



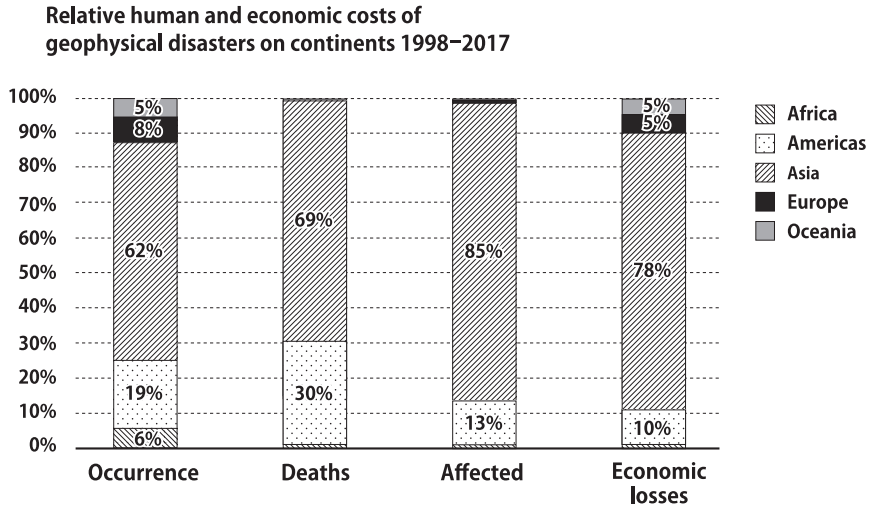
Source: IDMC, 2018

Figure 16 Average Annual Displacement, by Disaster Category

reported fatalities. The latter two categories of number affected and economic losses show that the high-income countries are the most robust in terms of limiting displacement and other outcomes, but also suffered the greatest economic costs. However, it is important to keep in mind that these direct economic losses are quite likely substantially less than actual costs, due to under-reporting in the high-income areas. Moreover, the costs for lower-income areas can only be guessed at, due to the paucity of reports.

Figure 16 affords a different perspective on disasters and their costs. It shows the differential in annual levels of displacement per 100,000 inhabitants, by disaster category, for the high-income countries, East Asia and the Pacific, and then Japan. Japan's exposure to disasters, at least in terms of per-capita displacement effects, is shown to exceed the average for the other high-income countries. But the data for East Asia and the Pacific as a whole suggest the region is not only afflicted with a significant level of climate and seismic hazards, but that its communities suffer a high level of displacement.

These differential effects are given further support by **figure 17**. It displays continental variations in the frequency of occurrence of geophysical disasters, deaths, displacement and other effects, and economic losses. The Asian region is shown to be subject to the majority of impacts. These geophysical events cannot be attributed to climate change, at least in the present. But one could argue that their impacts weaken



Source: Wallemacq and House, 2018

Figure 17 Disaster Impacts, by Continent, 1998–2017

the resilience of individuals and communities, rendering them more vulnerable to climate-driven disasters as well as slow-onset effects (such as increasing humidity or aridity, sea-level rise, and so on). In this respect, it is important to keep in mind that the Asian region is home to 4.5 billion people, or about 60% of the global population of 7.6 billion.

Net Assessments of the Past, Present and Future

In the above, we have seen that there is wide disagreement over the degree of displacement and conflict stemming from climate change. There is also a considerable problem in resolving the disagreement due to the large gaps in accurate data. Moreover, we have also seen that the pace and scale of climate change itself is a hotly contested area, in large part due to the bias towards linear assessments of a phenomenon that is evidently non-linear. And our review of the data on disaster impacts reveals a serious under-reporting of damages even in the high-income countries. In short, any arguments concerning these issues should be couched in uncertainty, but informed by an awareness that the data are almost certainly under-estimates of the gravity of the respective crises.

These data gaps are not inevitable, of course, and the diffusion of advanced monitoring technologies could help to address them (Rademaker et al. 2018). But in

the present, a critical issue is how best to apprehend and address current reality in the face of data gaps and disciplinary siloes. An additional imperative is to maximize no-regrets counter-measures to the fat-tail risks that are increasingly moving to the median of the non-normal. One means of assessing and addressing these items, and their dynamism, is to learn comprehensive lessons from the past. Paleoclimatology does this in increasingly great detail.

This paper is not concerned with reviewing the extreme climate impacts unearthed by paleoclimatology. But it is pertinent to not that the work has uncovered quite startling evidence of very abrupt climate change. One example is the nearly global Younger Dryas cooling event that began approximately 12,800 years before the present and the quickly ended 1,200 years afterwards. The geological record, particularly ice-core data from Greenland, contains ample evidence of this event. A sobering lesson from these data is that "cooling into the Younger Dryas occurred in a few prominent decade(s)-long steps, whereas warming at the end of it occurred primarily in one especially large step of about 8°C in about 10 years and was accompanied by a doubling of snow accumulation in 3 years; most of the accumulation-rate change occurred in 1 year (National Research Council, 2002). More recent investigations of fossilized coral reefs off the coast of the US state of Texas offers persuasive evidence of several meters of sea-level rise occurring in sudden bursts within decadal time frames. This evidence led the authors to suggest that "the steady and gradual sea-level rise, observed over the past two centuries may, therefore, not be a complete characterization of how sea level would rise in the future" (Khanna et al., 2017).

A range of interesting and useful interdisciplinary studies that draw on paleoclimatology in researching economic and political change have already been done. One of the earliest and most interesting of these studies is the 2003 work "An Abrupt Climate Change Scenario and Its Implications for United States National Security." The report (hereafter, "Abrupt Climate Change") was explicitly aimed at imagining "the unthinkable to push the boundaries of current research on climate change so we may better understand the potential implications on United States national security" (Schwartz and Randall, 2003).

The "Abrupt Climate Change" study was done at request of Andrew Marshall, an economist and director of the Pentagon's Office of Net Assessment (ONA). The ONA was created in 1973, and Marshall was appointed as its director. He held the post until 2014 (Gady, 2015). The ONA's task was to act as a think tank for studying

the future, generally via contracted work. Marshall was a major figure in the development of net assessment, which is essentially the craft of posing "out of the box" questions and integrating information in order to overcome the stovepiped, short-term thinking that plagues bureaucratic agencies. As one expert analysis describes it, net assessment "tends to study issues that are important but over-looked. There are many such problems in national security. The methodological tools for analyzing such understudied problems are often less important than simply identifying them in the first place. This is in contrast to the usual tendency to exhaustively analyze over and over what is already known" (Bracken, 2006). To repeat the colloquialism used earlier, net assessment attempts to look beyond the area illuminated by the streetlight in order not to be hit by a truck.

Marshall's order of a survey on the national-security implications of climate change was not without precedent. Archival evidence suggests that the first analysis of how climate change might threaten US national security was prepared by the US Navy, in May of 1990 (Werrell and Femia, 2017). The 1990 study was undertaken by the United States Naval War College and released as "Global Climate Change: Implications for the United States Navy." The report did not examine the risk of increased migration and conflict, but rather focused on the implications for naval assets (Kelley, 1990).

The 2003 "Abrupt Climate Change" report studied the threat more expansively, by delving into the historical record of abrupt climate impacts. Its deliberzate effort to examine worst-case scenarios made it highly controversial, but its methodological approach attracted expert attention (Shearer, 2005).

"Abrupt Climate Change" did not focus on warming per se. Rather, its point of departure was the century-long cooling event that began 8,200 years before the present, an event that followed thousands of years of warming in the wake of the Younger Dryas period referred to earlier in this paper. It pointed out that "[d]uring the 8,200 event severe winters in Europe and some other areas caused glaciers to advance, rivers to freeze, and agricultural lands to be less productive. Scientific evidence suggests that this event was associated with, and perhaps caused by, a collapse of the ocean's conveyor following a period of gradual warming (Schwartz and Randall, 2003: 6). Focused on this phenomenon of cooling, "Abrupt Climate Change" examined subsequent events, particularly the Little Ice Age from about 1300 to 1850. The causal factors were mooted to be a slowdown in the thermohaline circulation or perhaps

reduced solar activity coupled with volcanism. Of most interest to "Abrupt Climate Change" were the effects of such massive and abrupt environmental change on planetary "carrying capacity[17]" and thus the fate of entire civilizations. It sought to "dramatize the impact climate change could have on society if we are unprepared for it" (Schwartz and Randall, 2003: 7).

The central thesis of "Abrupt Climate Change" is that disruption of the carrying capacity poses a profound threat to national security. Looking at the past, it finds that that "[v]iolence and disruption stemming from the stresses created by abrupt changes in the climate pose a different type of threat to national security than we are accustomed to today. Military confrontation may be triggered by a desperate need for natural resources such as energy, food and water rather than by conflicts over ideology, religion, or national honor. The shifting motivation for confrontation would alter which countries are most vulnerable and the existing warning signs for security threats."

"Abrupt Climate Change" also cuts through academic conflicts over precision. It concedes that "[t]here is a long-standing academic debate over the extent to which resource constraints and environmental challenges lead to inter-state conflict. While some believe they alone can lead nations to attack one another, others argue that their primary effect is to act as a trigger of conflict among countries that face pre-existing social, economic and political tension." Yet "Abrupt Climate Change" insists that "it seems undeniable that severe environmental problems are likely to escalate the degree of global conflict" (Schwartz and Randall, 2003: 14).

In short, "Abrupt Climate Change" epitomizes the analytical goals of net assessment: it transcends the case-study approach and disciplinarily siloed emphasis on independent variables that influence changes in one dependent variable. And at least some of its predictions appear to be accurate. It authors warn of a future Europe struggling internally due to an influx of refugees. It is thus instructive to note, as former United States Secretary of State John Kerry argued on November 15, 2018, that this phenomenon is already underway. Kerry warned that "Europe is already crushed under this transformation that is taking place due to migration. In Germany Angela Merkel is weakened. Italian politics is significantly impacted" (Kerry, 2018).

17) The authors define "carrying capacity" as "the ability for the Earth and its natural ecosystems including social, economic, and cultural systems to support the finite number of people on the planet" (Schwartz and Randall, 2003: 15).

Former US Deputy Under Secretary of Defense (Environmental Security) Sherri Goodman followed up on this work. In 2006, the US military was fighting in Iraq and Afghanistan and beginning to experience the costs of climate extremes as well as see projections for increased water scarcity, declining agricultural productivity, and massively increased numbers of refugees. In this period, Goodman worked at the CNA Corporation, an advisor agency to the US military. Goodman responded to the concatenation of events and issues by setting up the CNA Military Advisory Board, a committee of retired ３-star and ４-star US generals and admirals, and served as its Executive Director from MAB's 2007 founding through to 2015. She is now a Wilson Center Senior Fellow[18]. She is notable for highlighting the multiplicity of factors involved in climate change and its effects, especially on women. But particularly relevant to this paper is the fact that she played a special role in translating this multiplicity for military leaders by describing climate change as a "threat multiplier."

This conceptualization spoke to their concern for security threats and helped them understand why climate change is an immediate crisis rather than a subordinate issue to be dealt with in coming decades. A "threat multiplier" exacerbates virtually all other national security threats (Banerjee, 2018). As Columbia University Earth Institute Political Scientist Mark Levy put it, Goodman "brought the generals and admirals around to seeing that environmental security was connected to national security...It took the wind out of the sails of a lot of climate denialists" (in Vergano, 2015). Goodman helped the defense community understand the implications of trends they had already been warned about internally, such as via the 2003 paper on "Abrupt Climate Change" commissioned by the Pentagon's Net Assessment team under Andrew Marshall.

This kind of comprehensive research has continued. Recent surveys indicate that since 2010 the US Department of Defense has published at least 35 reports that explicitly analyze the national security and other implications of climate change. Moreover, the interest has broadened to the larger US intelligence community, which has undertaken over 10 major studies. A recent article on these initiatives argues that "these national security reports, and related comments by prominent military officials, reflect a consensus among national security stakeholders that climate change is a critical national security issue" (Melton, 2018).

18) Sherri Goodman's bio is available at the Wilson Centre website: https://www.wilsoncenter.org/person/sherri-goodman

A good example of the quality of the research emerging from US national-security sources is seen in the CNA's 2017 study on "The Role of Water Stress in Instability and Conflict" (CNA, 2017). The work is careful to note that there are no simple causative relationships between water-stress and conflict. Rather, it highlights how water stress can lead to secondary effects, including migration, that in turn exacerbate the danger of conflict. The CNA rightly refer to this as "hydro-political tensions and conflict." And they are particularly concerned about the role that water shortages can play in hastening the already evident global trend towards expansion of megacities with poor capacity to address basic needs (CNA, 2017).

As of this writing, the most recent assessment of climate change's national security implications for the United States was published in the November 23, 2018 Fourth National Climate Assessment Volume II (hereafter "NCA４ Vol II")[19]. NCA４ Vol II derives from the US Global Change Research Act of 1990. The Act "mandates that the U.S. Global Change Research Program (USGCRP) deliver a report to Congress and the President no less than every four years that '１) integrates, evaluates, and interprets the findings of the Program...; ２) analyzes the effects of global change on the natural environment, agriculture, energy production and use, land and water resources, transportation, human health and welfare, human social systems, and biological diversity; and ３) analyzes current trends in global change, both human-induced and natural, and projects major trends for the subsequent 25 to 100 years'" (USGCRP, 2018).

The 1,656 pages and 29 chapters of NCA４ Vol II cover the full range of issues, starting with the science of climate change, its impacts, and the options for mitigation and adaptation. In terms of sheer numbers of participants, the NCA４ Vol II is more collaborative than the IPCC SR15, which was prepared by 91 authors from 40 countries (IPCC, 2018). NCA４ Vol II was compiled by a team of over 300 United States federal government and non-federal experts. The latter include representatives from state, and local governments, tribes and Indigenous communities, national laboratories, universities, and the business sector. The process of writing the NCA４ Vol II was not as international as IPCC SR15; but building on previous iterations, NCA４ Vol II deliberately addressed the international impacts of climate change. NCA４ Vol II also emphasized the interconnectedness of climate impacts and how they can

19) The entire United States Fourth National Climate Assessment Volume II is available at the following URL: https://nca2018.globalchange.gov

lead to cascading failures in such critical infrastructures as the power sector.

Chapter 16 of NCA４ Vol II is titled “Climate Effects on U.S. International Interests,” and directly takes up the question of climate change, migration and conflict. The American military has bases in nearly every region of the globe, and is deeply involved in humanitarian assistance and disaster response. So NCA４ Vol II Chapter 16 first addresses the climate hazards for US military assets, and then turns to the broader challenges. It concedes that “[d]irect linkages between climate-related stress and conflict are unclear, but points out that “climate variability” has been shown to affect conflict through intermediate processes, including resource competition, commodity price shocks, and food insecurity.”

Though NCA４ Vol II projections of temperature changes are considerably less than those reviewed by “Abrupt Climate Change” (and warned of by climate scientists critical of IPCC SR15), it appears to maintain the overall approach of net assessment. NCA４ Vol II thus cuts through methodological squabbles by pointing out that “[t]he potential for conflict increases where there is a history of civil violence, conflict elsewhere in the region, low GDP or economic growth, economic shocks, weak governance, and lack of access to basic needs.” NCA４ Vol II highlights several examples in this regard, showing how climate change effects act as a threat multiplier that can overwhelm the governance and other elements of political stability: “droughts around the world in 2010 contributed to a doubling of global wheat prices in 2011 and a tripling of bread prices in Egypt. This and other factors, including national trade policy and poverty, contributed to the civil unrest that ultimately resulted in the 2011 Egyptian revolution. While the 2010 droughts were not the sole cause of the revolution, they contributed to destabilization of an already unstable region. Likewise, drought in Somalia has forced herders to sell livestock they could not provide for, reducing their incomes and leading some to join armed groups. Water scarcity and climate-related variations in water availability can increase tensions and conflict between countries. In these and other instances, conflict was related to stress from climate-related events, but non-climatic factors also had an important role.”

Human migration is another potential national security issue. Extreme weather events can in some cases result in population displacement. For example, in 1999 the United States granted Temporary Protected Status to 57,000 Honduran and 2,550 Nicaraguan nationals in response to Hurricane Mitch. In 2013, more than ４ million people were internally displaced by Typhoon Haiyan in the Philippines, and the United

States committed 13,400 military personnel to the relief effort. Six months after Typhoon Haiyan, more than 200,000 people remained without adequate shelter. While neither Hurricane Mitch nor Typhoon Haiyan was solely attributable to climate change, tropical cyclones are projected to increase in intensity, which would increase the risk of forced migration. Slower changes, including sea level rise and reduced agricultural productivity related to changes in temperature and precipitation patterns, could also affect migration patterns (Smith et al., 2018).

This interdisciplinary, multi-factor analysis of climate change, migration and conflict is in the tradition of net assessment. We have also seen that much of this analysis is couched in a national-security discourse, one wherein climate change is represented as a "threat multiplier." This "securitization" of the climate debate raises it from an environmental or political issue to the level of an existential threat. There is much debate over whether it is useful to frame climate change in this way (Peters and Mayhew, 2016; Scott, 2012). Some critics regard securitization to be a profound threat. In the words of one author, it drives a trend to "decentralize and expand the security society by replacing the nation-state collective fantasy of national security with the new planetary ecological-state collective fantasy of natural security" (Marzec, 2016). But this assertion seems exaggerated in light of how securitization and net assessment have led to broader attention to the range of climate change drivers and impacts.

Linear to Non-Linear

As noted in the introduction, Peter Maurer, the president of the Red Cross, is emphatic about the relationship between accelerating climate change, increasing migration and the risks of conflict. Maurer's use of the term "perfect storm" of course derives from the 2000 movie of the same name. The movie focuses on a collision of meteorological factors that give rise to a profoundly large storm, which in turn produces an enormous rogue wave, meaning one over 30 metres. The "perfect storm" phrase is apt not just because we are seeing migration and conflict crises unfold and worsen in real time, threatening lives and impacting politics across the developing world. The phrase is apt because for a long time rogue waves were thought to be the fantasies of the numerous mariners who had reported them over the centuries. The scientific problem was that prevailing theory—linear theory—held rogue waves to be

virtually impossible, due to the models and math of wave science. These models insisted that at best, a 30 metre wave might be expected once every 30,000 years. But in recent years, satellite evidence of multiple rogue waves compelled experts to shift away from linear theory to non-linear theory (Fleming, 2017).

In fact, this problem is common throughout academe, whether it be plate tectonics, quantum mechanics, financial crises, and other areas of new discoveries and/or fat-tail extremes (Haldane and Turrell, 2018; Merritt, 2000; Nicola, 2018). The lesson from this history is that the hard and soft sciences are often slow to recognize reality, even in the face of ample empirical data. Over the past 15 years, concerns that climate change is an immediate problem, and accelerating, have moved from the margins to the mainstream. That progress is one reason for the IPCC's 2018 work, IPCC SR15, discussed earlier in this paper. At present, concerns that accelerating climate change may be exacerbating migration and conflict are moving from the margins. It seems very likely that this conceptualization will become mainstream, as data collection becomes more sophisticated and precise and multi-disciplinary studies become more bold. That appears to be where the field is going, driven by the evidence. "Common sense" and the "conventional wisdom" can shift quite rapidly under the weight of fact, but the role of institutional and ideational inertia should never be underestimated.

Indeed, the warnings of Peter Maurer, the president of the Red Cross, do not reflect the mainstream view in academic studies on migration and conflict. We have seen that there is lots of disagreement and uncertainty, about impact, numbers and what to do to mitigate oncoming crises. This uncertainty has led to a generalized academic reluctance to address the big picture in favour of more restricted case-study types of analyses.

These analytical shortcoming trend appears to be confirmed elsewhere. A 2018 meta-survey paper on health and existential risks to civilization suggests there has been a retreat from integrated analyses to more disciplinarily-bounded approaches. The paper proposes various reasons, both institutional and ideational.

As to the former, the paper suggests that one problem is "the fragmentation of science and limited funding for multidisciplinary work. Comparatively few authors other than if collaborating in large multidisciplinary teams (rare for most authors primarily concerned with health), are rewarded or funded for thinking systemically. This problem is possibly worsening. Related to this many recent papers are by sub-disciplines of health that have not previously published on the topic of climate change.

Such papers are probably less likely to discuss existential risk" (Butler, 2018).

But institutional factors may be exacerbated by perceptions of what is acceptable. In this regard, the author moots that researchers may be inhibited by what has been dubbed "scientific reticence" and "erring on the side of least drama" (on these, see Peacock, 2018). Thus, the survey's author refers to a powerful ethic in climate-related research that sufficient room must be left for hope, lest expert and general publics be paralyzed by fear: "Another likely contributor to the comparative degree of restraint is the view, backed by some research that an excess of fear is counter-productive. However, the smell of smoke in a theater requires the sounding of a vigorous alarm. Compounding the difficulty of communicating the risk over climate change is the lag between the whiff of smoke and the onset of visible fire" (Butler, 2018).

The author warns that this approach, of downplaying the emerging evidence of "extraordinary risks" from climate science, in turn hazards failing in "the duty of care to protect health" (Butler, 2018). The US Center for Disease Control produces a generalized template of the effects of increased humidity and other climate changes on disease incidence. It warns that accurate projections of the disease burden are essential for formulating plans and mobilizing adequate resources (CDC, nd). Moreover, emerging work on the psychological effects of climate change suggest that its effects (such as higher temperatures and precipitation) already take a measurable toll on mental health (Obradovich et al. 2018). Hence, there are many hazards to downplaying the risk of increasingly rapid onset climate effects. These risks include a lack of preparedness in resilient critical physical infrastructure but also in such essential social infrastructure as health services.

An additional area where existential risks go unexplored is the link between food crises, migration and conflict. This hiatus is surprising and disconcerting, because there is abundant evidence that the growth in productivity of global agriculture is falling at the same time as soil erosion is increasing, phosphate reserves are strained, and other challenges are mounting (Grantham, 2018). In this context, Sadliwala and de Waal, specialists on migration, food crises, and conflict, sought to investigate the volume of interdisciplinary work in the field. They assessed the research volume by undertaking a search via Google Scholar, and found that the terms "famine" and "migration" yielded approximately 150,000 results. They then investigated the results, and determined that very few were relevant. After clearing away the non-scholarly items, they were left with only 35 articles, books, and chapters (8 percent

of overall results) that examine the relationship between famine and migration. And within this literature they found little to work with, due to an inordinate diversity in the scope of studies and methodologies deployed. They determined that "[s]cholars are overwhelmingly focused on the impact famine has on mortality, fertility, and refugee assistance, and not the how, when, who, and so what of the famine–migration nexus" (Sadliwala and de Waal, 2018).

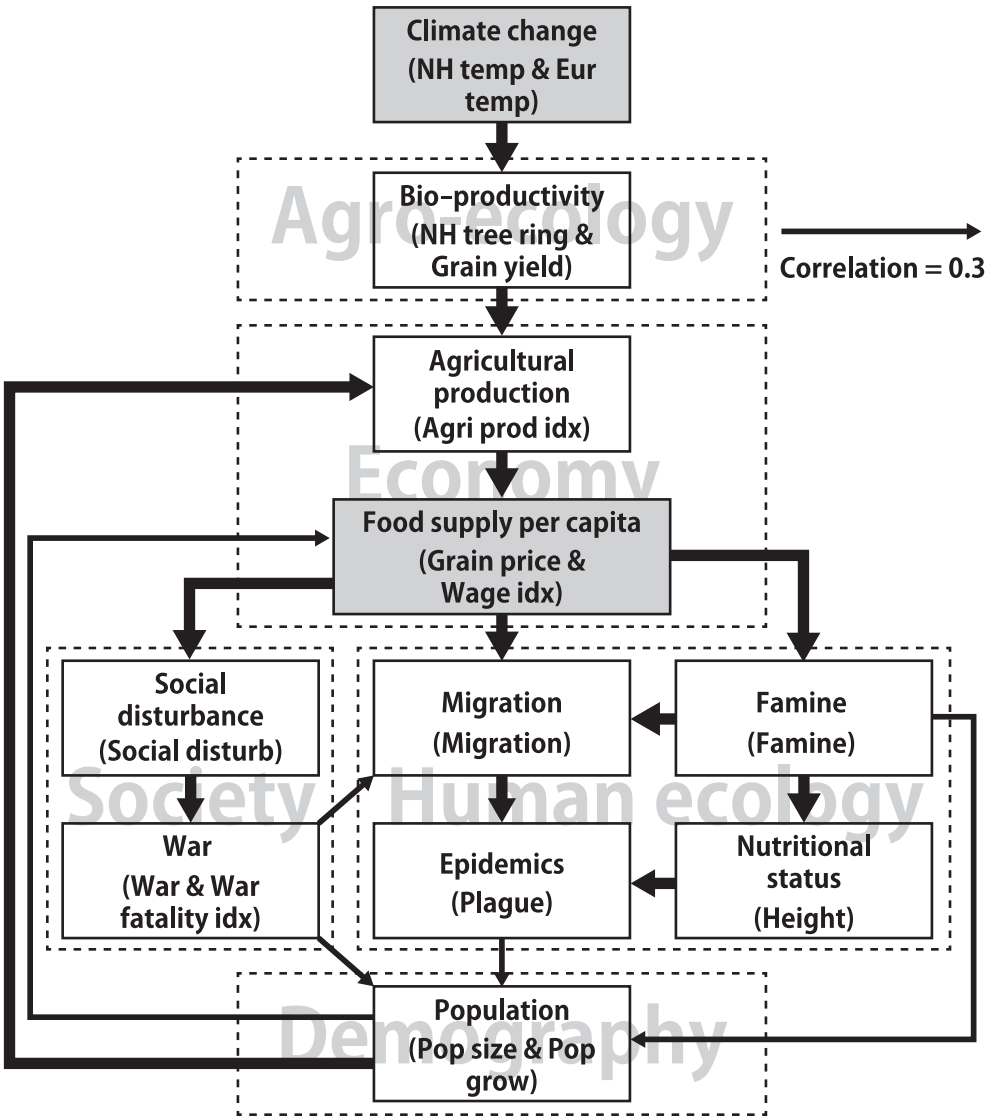
Jeremy Grantham offers another indicator of the crippling effect of disciplinary siloes. Grantham investigated hurdles confronting increased global agricultural productivity, which is essential to meeting the food needs of an expanding global population and its dietary shifts. Grantham warned that "[w]e face two increasing problems that seem likely to push productivity backwards: soil erosion and climate change. As we dug into these two problems, we quickly discovered a third: the giant seams that can run between different branches of science. Starting with erosion, we spoke to several soil scientists who specialized in erosion who were not aware that future climate change would materially affect erosion even though, as previously mentioned, the single most dependable feature of climate change is an increase in the very heavy downpours that do almost all the erosion damage—with 5- to 10-foot gullies sometimes appearing overnight in the great storms in Iowa and Kansas" (Grantham, 2018). Considering the existential stakes, this lack of communication among soil scientists is incredible. It highlights a profound failure of governance in the face of profound fat-tail risks.

Interdisciplinary Research

The above examples suggest a clear need for multi-factor, interdisciplinary work. This research could do well to learn from the "threat-multiplier perspective" that has been diffusing among US national security specialists and the military agencies. Migration and conflict are dependent variables that are influenced by a wide range of independent and intermediate variables, such as rates of urbanization, agricultural productivity, and the like. Research needs to examine causality among them, as they influence the dependent variable, or outcome. And the accumulating evidence of non-linear climate change suggest that it would be useful to factor in time.

One example of this kind of work is seen in Zhang et al. (2011), the source of **figure 18**. Zhang et al. examined 3 centuries of climate change, during the Little Ice

Age, and crises in Europe. Their research found a complex pattern of causal linkages, as displayed in the figure. In their analysis, climate change impacts agriculture and other elements of bio-productivity, impacts that vary by the speed and scale of change and the vulnerability of the local ecology.



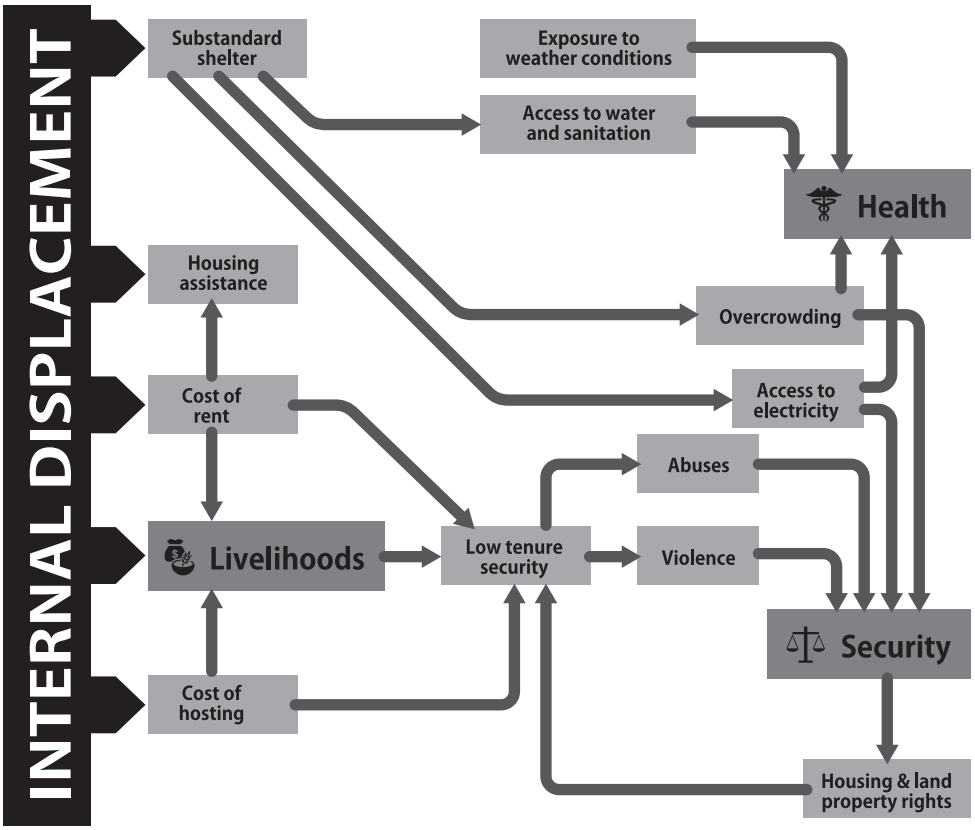
Source: Zhang et al., 2011

Figure 18 Multi-Factor Analysis of Causation in Climate Change, Migration and Conflict

In other words, climate change's effects on migration are mediated by local factors. They argue that "climate change and associated bio-productivity fluctuation are revealed as the ultimate cause of economic, social, human ecological, and demographic problems." They also offer a warning to contemporary policymakers and publics: "Any natural or social factor that causes large resource (supply) depletion, such as climate and environmental change, overpopulation, overconsumption, or nonequitable distribution of resources, may lead to a general crisis, according to the set of causal linkages... The scale of the crisis depends on the temporal and spatial extent of resource depletion." The above work was also confirmed in Hsiang et al. (2013), whose meta-survey of research data-sets that stretch across disciplines and timeframes (including paleoclimatology) showed that climate change and conflict are quantitatively related. Hsiang et al. (2013) therefore conclude that global mitigation and adaptation initiatives are urgently required. Grantham's work on the multiplicity of contemporary challenges, especially in the agricultural sector, also suggests that the above warning deserves very close attention (Grantham, 2018).

These concerns were echoed in the March 2018 World Bank Report, Groundswell: Preparing for Internal Climate Migration (Rigaud, et al. 2018). The report focuses on the three regions of Sub-Saharan Africa, South Asia, and Latin America. Together, these three regions compose 55% of the developing world's population. The World Bank's investigation warns that climate change is likely to push tens of millions of people to migrate within their countries by 2050. It projects that without concrete climate and development action just over 143 million people, or around 2.8% of the population of these three regions, could be forced to move within their own countries to escape sea-level rise, salinification, and other slow-onset impacts of climate change. The authors project that these migrants will move from areas with lower water availability and crop productivity in addition to areas affected by rising sea level and storm surges. Their research also forecasts, not surprisingly, that the poorest and most climate vulnerable areas will hit hardest by these variables. The report warns that "[t]hese trends alongside the emergence of 'hotspots' of climate in- and out-migration will have major implications for climate-sensitive sectors and for the adequacy of infrastructure and social support systems." Using even conservative estimates on climate change drivers, the report finds that internal climate migration will likely rise through 2050, to tens of millions of people, and then accelerate. In order to mitigate these outcomes, the report calls for "significant cuts in greenhouse

FIGURE 5: Selected links between internal displacement, housing and infrastructure, as highlighted in the literature



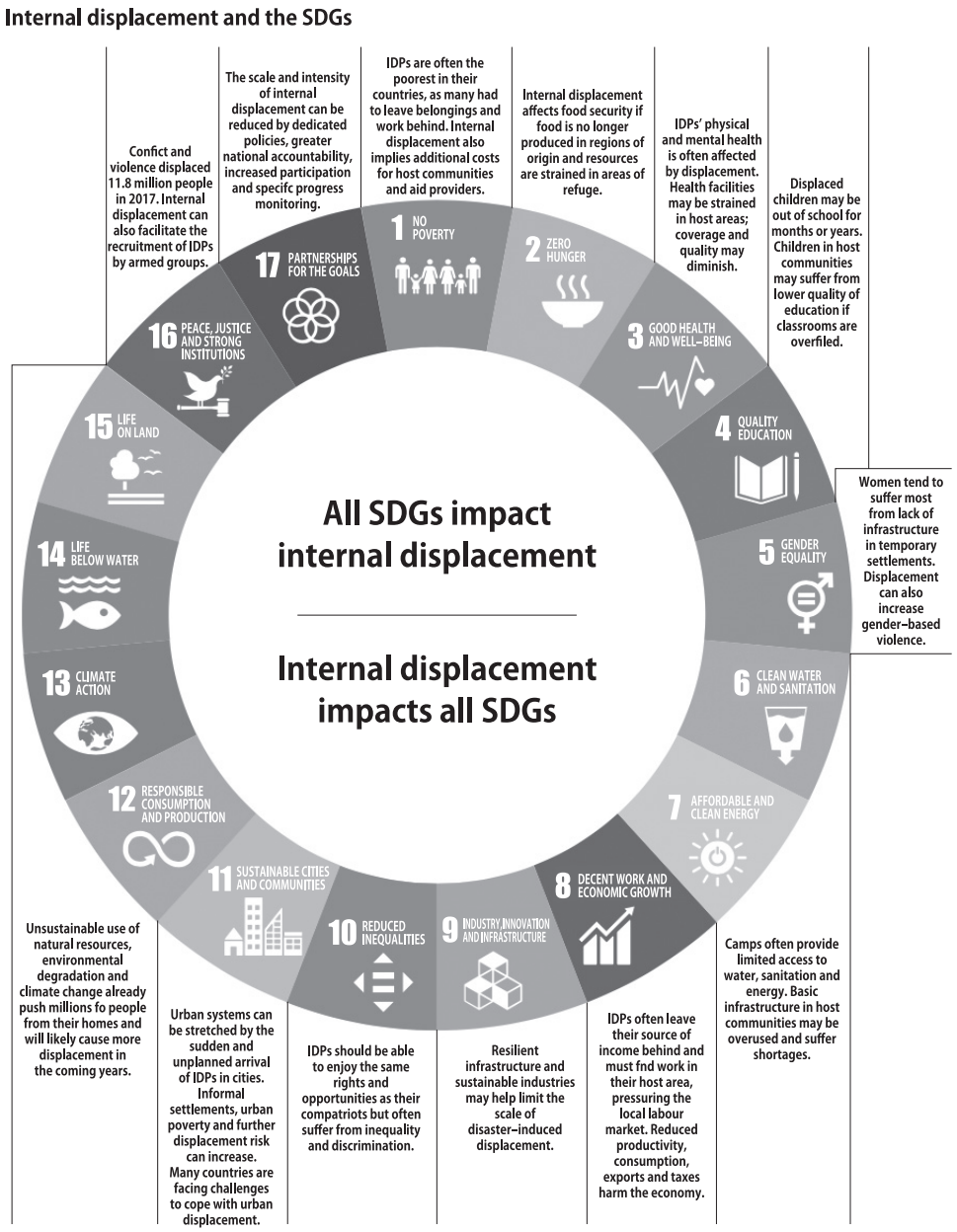
Source: Wallemacq and House, 2018

Figure 19 Multi-Factor Causation Migration and Conflict

gas emissions and robust development action" (Rigaud, et al. 2018).

Figure 19 is one indicator of the complexity of negative outcomes the World Bank's research warns of. The figure shows that internal displacement leads to a host of changes in livelihoods, health, security and other items, with violence incorporated in the larger "security" category. These influences and outcomes will almost certainly involve tens of millions, if not hundreds of millions, of people. The causal link with conflict is certainly not precisely predictable, but the scale of risk (especially the fat-tail risk) is already deeply worrisome to a range of experts and institutions with global reach. The growing consensus among these experts and agencies is that sustainable and resilient local development is imperative.

This perspective was reflected in a 2018 research report by the Swedish International Development Cooperation Agency (SIDA). The report is titled "The relationship between climate change and violent conflict." It argued that "[t]here seems to



IDMC: 2018

Figure 20 Internal Displacement and Sustainable Development Goals

be a consensus in the research community that there is no direct relationship between climate change and the eruption of violent conflicts, particularly extensive inter- and intra-state conflicts. This is a conclusion also officially endorsed by the IPCC. Sequences of events leading to outbreaks of violence are always multifactorial and complex and it is usually not possible to identify single triggering factors." In other words, the report points out that at present there is complexity in causality. But complexity in causality does not mean the absence of causal linkages. For that reason, it suggests coping through integrated and comprehensive management, as the "interaction of climate-related phenomena means that they cannot be managed as single issues by actors who function independently of each other" (Scharr, 2017).

Because of complexity, an integrated approach to resolving or at least alleviating the crises is needed. As highlighted in **figure 20**, SDGs are focused on this integration. The figure shows that all of the goals are affected by internal displacement and the goals in turn affect internal displacement.

New research on resilient infrastructure backs up this view. It highlights resilient infrastructure as crucial to realizing SDGs and helping people stay in place or move from rural areas to safer, healthier cities. These are no-regret pragmatism: in the face of academic uncertainty about the precise links between climate change, migration and conflict, there can be no doubt that providing kids with clean water and other public goods will alleviate the perfect storm and its rogue waves.

For example, in October of 2018 Oxford University and the United Nations Office for Project Services produced a report on the crucial role of resilient infrastructure (Thacker, et al., 2018). They place infrastructure investments in a mix of critical public goods. These latter include investments in health, education and food security, realized by climate-smart agriculture and sustainable management of water resources. They also highlight the role of renewable energy and other infrastructure. The concept also includes such governance infrastructure as "market systems with financial services that facilitate diversified and less vulnerable livelihoods" (Thacker, et al., 2018).

One warning about ongoing trends in funding this kind of mitigation has been expressed in the Global Humanitarian Assistance Report, 2018. Its surveys of assistance indicate that "[a] greater proportion of official development assistance (ODA) is being spent as humanitarian assistance. Although both show an upward trend from 2007, the level of humanitarian assistance within overall ODA is growing faster (at

124% since 2007) than overall ODA (at 41% since 2007). Increased volumes of humanitarian assistance to the 20 largest recipients have not been matched by investments of non-humanitarian ODA" (Development Initiatives, 2018). In order words, investments are focused on effects rather than causes.

Resilience and the Japanese Paradigm

In the face of such enormous uncertainty and fat-tail risks, agencies have increasingly emphasized "no-regrets" solutions by building resilience in affected areas (eg, van Schaik and Bakker, 2017). Moreover, cognitive psychologist Steven Pinker (2018) highlights the fact that bringing in multiple solutions to the wicked problem of climate change helps to broaden the consensus that the problem exists and must be dealt with. Pinker concedes that this cognitive bias is irrational because "how you solve a problem is independent of whether a problem exists." But it appears that the resilience paradigm can help overcome tribalism and galvanize a broad mitigation/adaptation coalition[20].

The Intergovernmental Panel on Climate Change's Fifth Assessment Report (hereafter, "IPCC AR５")[21] section on human security identifies "Critical infrastructure and state capacity" as a major concern. IPCC AR５ points out that "[c]limate change and extreme events are projected to damage a range of critical infrastructure, with water and sanitation, energy, and transportation infrastructure being particularly vulnerable. Climate change is expected to exacerbate water supply problems in some urban areas that in turn pose multiple risks to cities" (Adger, Neil W. and Juan M. Pulhin, et al., 2014).

Japan would appear to offer lessons in governance and the integration of technology, to help cope with the underlying crisis. The country has long been engaged in bolstering human security through disaster risk reduction. The UNISDR's 2015-30 Sendai Framework on Disaster Risk Reduction[22] is heavily informed by Japanese ex-

20) Harvard University Professor of Psychology Steven Pinker's comments can be found at 20:00-26:15 of the November 11, 2018 "Climate One" podcast on "Are Human Lives Improving" : https://climateone.org/audio/are-human-lives-improving

21) The Intergovernmental Panel on Climate Change's Fifth Assessment Report (AR５) was published in 2014 and is available here: http://www.ipcc.ch/report/ar5/

22) An overview of the United Nation's Office for Disaster Risk Reduction (UNISDR) Sendai Framework is available here: https://www.unisdr.org/we/coordinate/sendai-framework

pertise and experience (DeWit, 2017). And Japan's JPY 4 trillion-plus program of National Resilience strongly expresses the governance and other goals of the Sendai Framework. Japan's approach is hardly sufficient to cope with climate threats to human security . Japan affords some important, overlooked lessons in integrating hard and soft infrastructure for no-regrets solutions. Japan's approach maximizes the number of stakeholders and co-benefits, fostering pragmatic collaboration and bolstering human security.

Since 2014, Japan's imperative of resilient adaptation, for lifeline infrastructures (water, communications, transport), has become institutionalized in a variety of new commissions and agencies, including the National Resilience Promotion Office[23]. The policy is also inscribed in an expanding portfolio of national and subnational "National Resilience" plans that have legal precedence over other plans[24].

As of August 1, 2018 the Japanese central government's National Resilience umbrella programme is also matched by local programmes in all 47 prefectures and 135 cities and towns[25]. Also, these numbers are growing, fostered by local collaboration and other means to diffuse the programme and facilitate its adoption by cash-strapped and people-poor local governments.

The resilience budgets are also quite large. The initial budgets between FY 2014 and 2018 are over JPY 3.5 trillion[26]. In 2018, spending requests accelerated, driven by unprecedented disasters (McKirdy, 2018) and other factors. The JPY 4.89 trillion request for FY 2019, when coupled with the inevitable supplementary budgets and expanding tax breaks[27], may see Japan spend more on resilience than the JPY 5.5 trillion requested for national defence[28]. This relative cost calculation for resilience versus national defence is especially important, because Japan is under pressure—

23) An overview of some of the agencies and commissions is available (in Japanese) at: https://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/

24) The central government's National Resilience plans for 2014-2018 are available (in Japanese) here: https://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/kihon.html

25) Links to Japan's subnational National Resilience plans are available (in Japanese) here: https://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/tiiki.html

26) The 2014-2019 National Resilience budgets are available (in Japanese) here: https://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/yosan.html

27) A summary of the FY 2019 proposed tax reductions and exemptions is available (in Japanese) here: https://www.cas.go.jp/jp/seisaku/kokudo_kyoujinka/pdf/h31zeiseikaisei_gaiyou.pdf

28) Japanese defence spending, whose 1% of GDP level is low relative to the US (3.1%) and EU countries' general average (1.3%) , gets overwhelming media attention, whereas its resilience

especially by its American ally—to spend increasingly more on national defence. The US Administration of President Donald Trump insists that Japan raise its 2018 level of defence spending from roughly 1.0% of GDP to the NATO commitment of ２% of GDP (Nikkei, 2018)[29].

Japan's National Resilience programme is evolving into full-fledged industrial policy. The focus of National Resilience increasingly centres on information technology (ICT), the internet of things (IoT), and artificial intelligence (AI). It aims to smarten power, water, communications, transport and other critical infrastructure as well as network them together. It is also deliberately linked to SDGs, in order to expand its potential as a means for international engagement. The most comprehensive and recent discussion of this use of smart technology is available (in Japanese) in Kashiwagi Takao's *Super-Smart Energy Society 5.0*, published on August 27, 2018 (Kashiwagi, 2018). An example of how smart technology is used in National Resilience is seen in the development and deployment of advanced radars for bolstering meteorological data against extreme weather. These next-generation radars give rapid and pinpoint advance warning of impending rainfall. That situational awareness allows water managers to adjust dams, river protections, sewerage systems and other critical infrastructures to cope with the hydrological challenges. Tokyo Metropolitan Government's (TMG) sewerage division has already deployed this integration of technology. TMG uses advanced radar and monitoring technologies to manage its 16 million meters of pipes that move 2.2 million cubic metres of water per day (TMG, 2017). TMG's use of advanced radars and other technologies can also be viewed in videos (in Japanese) produced by TMG and TV Asahi, and released between June 11 and 15 of 2018[30].

There are profound hydrologic and topographical reasons that Japan's National Resilience focuses on such challenges. Japan receives double the global average of rainfall, in increasingly concentrated bursts. Fully 70% of the country is mountainous, and nowhere in Japan is more than 150 kilometres from the sea. In consequence,

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investments are either overlooked or derided as pork barrel public works in international media and websites.

29) Note that Japan's calculation of defence expenditures varies if one includes veterans' social security costs. And some of Japan's defence spending is part of the "National Resilience" budget.

30) The link for the videos is available here: https://www.tv-asahi.co.jp/t-site/bk/20180611/index.html

Japan's rivers are very steep and prone to flood. Moreover, 75% of the country's assets and 50% of the population are crowded onto 10% of the land surface, largely flood plains close to the sea (DeWit, 2017). So smart networking of critical infrastructures is literally a matter of life and death, livelihoods, and other key aspects of human security.

The evidence also indicates that Japan's National Resilience initiative is powerfully supported by public opinion. Japan's authoritative "Environmental Consciousness Survey," released in September of 2016, shows that the country's strongest level of consensus for anything related to energy and the environment is the 77.8% support for using public funds to build resilience in the face of climate change[31]. Also, the Tokyo Metropolitan Government's annual surveys of residents' opinions shows that disaster risk reduction (DRR) is frequently the top item of concern[32]. And the *Yomiuri* newspaper confirmed this support in an opinion poll released on September 24, 2018. The poll showed that (in a multi-choice ranking) disaster resilience was the top priority (89%), beating out economic policy (85%) and policies relating to aging and social security (77%)[33].

Moreover, Japan's "Environmental Consciousness Survey" also indicated that there is 68.1% support for using ODA to build resilience in developing countries[34].

As noted earlier, the IPCC AR５ report on human security identifies "critical infrastructure and state capacity" as a major concern. It is especially worried about hydrologic threats, through intense rain, drought, sea-level rise, and other hazards. Japan is increasingly good at linking the soft and hard infrastructures of resilience, through inclusive planning and networking critical infrastructures.

In fact, Japan's National Resilience institutionalizes the Sendai Framework. The Framework stresses the need for "prior investment," so as to build resilience in the face of multiple hazards and reduce their impact. It also argues for "mainstreaming disaster risk reduction," through an inclusive, whole of government approach that

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31) See the chart (in Japanese) on p. 20 of the report: https://www.nies.go.jp/whatsnew/2016/jqjm10000008nl7t-att/jqjm10000008noea.pdf

32) The Tokyo Metropolitan Government annual poll results are summarized (in Japanese) here: http://www.metro.tokyo.jp/tosei/hodohappyo/press/2017/11/09/25.html

33) See (in Japanese) "3rd Election as LDP President," *Yomiuri Shimbun*, September 24, 2018, p. 14.

34) See the chart (in Japanese) on p. 20 of the report: https://www.nies.go.jp/whatsnew/2016/jqjm10000008nl7t-att/jqjm10000008noea.pdf

makes coping with hazards a priority in all planning initiatives. The Sendai Framework calls for "the full engagement of all State institutions of an executive and legislative nature at national and local levels and a clear articulation of responsibilities across public and private stakeholders, including business and academia, to ensure mutual outreach, partnership, complementarity in roles and accountability and follow-up" (UNISDR, 2015)[35] Japan's National Resilience is increasingly implementing that pro-active integration of hard and soft infrastructures. It is also evolving a coordinated framework of central, regional and local capacities and responsibilities in the face of what are unprecedented positive and negative externalities.

Japan's National Resilience is also iterative: it is annually updated and revised, in light of comparatively transparent and comprehensive performance targets. It is also publicly supported, responsive, collaborative, well-funded, and serves to unite innovative capacity on collective problems. National Resilience lacks explicit greenhouse gas mitigation targets, but uses the very real threat of natural disasters and other hazards to reshape energy, environmental, urban, fiscal and related policy regimes. And we have seen that National Resilience has already led to broad collaboration among government agencies, the private sector and civil society . This collaboration is clear from the diverse involvement of NPOs, disaster professionals, local governments, business associations and other stakeholders in drafting the national and local resilience plans. It is also evident in the composition of the 19 working groups that compile sectoral studies (on green infrastructure, fire prevention, landslide countermeasures, underground infrastructure mapping, and other items) within the Association for Resilience Japan[36].

We have seen that climate change is a wicked problem and very likely an existential crisis. To be sure, assessing and addressing climate change, even its impacts on migration and conflict, is fraught with disagreements and distractions. But we have also seen that coalitions can be built on the basis of including a variety of no-regret "solutions" framed in terms of the SDGs. It is unclear whether Japan's National

35) See United Nation's Office for Disaster Risk Reduction (2015), "Sendai Framework for Disaster Risk Reduction 2015-2030," p. 13: https://www.preventionweb.net/files/43291_sendaiframeworkfordrren.pdf

36) The diverse membership of the Association's 19 working groups, together with reports and other details (such as meeting schedules), can be confirmed (in Japanese) here: http://www.resilience-jp.biz/wg/

Resilience paradigm will evolve to deal adequately with the country's domestic challenges, let alone those of more vulnerable countries and regions. But there are few concrete initiatives for bolstering the governance and integrating the critical infrastructures of global cities. And as the CNA and other national security agencies warn, these could increasingly become crucibles for conflict. So the Japanese case offers valuable lessons for how collaborative governance and smart technology can maximize the effective use of constrained fiscal, material, human and other resources, as well as time.

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